- "Challenges and Learning's from Use of Oil Spill Dispersants in Norway"

- Norwegian regulations / requirements

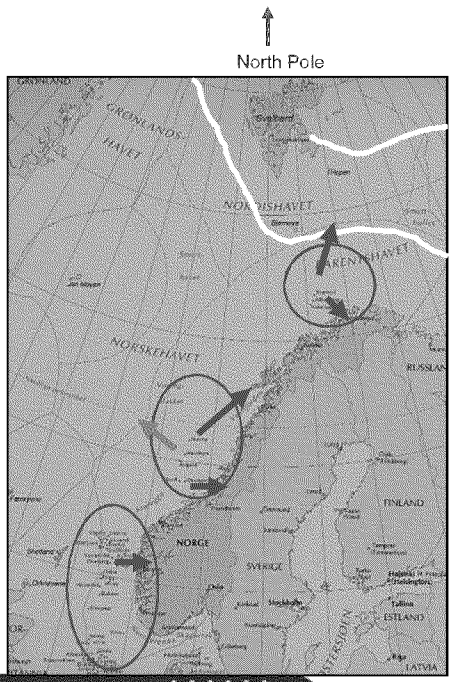
Per S. Daling
Senior Scientist
Marine Environmental Technology Dept.
SINTEF, Trondheim, NORWAY

per.s.daling@sintef.no

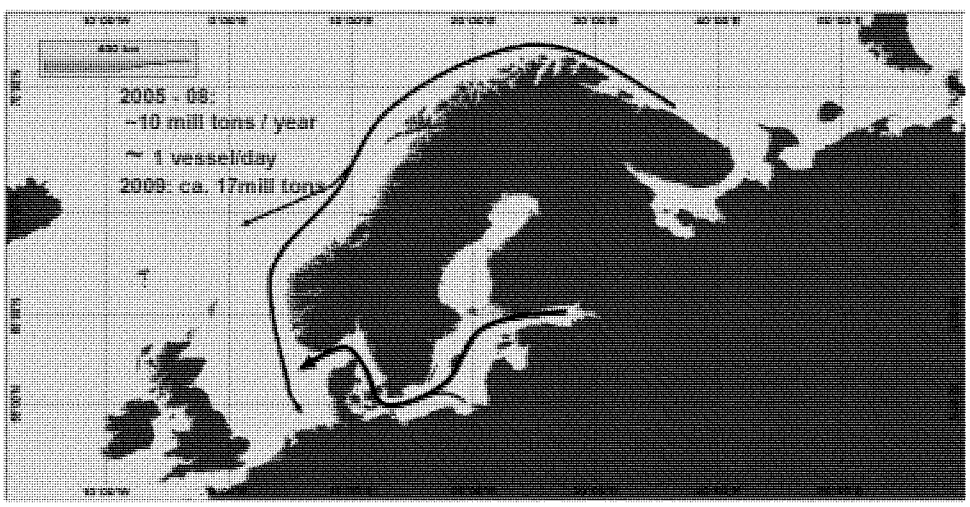
Outline for the presentation

- Intro:
  - Norwegian challenges: offshore oil production / transport along the Norwegian coast
  - Use of dispersants as a response tool in Norway
- Recent experiences in Norway:
  - Developing strategies for application from vessels
  - Operations in darkness (real incident)
  - Operations in ice covered area
- Future R/D needs / Plans at SINTEF (incl. sub-surface injection of dispersants)
- Regulations / requirements for use of dispersants in Norway

Present status for the petroleum industry in Norway

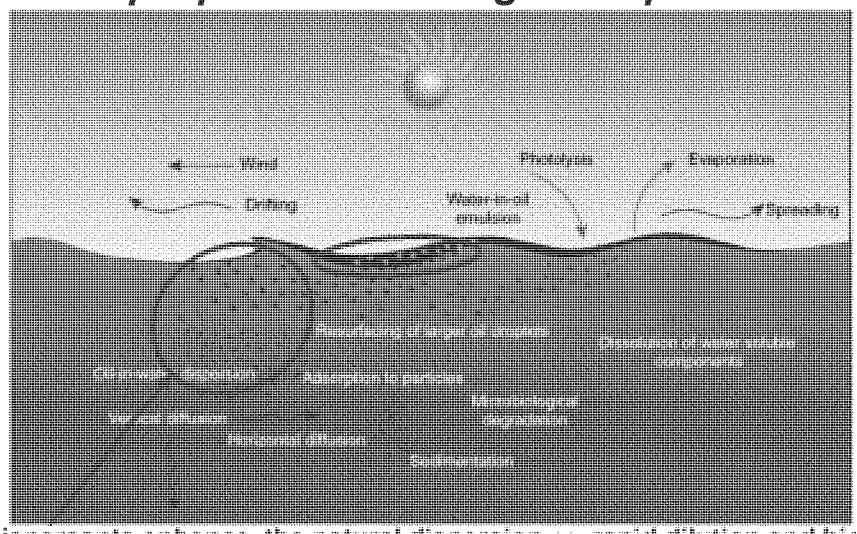


The Norwegian government is concerned about the increased transport of oil in the Norwegian waters



2002: 4 mill tons | 2003: 8 mill tons | 2004: 12 mill tons | 2009: ca 18 mill tons

Weathering processes and the purpose with using of dispersants



- Dispersants enhance the natural dispersion ☐ rapid dilution and bio-degraded by micro-organisms in the water (Oil does not sink to bottom!!)

Critical parameters for obtaining an efficient dispersant response operation :

1. Performance of the dispersant under relevant conditions (salinity, temperature, physical properties etc.)
2. Oils dispersibility: property and weathering degree of the oil at prevailing env. conditions / spill situation
3. Application of the dispersant: Good access and contact to the oil
4. Sufficient energy for the dispersion process

Use of dispersants in Norway

- **Mechanical recovery has traditionally been the primary oil spill response strategy**
- **New regulations for use of dispersants (2002)**

  "Dispersants shall be used in oil spill situations where dispersants are considered to give the overall least environmental damage"

  - require good pre-planned documentation (NEDRA-analysis)
  - Oil industry: preparing contingency plans including planned use of dispersants at: refineries, oil terminals and off-shore fields
  - The State (NCA) is planning to build up a contingency with dispersants along the coast over the coming 3-4 years

Test site for dispersant field trials in Norwegian water

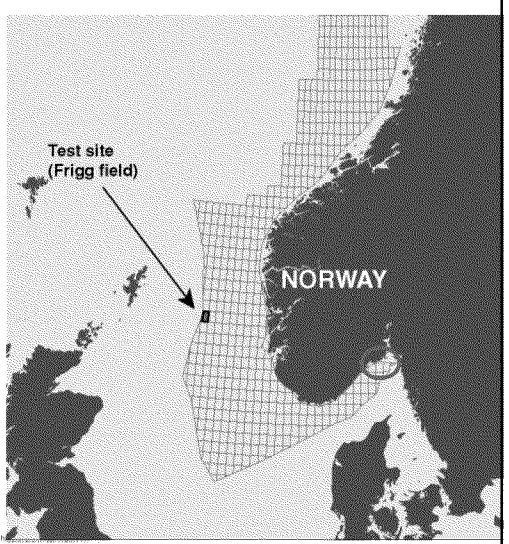
Series of field trials with different dispersant application methods:

- 1982, 1983, 1984, 1989 (boat/ fixed wing)
- 1994, 1995, 1996 (helicopter application)
- 2006: new boat application system
- 2009: novel boat application system, oil in ice

Organized by:

- Norwegian Clean Seas for Operating Companies (NOFO)
- SINTEF: scientific responsible

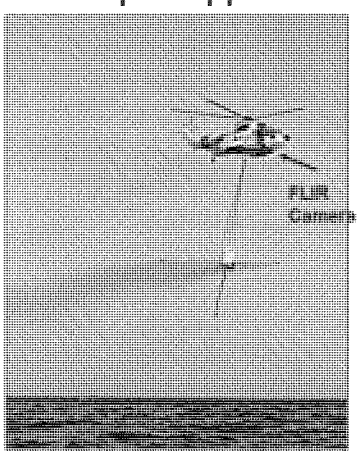
Gained much scientific documentations and operational experiences in use / application of dispersants !



Existing Dispersant Application platforms in Norway

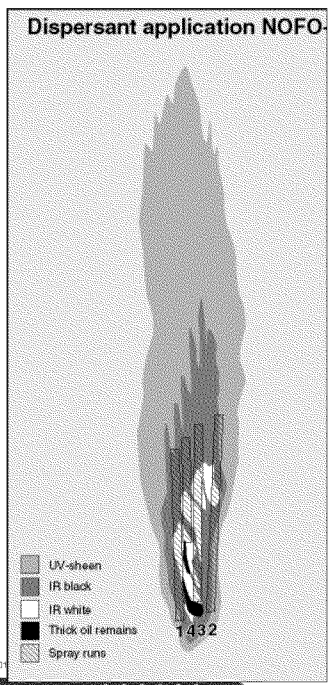
Boat application

Helicopter applications

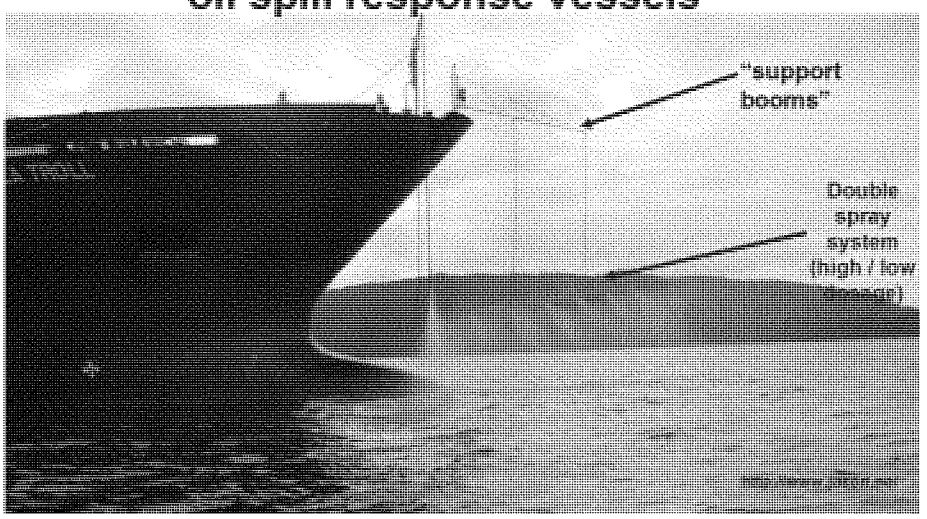


Operational strategy: "targeting" application from helicopter / vessel:

- FLIR - camera: important operational tool for precise application
- Treat the thick part (emulsion) of the slick (in the mm's range):
  - dosage: 25 – 30 USGPA
- Re-treatment - may be necessary for optimal dosage)



New application systems developed for oil spill response vessels



- Application of dispersant on the oil slick ahead the vessel
- Application speed: tested up to 18 knots (in calm sea) □ use on oil slicks spread over larger area

grafisk/admtegner/div-PSD/bonnex-film/thicknessexamples-nov-01.ppt

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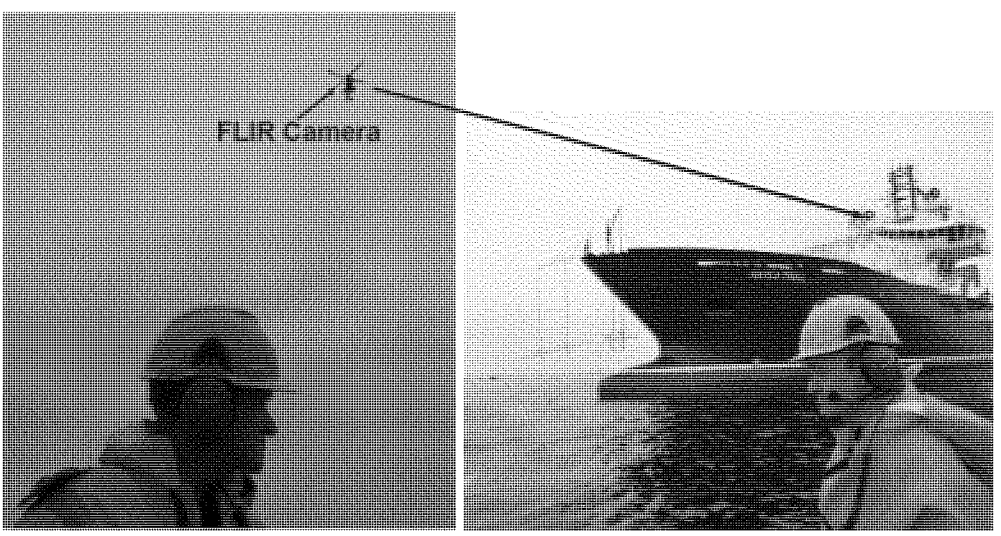
NOFO oil –on water exercise

Down-link of FLIR-video from Helicopter to Spraying Vessel



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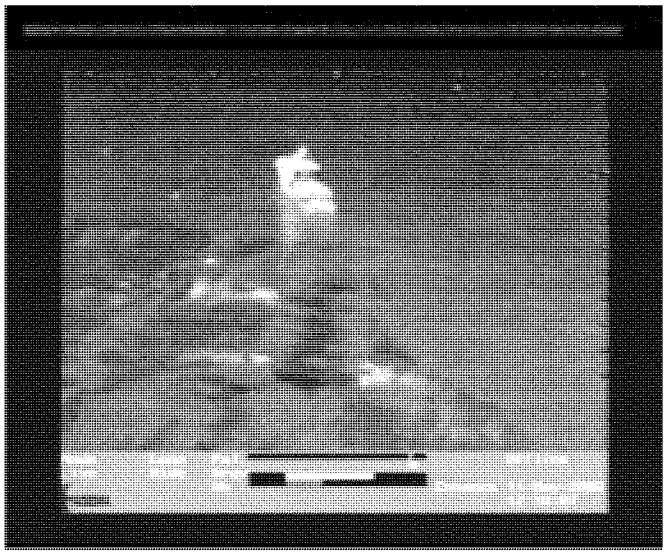
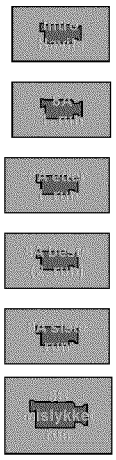
NOFO oil –on water exercise

Down-link of FLIR-video from Helicopter to Spraying Vessel





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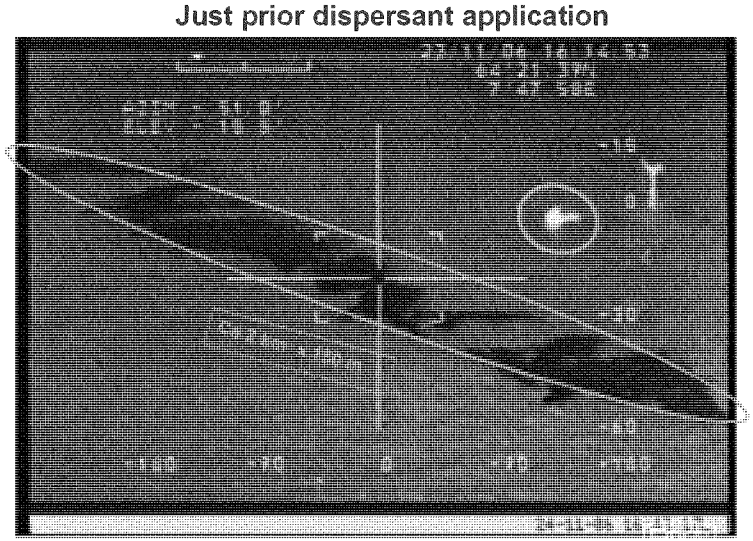
Spill at offshore production installation, late November
Down-link of FLIR-video from helicopter
Identify the area with thick oil in darkness,

Just prior dispersant application



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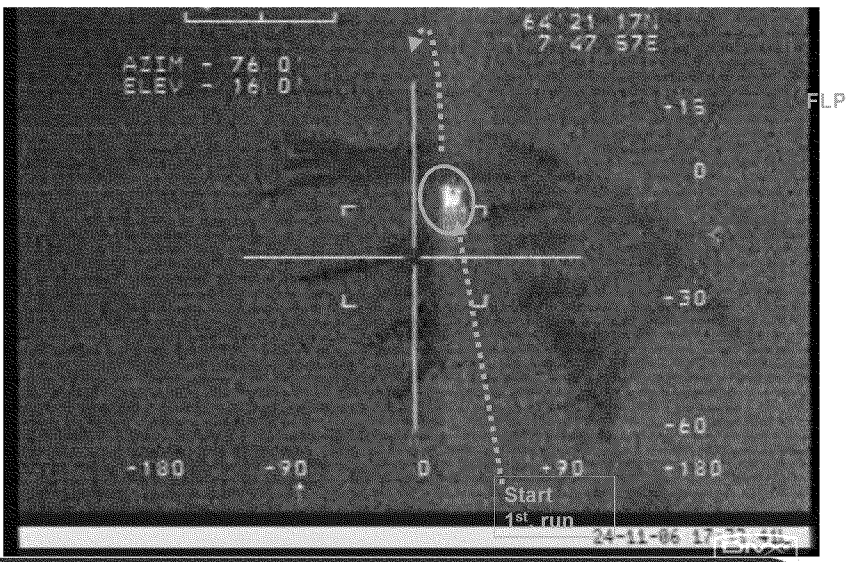
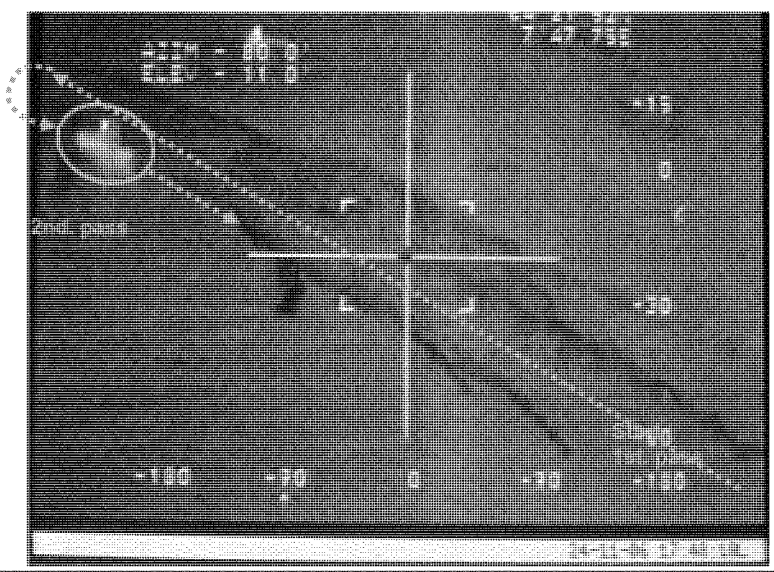
Dispersant application in darkness

During 1st. Pass



Dispersant application in darkness

During 2nd. Pass

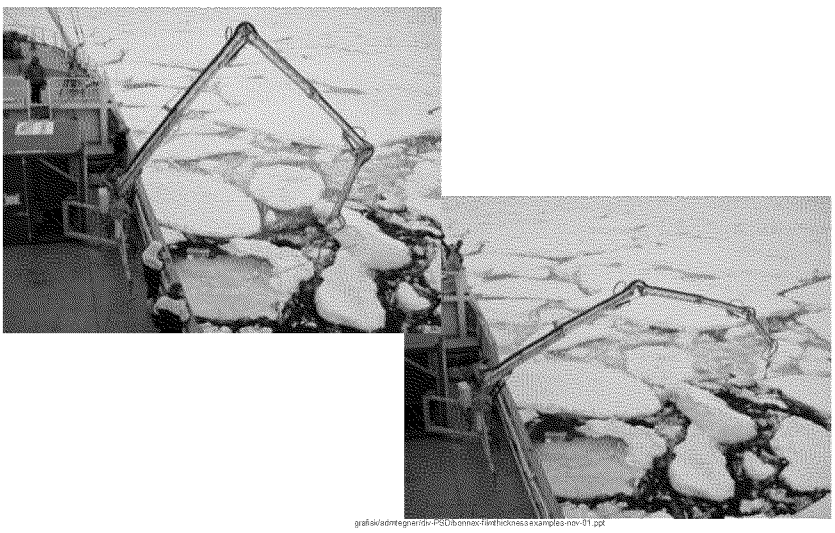


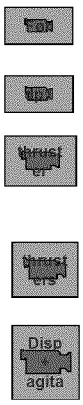
After 3.5 hours spraying operation:

< 5m^3 left on the surface

Oil in Ice JIP - FEX-2009

Novel Spray arm for dispersant application in ice





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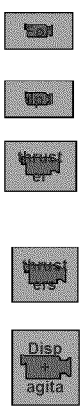
Oil in Ice JIP - FEX-2009

Novel Spray arm for dispersant application in ice

6 days weathering, ca 1000L C-9500/ Dasic applied agitation by Thrusters / MOB-water jet



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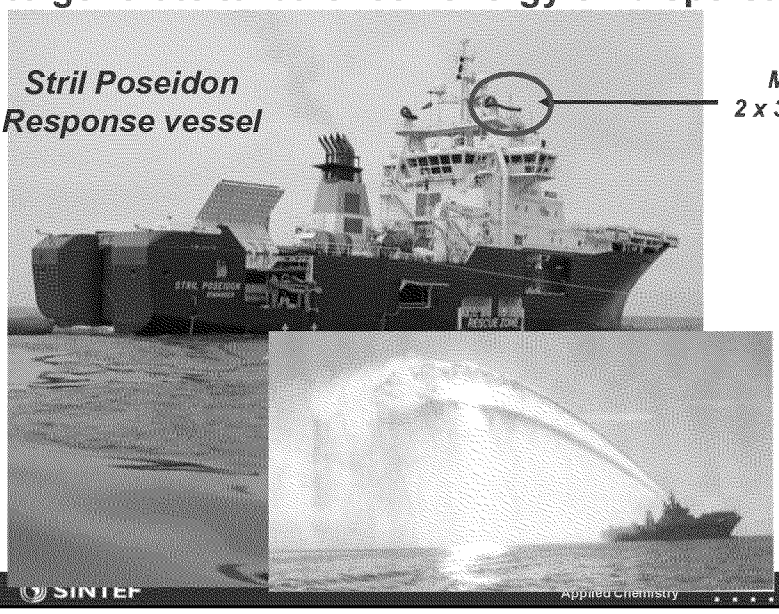
Use of Fi-Fi Monitors to generate turbulence / energy on dispersant treated oil



Monitor capacity:
2 x 3600m³ Seawater / h
= 2 m³ / sec.

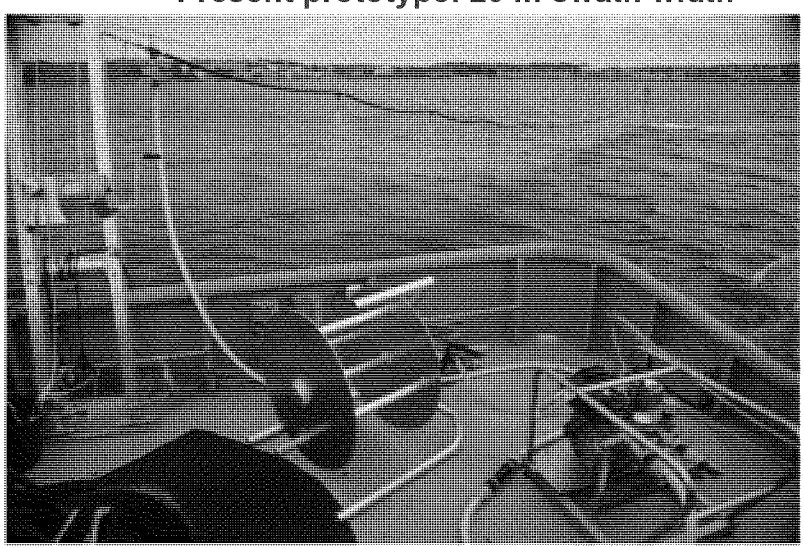
Throw length:
> 230 m

http://www.jason.no/

Ongoing NOFO-2010 R&D program:

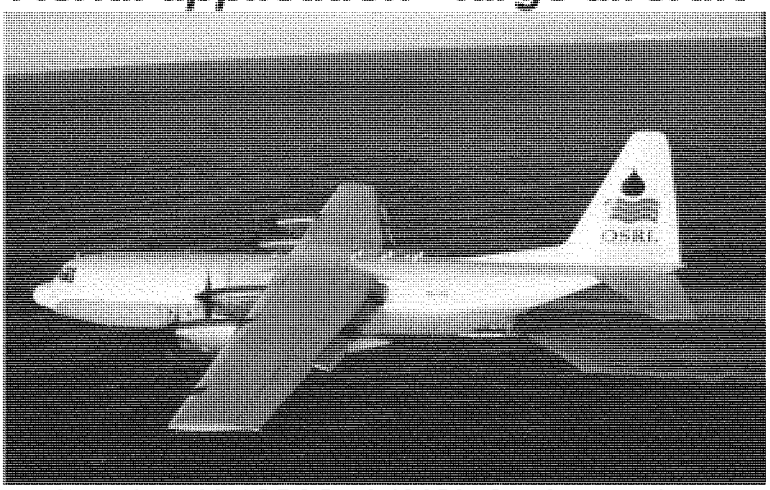
Boom Vane Dispersant Spray System (ORC)

Present prototype: 20 m swath width



http://orc.se

Aerial application - large aircraft



Hercules with ADDS Pack (OSRL, Southampton):
Installation time:< 0.5 hour, Capacity: 21 ton (application rate: 0.4 – 2.2 ton / min)

Exxon Norway / NOFO have agreements with OSR

Aerial application during DWH- incident using Hercules C-130 with "ADDS Pack"

Photo: MSRC

grafisk/admtegner/div-PSD/bonnex-film/thickness-examples-nov-01.ppt

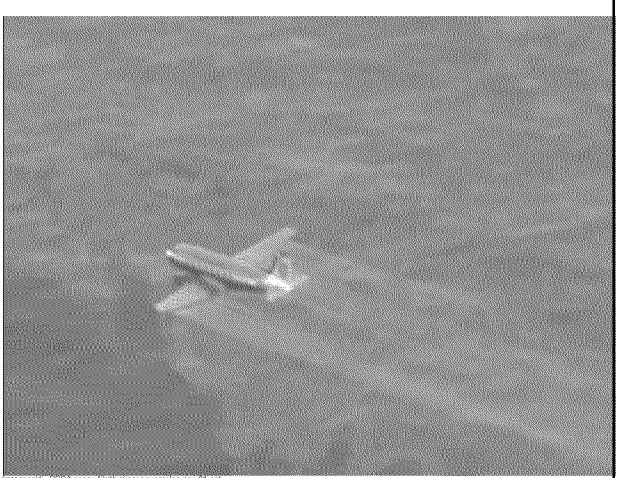
Aerial application during DWH- incident using two Hercules C130 with "ADDS Pack"

Photo: MSRC

Aerial application during DWH- incident

- 5 – 12 spraying fixed-wing aircraft + application from vessels
  Low application rate: 5 USGPA
- Total 4000m^3 applied

SINTEF / S.L. Ross were involved in optimizing the dispersant strategy for the ICP in Houma



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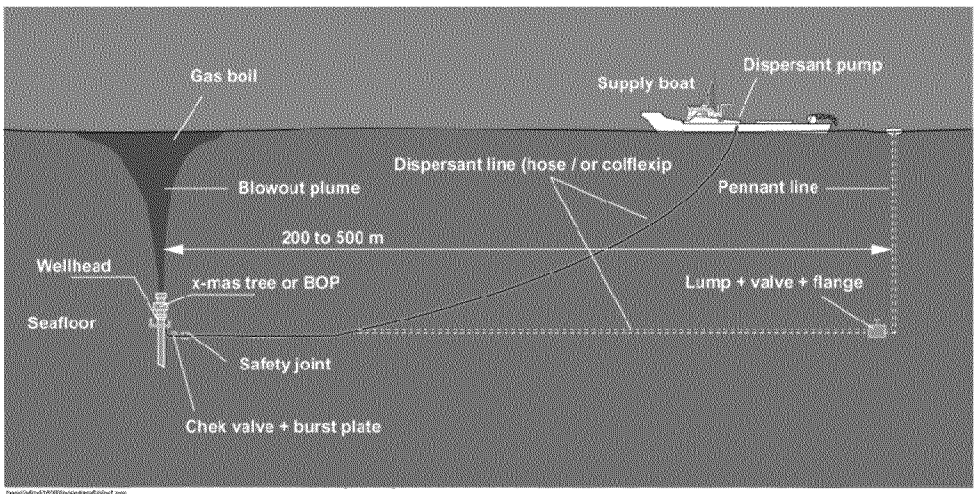
Sub-sea injection of dispersants:

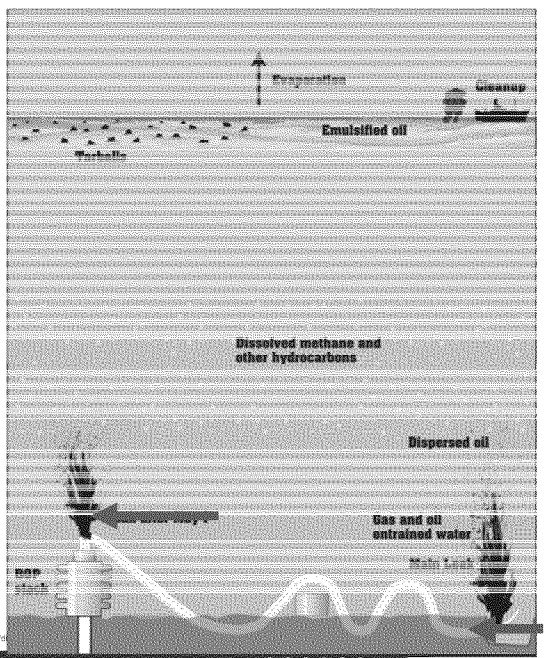
Feasibility studies performed at SINTEF in 1985 / 2002



Sub-sea injection of dispersants during DWH-incident

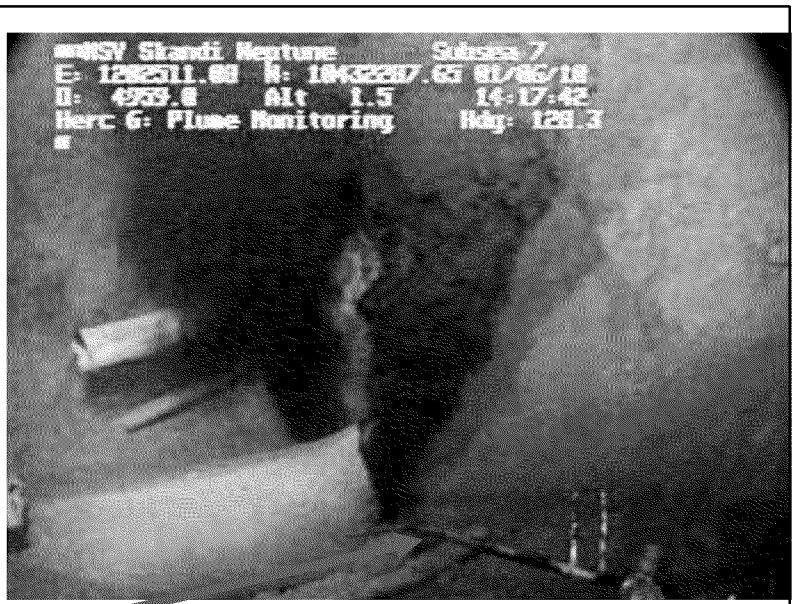
(total 3000m^3)

1. Injection into the end of the damaged riser
2. Application into the oil/gas plume in the water (after cutting the riser)



http://www.nola.com/news/gulf-oil-spill/deepwater-disaster/index.ssf

Injections in the end of the damaged riser



Dispersant dosage tube injected ca. 1 m into the damaged riser

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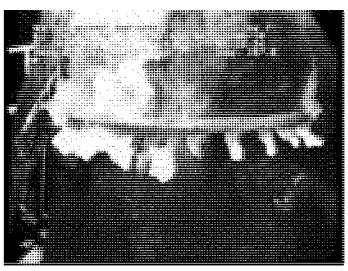
Leakage from BOP after cutting the riser (from June 1st)

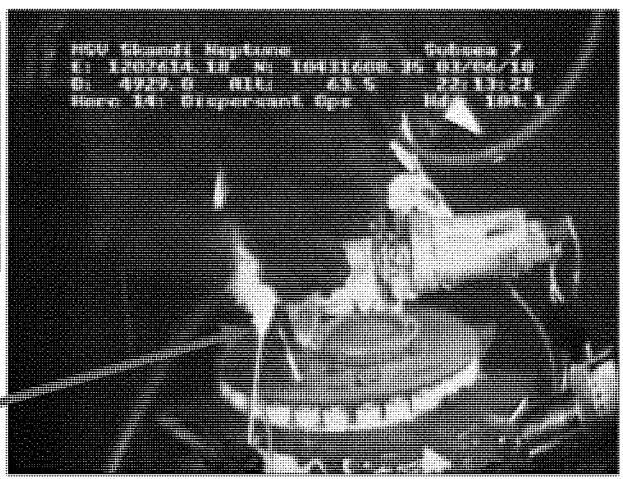
Sub-sea addition of dispersants – into the plume

- injection (60 m³ / day) through a wand held by ROV



Sub injection

Sub injection



Injection into the plume

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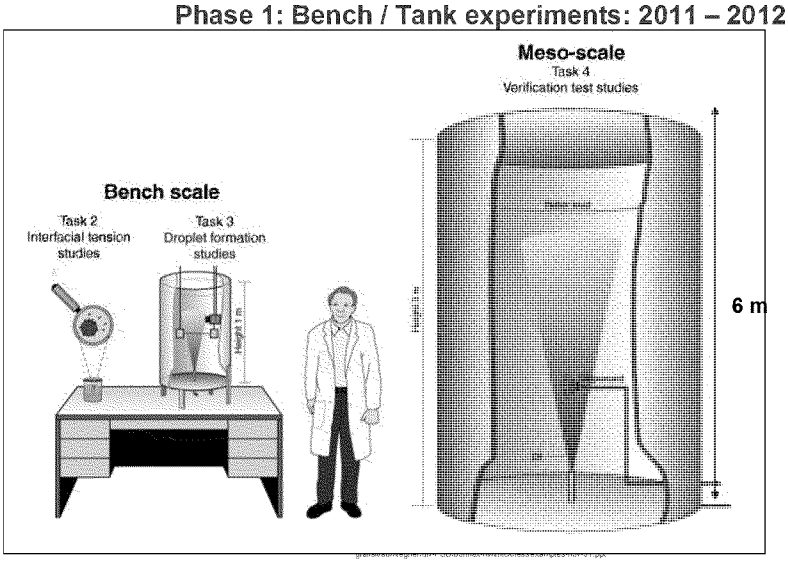
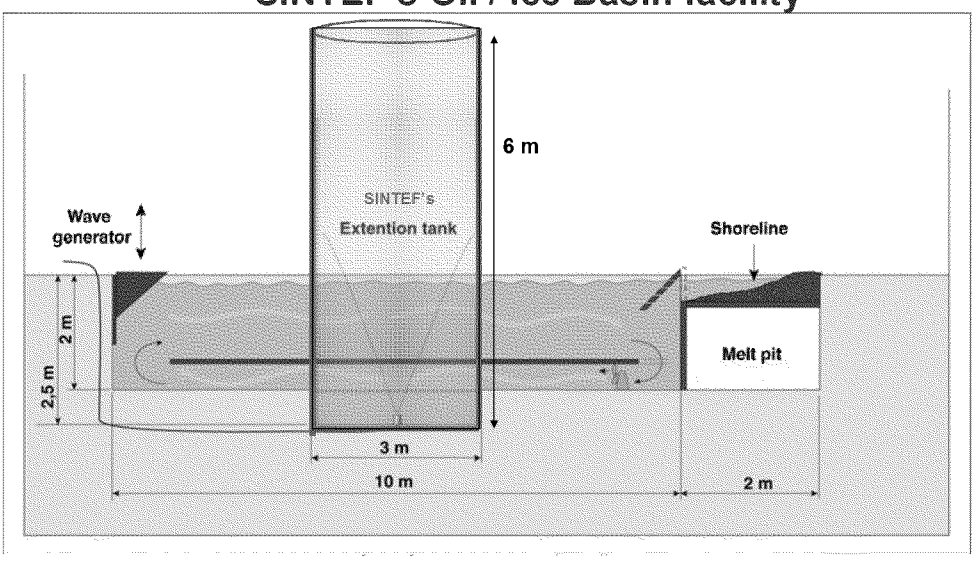
Present plans for establishing a JIP at SINTEF: Injection of dispersants into sub-sea oil leakage / blowouts

Phase 1: Bench / Tank experiments: 2011 – 2012



- Phase 2: Field trial: 2013

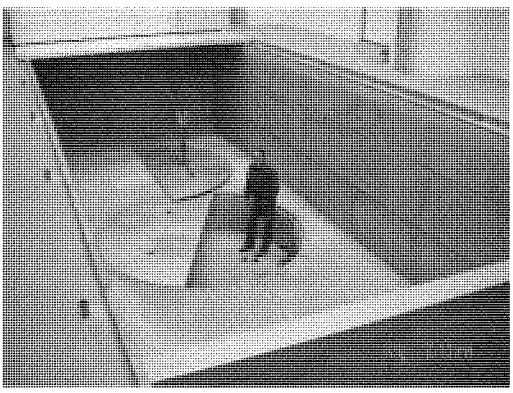
The Meso-scale- extention tank connected to SINTEF's Oil / Ice Basin facility



SINTEF's Oil / Ice Basin

During Installation of Extension tank, March, 2011

Before installation:



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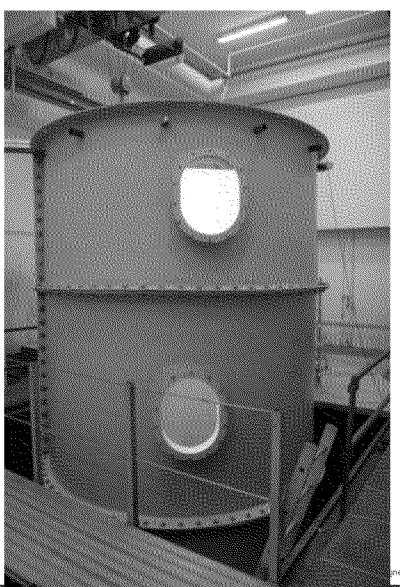
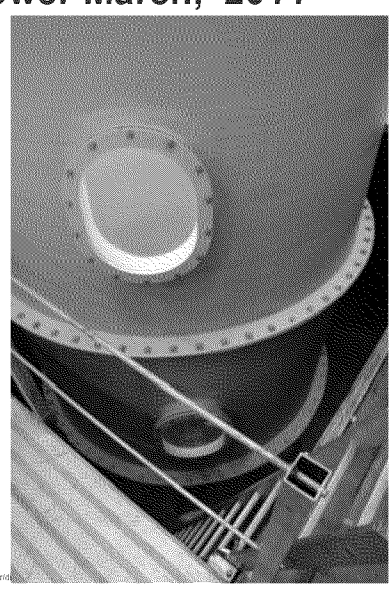
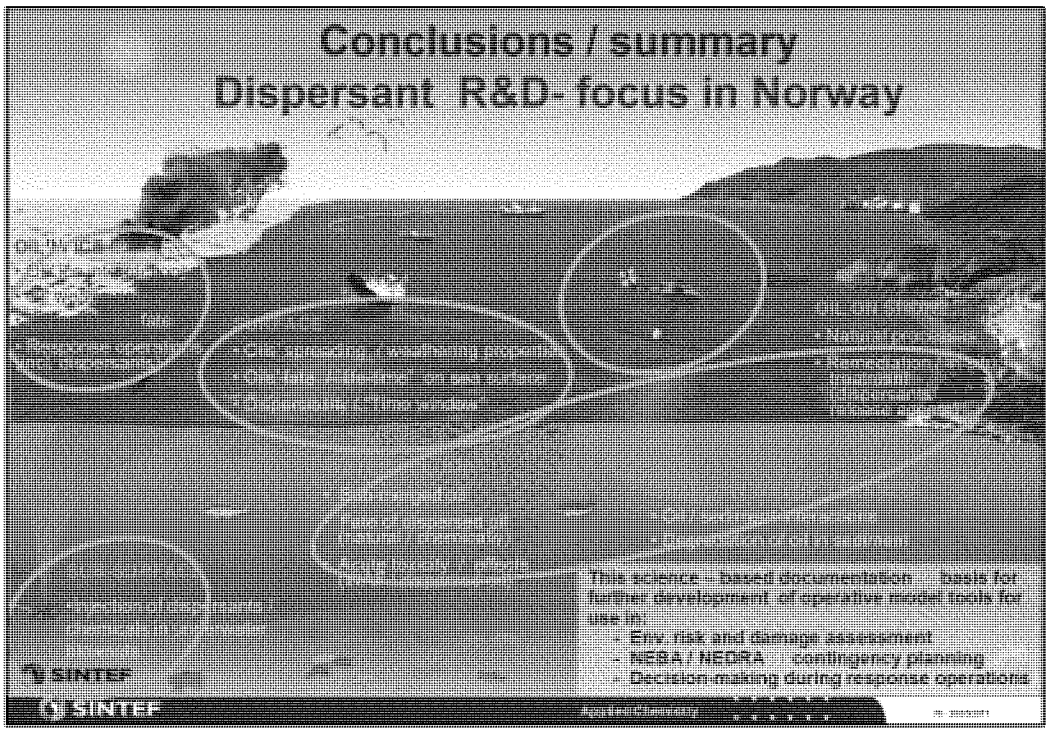
SINTEF's Oil / Ice Basin

Extension tower March, 2011





Start Pre-testing in April



Conclusions / summary
– Dispersant R&D and use in Norway

- **<u>Recent years:</u> Gained much knowledge and experience**
  - laboratory and full-scale field studies (offshore)
- **Supplementary / alternative to mechanical countermeasures in many countries (incl. Norway)**
- **There is a "time window" for use of dispersants at sea**
  - it varies from oil to oil – due to oils' weathering properties
- **In Norway: Present / Future R&D focus on study the potential for use of dispersants in:**
  - Coastal areas (sensitive, shallow area)
  - Cold and ice-infested areas
  - Sub-sea injection / Deep water
  - Fate and effects of dispersed oil droplets (mechanical vs. dispersant enhanced droplets)

grafisk/admtegner/div-PSD/bonnex-film/thickness-examples-nov-01.ppt

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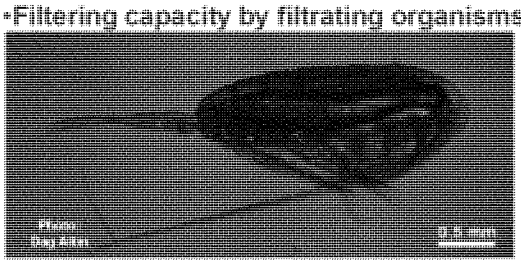
Ongoing studies at SINTEF:

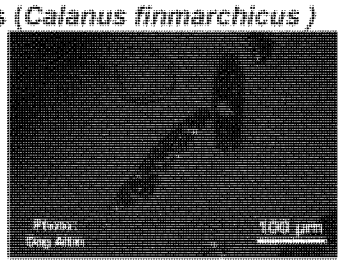
Fate of naturally / chemically dispersed oil droplets

RCN (Petromaks) / Statoil, Shell and Eni

- Oil – sediment interaction
- Biodegradation
- Filtering capacity by filtrating organisms (*Calanus finmarchicus*)



C. finmarchicus exposed to naturally dispersed oil



Fecal products of C. finmarchicus exposed to dispersed oil

"Fluorescence image:
Oil droplets: light green
Algae: red

Key question:
Will dispersant-enhanced oil droplets stick to the body surfaces in the same way ??

Future Dispersant R&D focus on Better documentation for environmentally safety and operational use in general:

- in Coastal areas (sensitive, shallow area)
- on shore (beach cleaners / dispersants)
- in low-salinity waters (e.g. Brackish water)
- sub-sea injections of dispersants (DWH – follow up)
- Important: to have good documentation about weathering properties / dispersibility of the relevant oils (basis for the contingency plan)
  (e.g. oils transported in US water)

grafisk/admtegner/div-PSD/bonnex-filmthicknessexamples-nov-01.ppt

Dispersant use in ice-infested water:

Further R&D / documentations needed / ongoing studies in Norway

- **Documentation of the fate of chemically dispersed oil**
  - spreading, dilution in water under ice (model simulations)
  - interactions between oil droplets and various ice / ice topography
  - degradation of oil droplets under / in ice
  - toxicity effects of dispersed oil droplets on arctic / ice fauna
  - potential for use of dispersants in more coastal water / sediment interaction
- **Further development / operational:**
  - optimising dispersant formulations customized for specific oils / cold conditions
  - application technology (increased capacity / dimension)

What now ?

How to lift dispersants to an operational oil spill response ?

"The aim should be to take the "emotion" out of dispersant use decision-making and replace it with a rational <u>science-based documentation</u>"

- **Such documentation will lead to:**
- **Better Operative scenario-based contingency plans/**
- **Better criteria for when and where to use / not to use dispersants**

grafisk/admtegner/div-PSD/bonnex-film/thickness-examples-nov-01.ppt

Short about the Norwegian regulations / requirements for dispersant use !

per.s.daling@sintef.no

Norwegian regulations for use of dispersants

- Founded on the principle of *"internal control".*
- The enterprise (e.g. operation of the oil field) responsible for the response has to produce pre-planned documentation that must be followed in an eventual spill response operation.
- The documentation must be available as part of an approved contingency plan: Based on analyses of relevant spill scenarios (different spill amount, different response options etc).
- These scenario-based contingency plans should demonstrate whether the use of dispersants will be the response that give the overall least damage for the environment in a given spill situation (based on "Net Environment Damage and Response Analysis" - "NEDRA" = 1 / NEBA)

Norwegian regulations for use of dispersants (2001):

Requirements to the dispersants itself

- No official list of approved dispersants are maintained by the authorities

Requirement to:

- **Toxicity test:**
  Basis for selection: one of the tests in OSPAR / PARCOM:
  - ISO/DP 10253 (*Skeletonema costatum* - Planctonic algae)
  - Simple screening test of dispersant alone
  - Acceptance criteria: EC50 > 10 mg/l Dispersant (concentrates) at sea
- **Effectiveness (oil specific)**
- **Re-checking of dispersants in stock**

grafisk/admtegner/div-PSD/bonnex-filmthicknessexamples-nov-01.ppt

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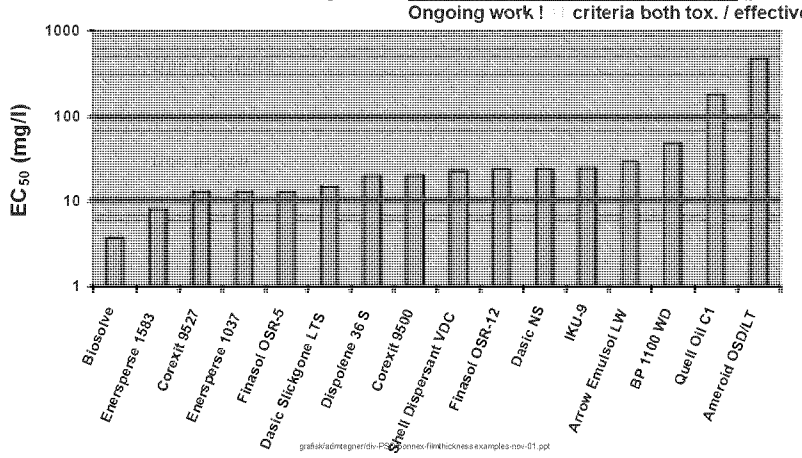
Present Norwegian regulations (2001)

Requirements to dispersants (§19.4):

1. Acute toxicity testing of Oil Spill Dispersants :

PARCOM: ISO/DP 10253 (*Skeletonema costatum* - Planctonic algae

Acceptance criteria:	EC50 > 10 mg/l	Dispersant (concentrates) at sea
	EC50 > 100 mg/l	Beach Cleaners/Dispersant shoreline (preliminary !!)
		Ongoing work ! criteria both tox. / effectiveness)



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Project at SINTEF (2009)

Ecotoxicity testing of dispersants / beach cleaners - Validation of present toxicity method

1. Toxicity Screening Testing of standard methods :

- **Comparison of ranking with several standard ecotoxicity tests**
  1. *Skeletonema costatum* – water column **(present method in Norwegian regulation)**
  2. *Acartia tonsa (copepod)*
  3. *Calanus finmarchicus (copepod)*
  4. *Corophium* volutator (sediment amphipod)

- **Can give valuable input for selecting an "European" toxicity test**

2. Simple test on dispersants Biodegradation – detoxification potential

- **Biological oxygen demand (BOD) in seawater followed by a simple ecotoxicity test (Microtox bioassay) to determine the detoxification of the dispersant (not completed – need further development)**

grafisk/admtegner/dv-PSD/bonnex-filmthicknessexamples-nov-01.ppt

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Why do we need knowledge about different oils' weathering properties at sea?

- **The specific oil properties have large influence on the fate and behavior of the spill (e.g. *"Braer" - Shetland versus "Sea Empress" ship incidents*)**

- **Increasing variation in the oils' properties:**
  - **new crude oils coming into production (e.g. North Sea / Worldwide)**
  - **wider spectre of refined products / fuel oils transported in barges and ships (from heating oil to very viscous fuels: e.g. Prestige)**

- **<u>Good knowledge</u> about weathering properties and <u>reliable weathering model tools</u> are fundamental for:**
  - **Environmental Impact Assessment**
  - **Oil spill contingency planning / NEBA-analysis**
  - **Decision-making during combat operations (at sea / in ice / on shore)**
    - **choose the right equipment: skimmers, dispersants, shoreline cleaners etc.**

- **<u>Norwegian Regulations:</u>**
  Oil Weathering Studies / Model Weathering Predictions to be carried out on all oils in production / transported in Norwegian water (part of the contingency plans)

SINTEF Applied Chemistry 106 - 20/05/2011

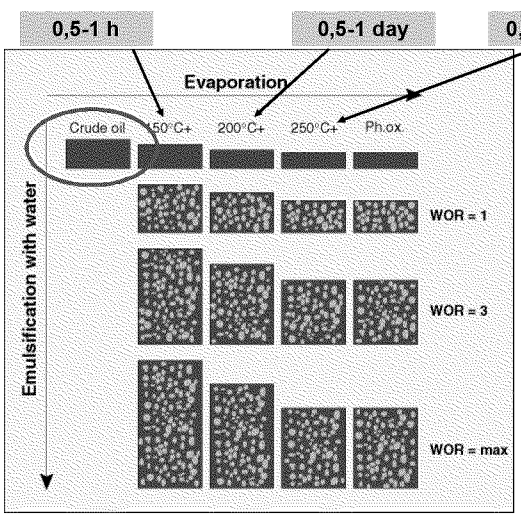
SINTEF methodology for characterization and prediction of oil weathering properties at sea

(Daling and Strøm, 1999)

- Bench-scale weathering / characterization
- Dispersant effectiveness lab. testing / Ignitability (in-situ burning) lab. testing
- Meso-scale flume weathering basin
- Oil weathering model predictions
- Correlation to ground-truth measurements

grafisk/admtegner/div-PSD/bonnax-Film thickness examples-nov-01.ppt

Bench-scale / step-wise weathering



Standardized weathering methodology (Daling and Strøm, 1999)

- Evaporation (topping): (Stiver and Mackay, 1984)
- Emulsification: (Mackay and Zagorski, 1982)

Extended topping / photo-oxidation of MC-252 crude oil:

- Topping: 275°C + residue
- Photo-oxidation (2mm slick on sea- water):
  - 18 h ph-ox: 275°C+
  - 40 h ph-ox ca. 290 -300°C+

Total: 18 different weathering samples from a fresh crude oil

Norwegian regulations – requirements to dispersants:
For an enterprise produce / processing oils (responsible for contingency / response):

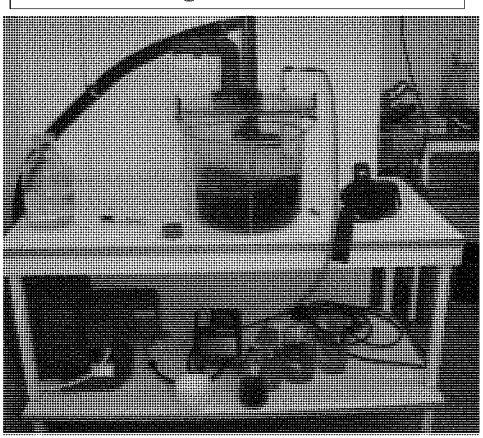
- Dispersant performance (effectiveness) has to be documented by the enterprise
- Part of the user's contingency plan (offshore oil fields / Oil terminals / refineries)

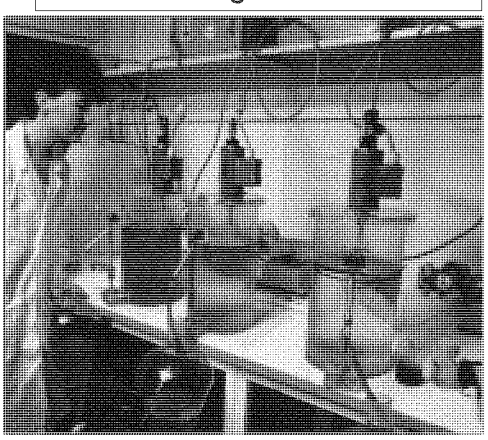
Dispersant performance documentation :

- To be tested on "their" specific oils (weathered / emulsions)
- Three steps :
  1. Screening of 5 - 8 dispersants (DOR = 1 / 25) (IFP)
  2. Dosage test (3 best dispersants) (IFP)
  3. Dispersibility vs. increased weathering. Basis for:
     - defining upper viscosity limit for chemical dispersibility
     - basis for predicting the "time window" effective use of dispersant use under different sea conditions

Dispersant effectiveness / Oils dispersibility Laboratory test methods used ion Norway

MNS test method - medium turbulence - breaking wave conditions	IFP dilution test method - low energy - Non-breaking wave conditions





Dispersant effectiveness testing in laboratory
- what can they tell us ?

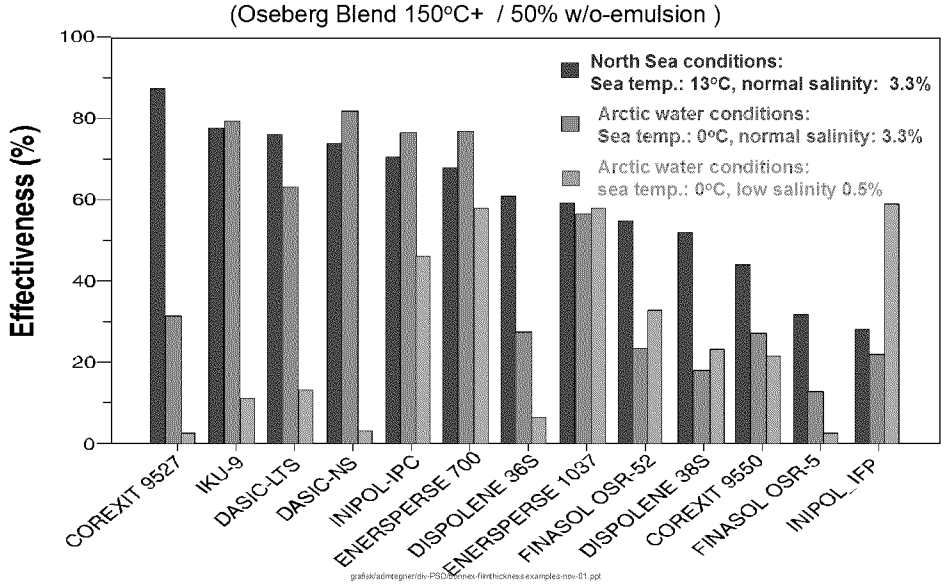
- **Cannot simulate all processes in the field**
- **Give relative numbers - not absolute values**
  (e.g. 70% effectiveness with the IFP
  does NOT mean we will get 70% in the field)
- **Rapid**
- **Testing under controlled conditions**
- **Can study effects of varying single parameters, e.g.:**
  - Screening of dispersants
  - Sea Temperature / water salinity
  - Dosage
  - Mixing energy / turbulence (use different test methods)
  - Dispersibility of different oils / weathering degrees etc....

grafisk/admtegner/div-PSD/bonnex-filmthickness-examples-nov-01.ppt

SINTEF Applied Chemistry 112 - 20/05/2011

Effectiveness of dispersants in Arctic waters versus North Sea conditions

(Oseberg Blend 150°C+ / 50% w/o-emulsion)



grafisk/admtegner/div-PSD/bonnex-filmthickness-examples-nov-01.ppt

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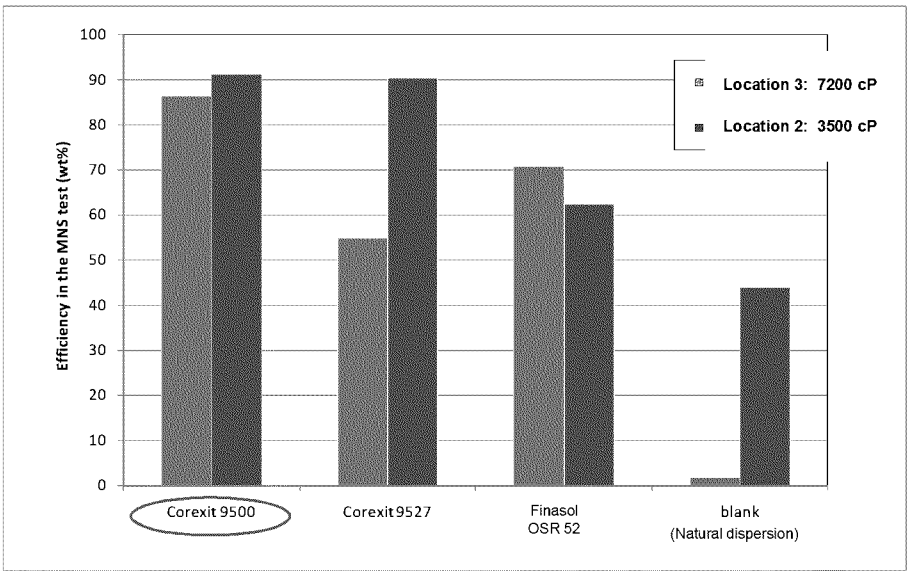
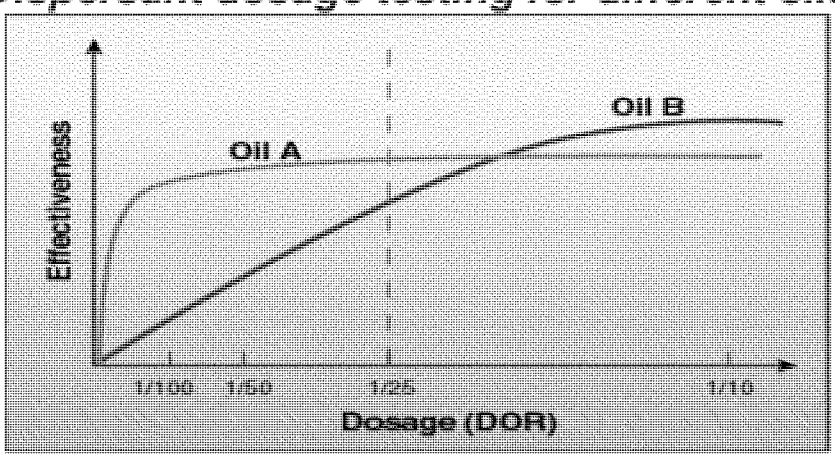
Screening of different dispersants on samples from the field (MNS-test Dosage: 1:25, test temperature: 32°C)

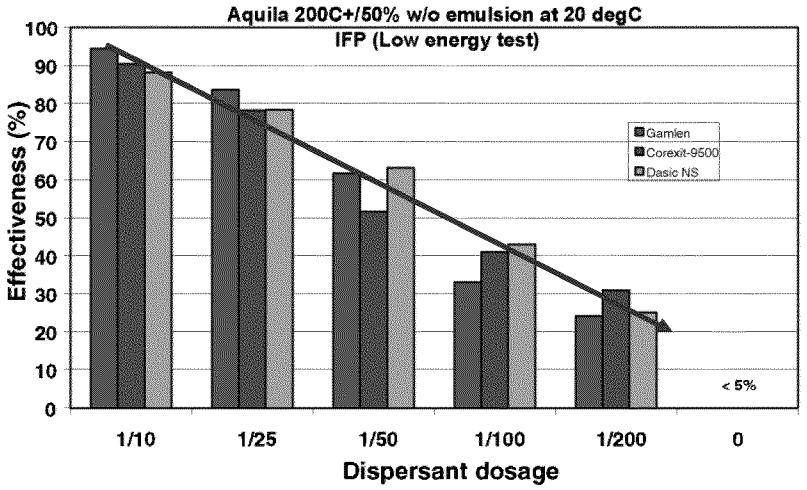


Dispersant dosage testing for different oils



- "Standard" dosage testing at DOR= 1 : 25 may not give "complete" picture of the dispersant efficacy on different oil types
- Important information for optimising the spraying operation
- Important information for dimensioning the dispersant contingency stock

Dispersant dosage testing IFP-method:



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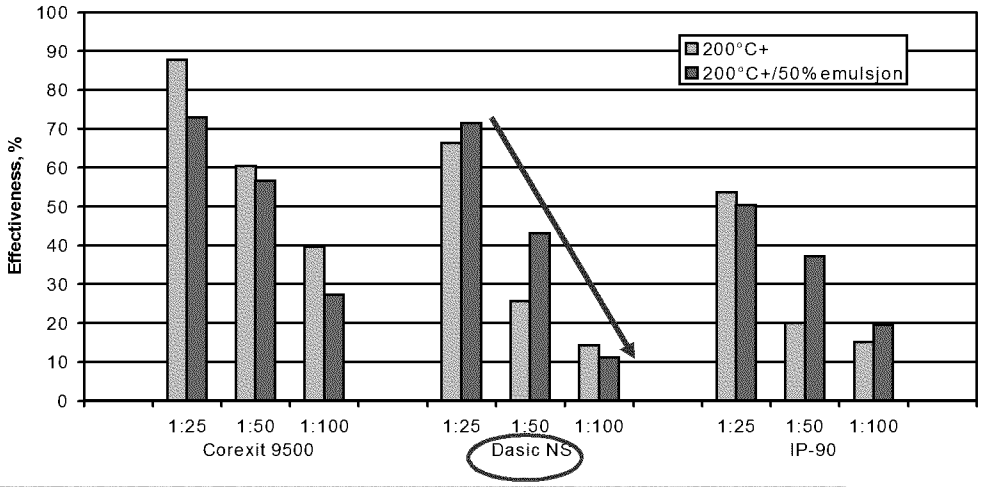
SINTEF Applied Chemistry 116 - 20/05/2011

Dispersant dosage testing IFP-method:

Screening of dispersants on Balder crude oil.
Dispersant dosages (DOR or DER)= 1:25, 1:50 and 1:100.



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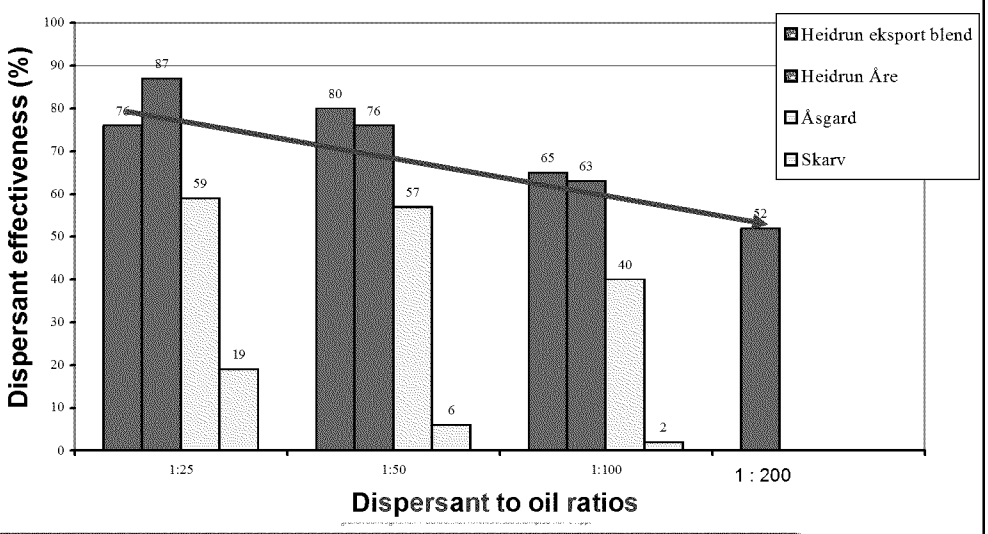
Dispersant dosage testing

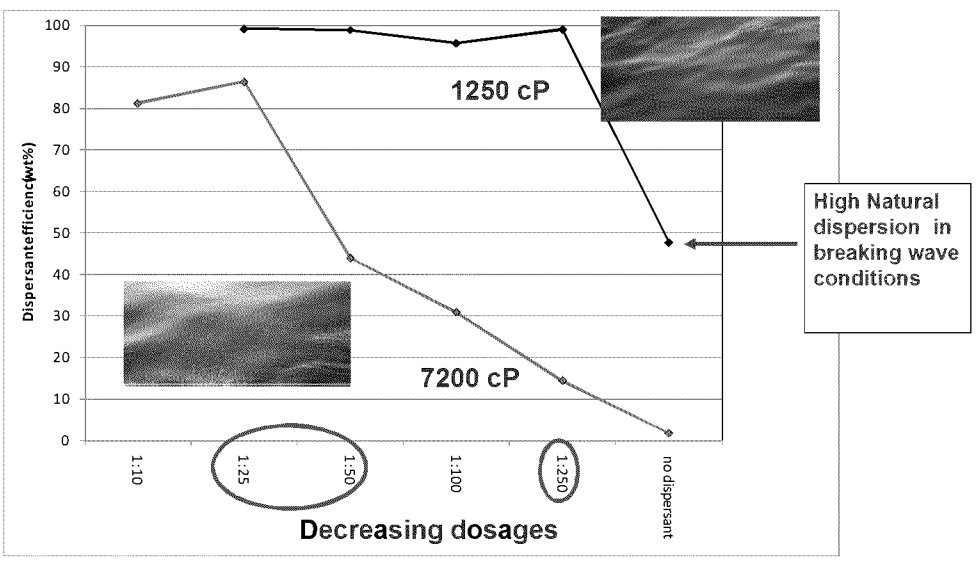
Examples of different Norwegian crude oils (Haltenbanken)

Doseringstesting av Dasic NS
IFP metoden



Dispersant dosage testing at SINTEF Oil Spill Laboratory – DWH samples

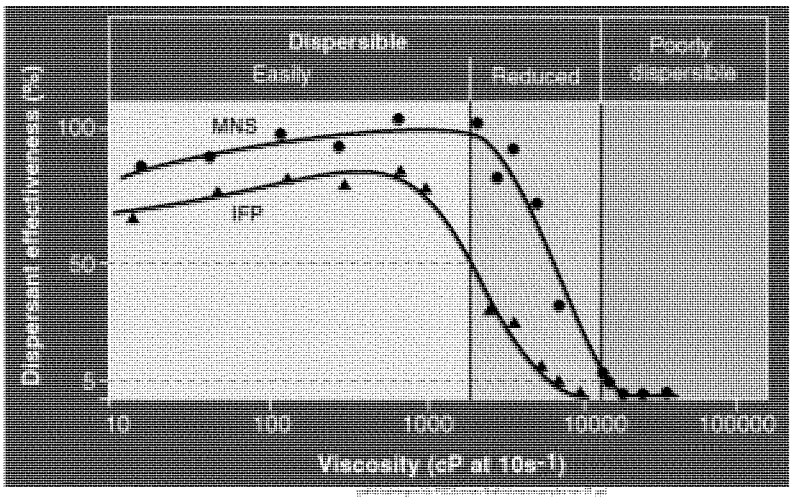
Effectiveness of different Dosages: 1 : 25 □ 1 : 250



grafisk/admtegner/div-PSD/bonnex-film/thicknessexamples-nov-01.ppt

Dispersant effectiveness vs. weathering at sea (increase in viscosity)

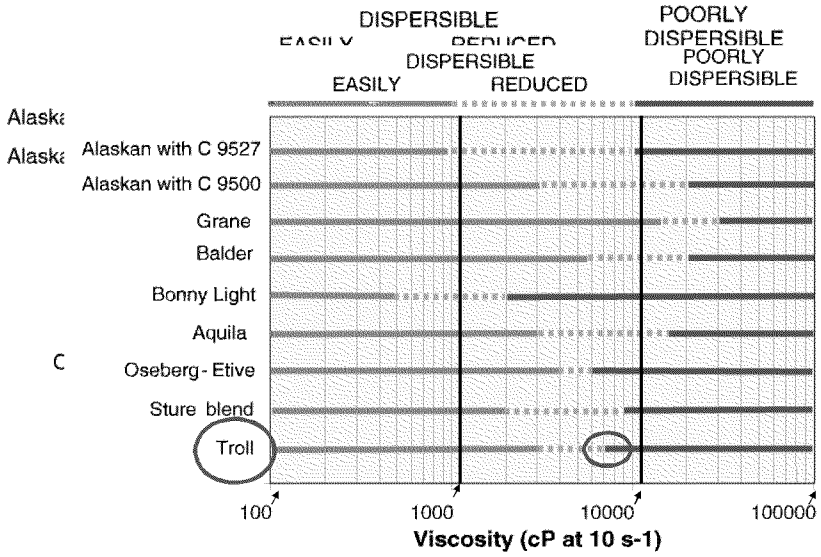
- Preparation of 16 weathered samples from each crude
- Test the dispersibility on lab. test methods (one dispersant):



Criteria used for dispersibility Norway

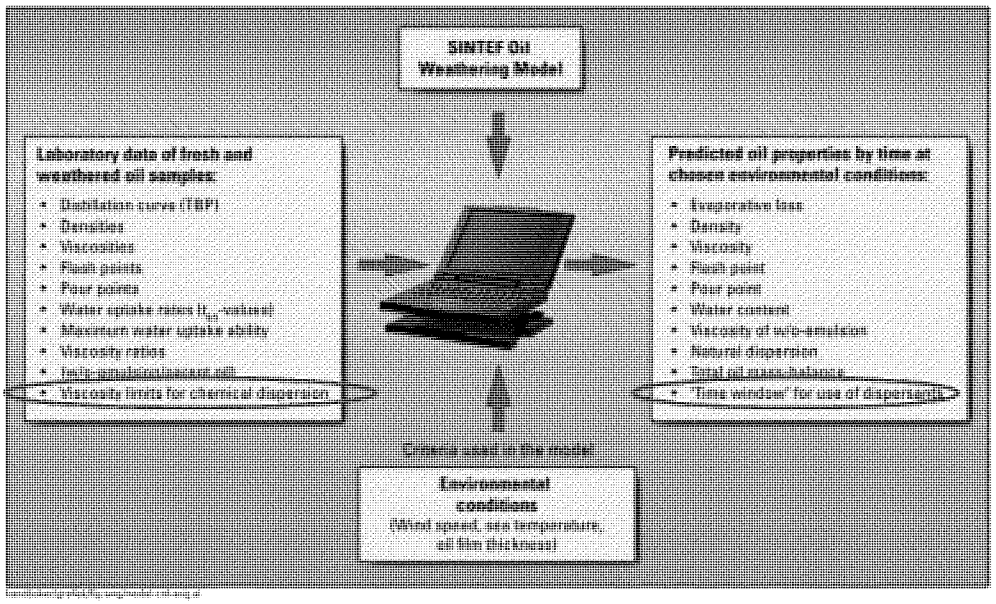
SINTEF Applied Chemistry 123 - 20/05/2011

Viscosity "boarders" in dispersibility for selected crude oils



124 - 20/05/2011

Oil Weathering and Dispersibility Methodologies



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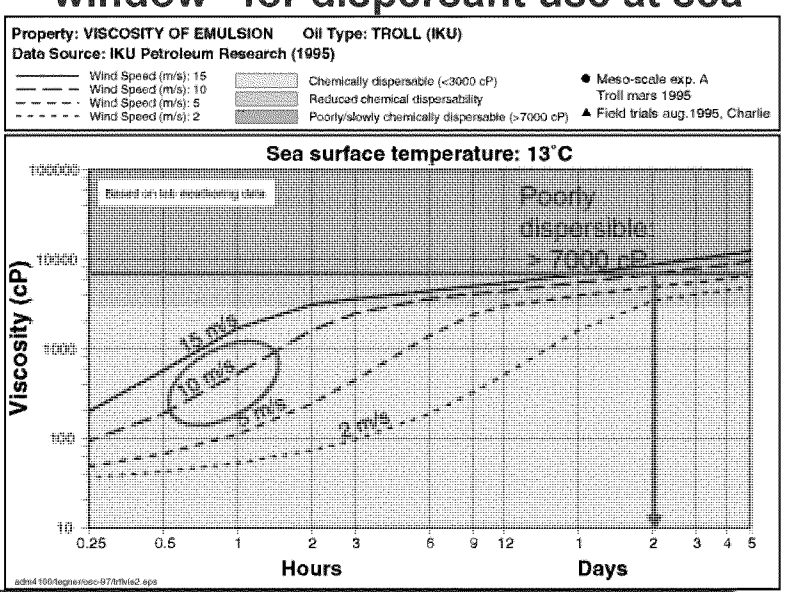
Predicted Emulsion Viscosity and "time-window" for dispersant use at sea



adm4100/tegner/osc-97/trfivie2.eps

OWM Weathering predictions of MC252:

Viscosity of emulsion /

"Long Time window for use of dispersants"

Property: VISCOSITY OF EMULSION
Oil Type: MACONDO MC252
Description: 200°C+-275°C+ input
Data Source: SINTEF Materials and Chemistry (2010), Weatherir

SINTEF

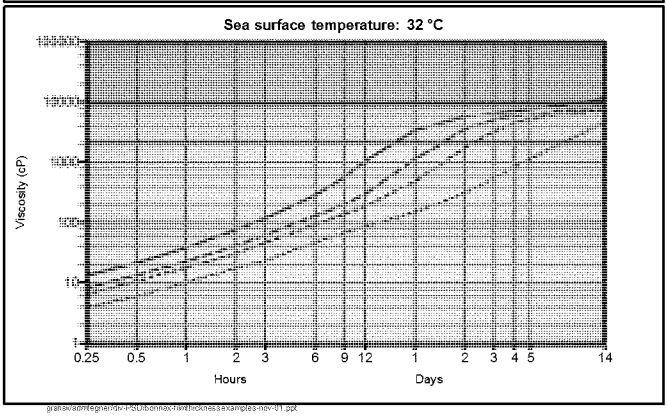
OWModel 3.2(modified) May © 2011

Surface release - Terminal Oil film thickness: 0.5 mm
Release rate/duration: 1.33 metric tons/minute for 15 minute(s)

Pred. date: Jan. 07, 2011

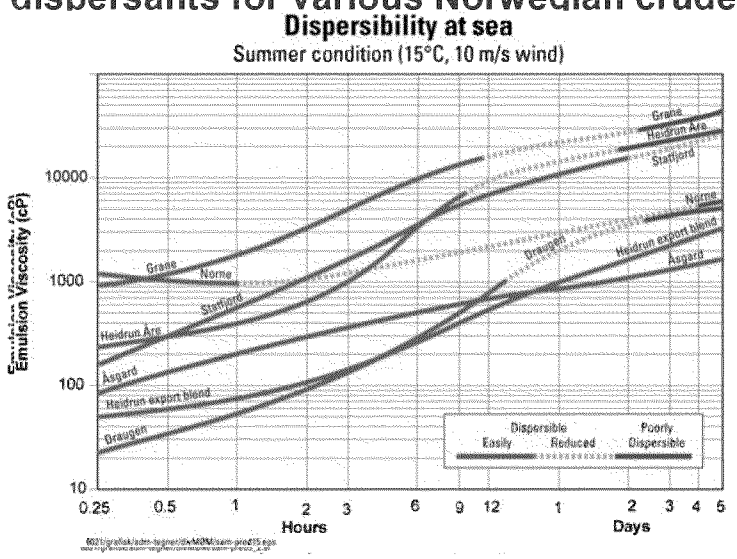
- Wind Speed (m/s): 10
- Wind Speed (m/s): 7
- Wind Speed (m/s): 5
- Wind Speed (m/s): 2

- Chemically dispersible (<2000 cP)
- Reduced chemical dispersibility
- Poorly / slowly chemically dispersible (>10000 cP)



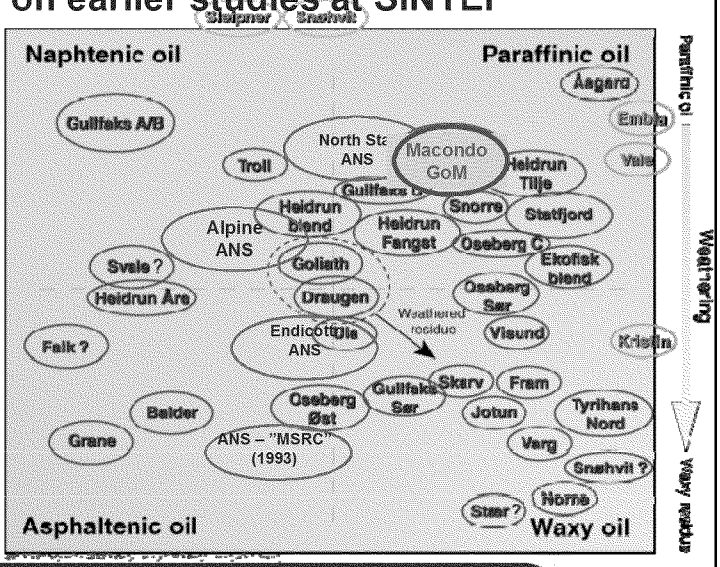
SINTEF Applied Chemistry 127 - 20/05/2011

Prediction of viscosity and "time window" for use of dispersants for various Norwegian crude oils



SINTEF Applied Chemistry 131 - 20/05/2011

Categorization" of MC-252- crude oil versus some Norwegian and US crude oils / Based on earlier studies at SINTEF



Norwegian regulations / requirements to contingency planning for dispersant use

In order to have an operative contingency including use of dispersants:

- Pre-planned documentation is needed!!
  - basis for decision making for using dispersants in a spill situation

grafisk/admtegner/div-PSD/bonnex-filmthickness-examples-nov-01.ppt

Basis for a rapid decision-making

Have to follow a <u>pre-planned documention</u> as part of an approved contingency plan. Important documentation:

- Natural resources / Sensitivity maps (seasonal)
- Degree of natural dispersion of the oil / "life-time" of the spill
- Potential effectiveness of dispersant treatment with respect to:
  - oil type / weathering degree-"time window"
  - environmental conditions (weather, dilution, salinity etc.)
  - dispersant dosage needed
- Capacity of the application response method / application strategy
- Monitoring: measure the effectiveness / Criteria for when to stop spraying

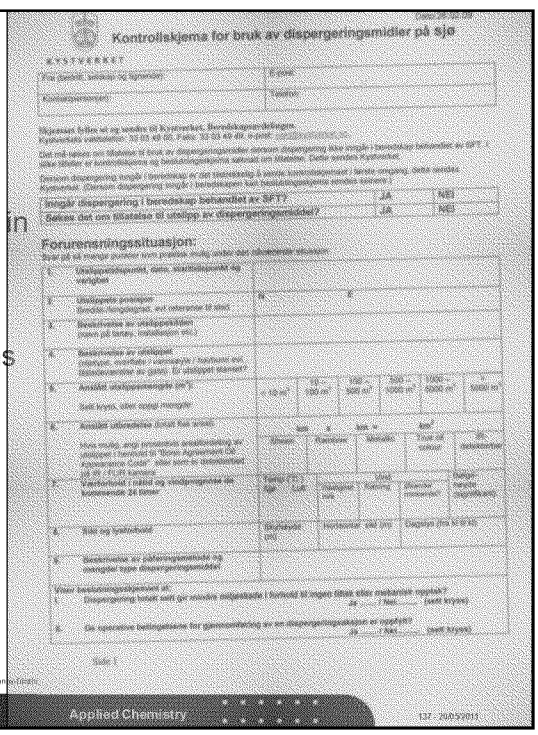
<u>In a spill situation:</u> has to fill out an operational "check-list" / report form:

grafisk/admtegner/div-PSD/bonnex-filmthicknessexamples-nov-01.ppt

SINTEF Applied Chemistry 136 - 20/05/2011

Operational report form – a "check-list":

- Users "Internal control procedure" in a decision-making situation
- To ensure that decision to use dispersants is within the conditions as fundamented in the pre-approved contingency plans.
- **Is filled out by the user - within minutes!!**
- The form is sent to the Norwegian Authorities when starting the dispersant spraying operation


Kontrollskjema for bruk av dispergeringsmidler på sjø

KYSTVERKET

Forurensningssituasjon:

grafisk/admtegner/div-PSD/bonnex-filmthicknessexamples-nov-01.ppt

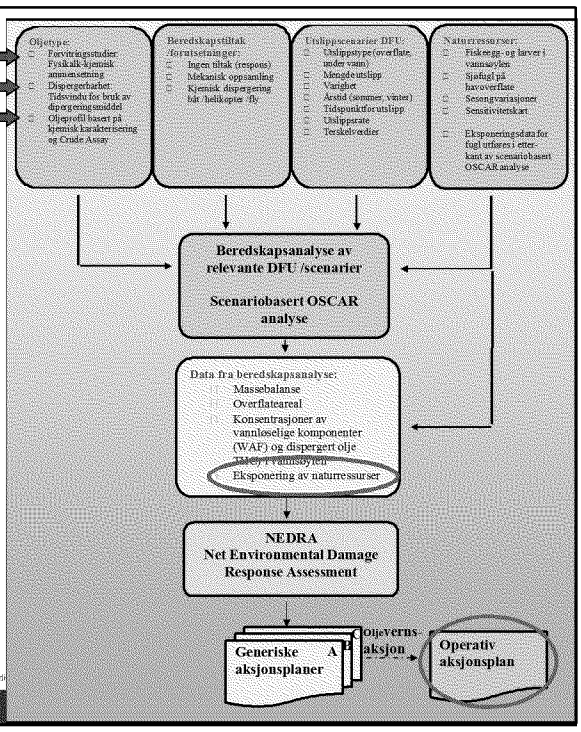
SINTEF Applied Chemistry 137 - 20/05/2011

"New Methodology for systematic analysis of spill-scenarios relevant for using dispersants / or not

Spill scenarios at a specific oil field:

10 m³, 50, 100, 500, 1000, 2000 , 5000 m³ +

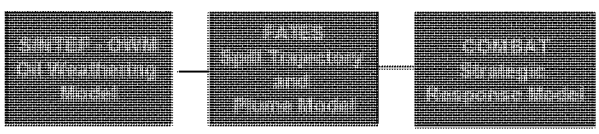
- Basis for developing *"generic action plans"*

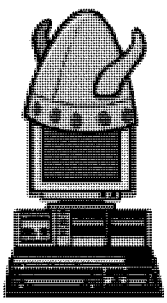


SINTEF

Oil Spill Contingency and Response *OSCAR*

Models for Quantification of COMBAT Effectiveness / Environmental Impact





- Mass balance (evaporated, naturally dispersed, degraded, beached, cleaned up, chemically dispersed) for different combat alternatives
- Surface trajectories
- 3-D concentrations in water
- Natural resources database / maps

SINTEF Applied Chemistry 140 - 20/05/2011

Example of OSCAR modelling

Spill scenario: Balder field (North Sea)

- 100 m^3 crude oil as a batch release of 1 hour.
- Wind conditions 5 and 10 m/s.
- Response alternatives:
  - No response
  - Mechanical recovery (initial response vessels)
  - Dispersant application (initial response vessels)

grafisk/admtegner/div-PSD/bonnex-filmthickness-examples-nov-01.ppt

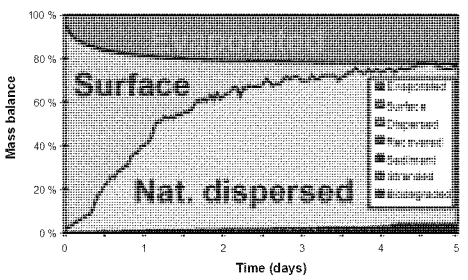
SINTEF Applied Chemistry 141 - 20/05/2011

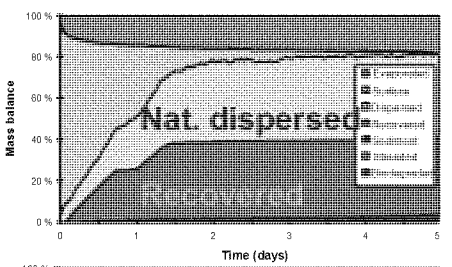
Spill scenario: Balder field

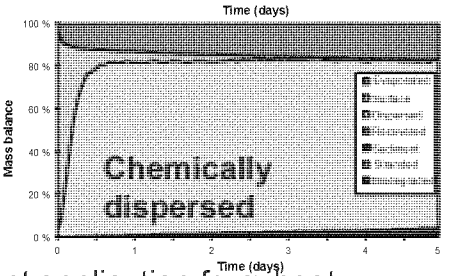
Mass-balance at 10 m/s wind speed

Mechanical recovery:

No response:







Dispersant application from boat

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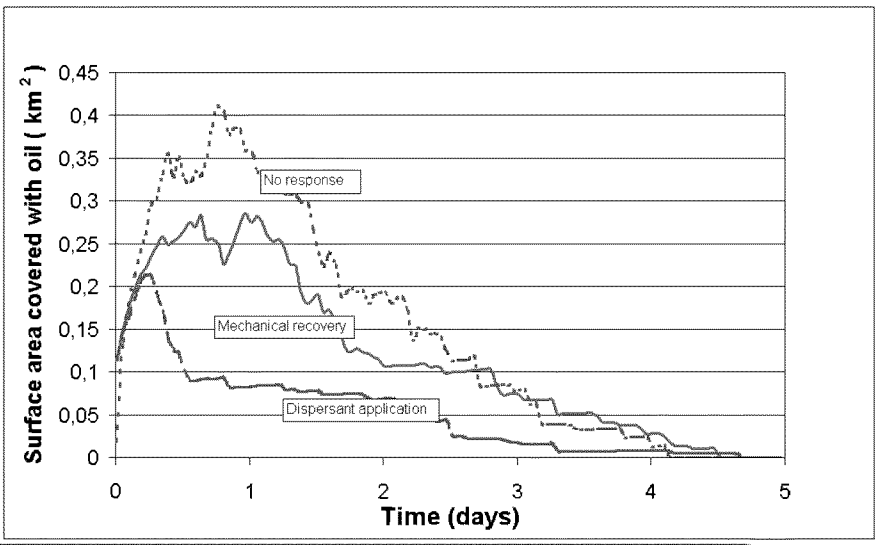
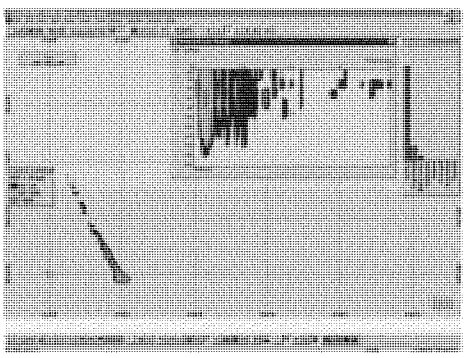
Surface area covered with oil



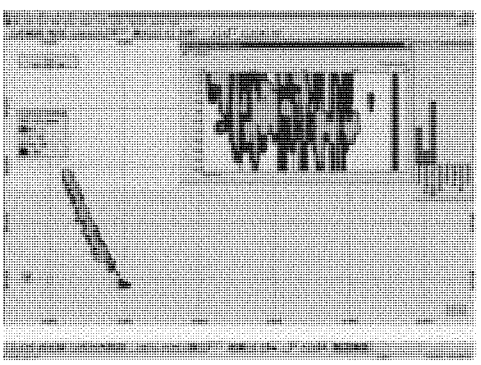
Concentration of dissolved components (WAF) in water column (snapshot)

(OSCAR calculate concentration of 26 oil component groups)

No response



5 h. after Dispersant application

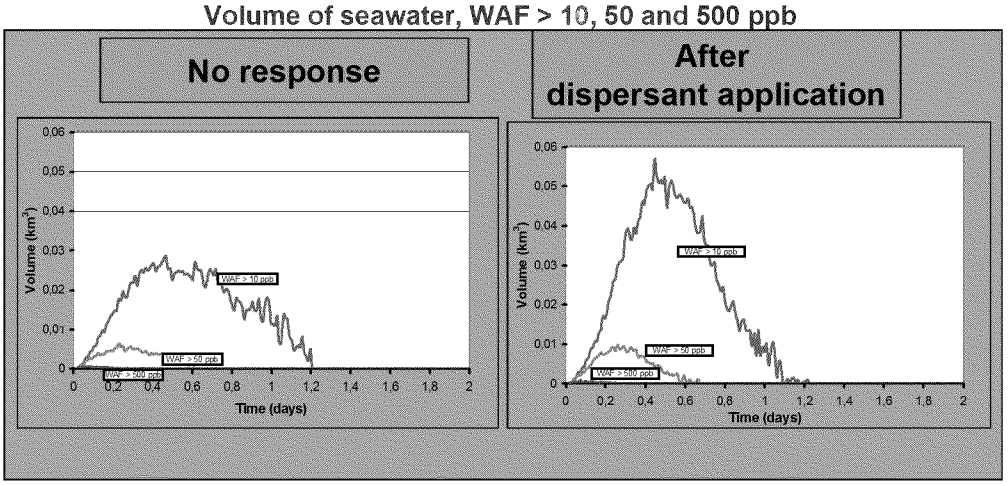


grafisk/admtegner/div-PSD/bonnex-filmthicknessexamples-nov-01.ppt

Concentration and dilution of dissolved components (WAF) in water column

(OSCAR calculate concentration of 26 oil component groups)

Volume of seawater, WAF > 10, 50 and 500 ppb

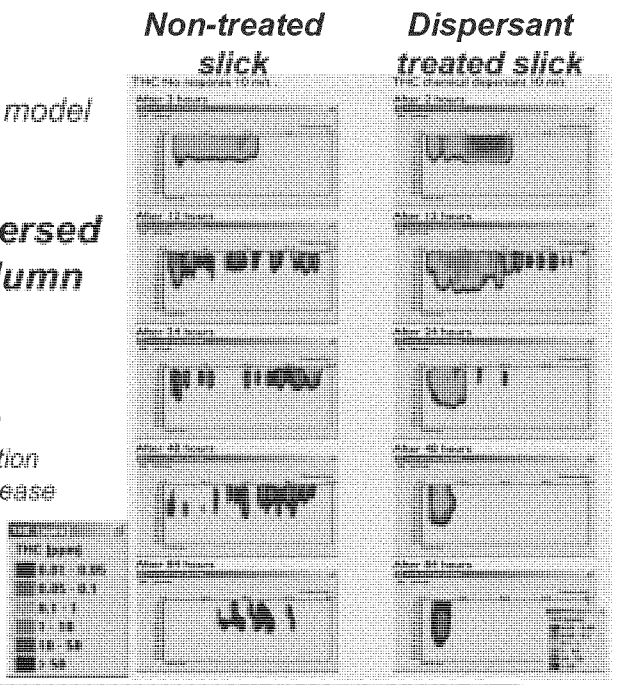


Effect concentration: 500 ppb

Use of "3-D plume" model tools:

Dilution of dispersed oil in water column

Spill scenario:
100m³ crude oil
Dispersant application
start 1 hour after release



Use of OSCAR model system

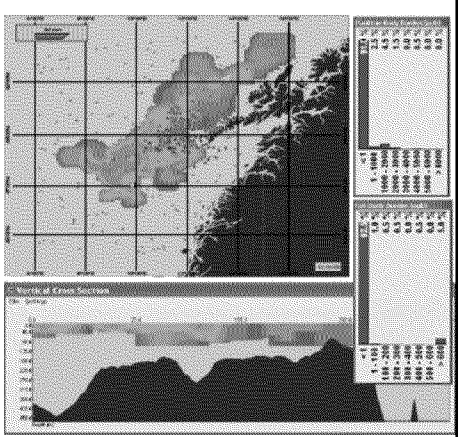
- A quantitative tool for analyzing environmental consequences for alternative response strategies
- Basis for NEDRA / NEBA - analysis of spill scenarios used in contingency plans including use of dispersants in Norway:
  - Offshore platforms / regions of oil fields
  - Oil terminals / Refineries
  - Authorities (SFT / NCA): Basis for dimensioning the governmental oil spill preparedness
- Tool used in connection to decision-making during response operations

grafisk/admtegneridiv-PSD/bonnex-filmthickness-examples-nov-01.ppt

SINTEF Applied Chemistry 151 - 20/05/2011

Present OSCAR model system
Better RISK AND DAMAGE ASSESSMENT

- Input of biological resources: statistical distribution in time and space
  - Dynamic modelling of the oil exposure to the marine organisms in the water column
  - Important tools for predicting realistic effects and losses of populations (acute toxicity) of various oil spill scenarios



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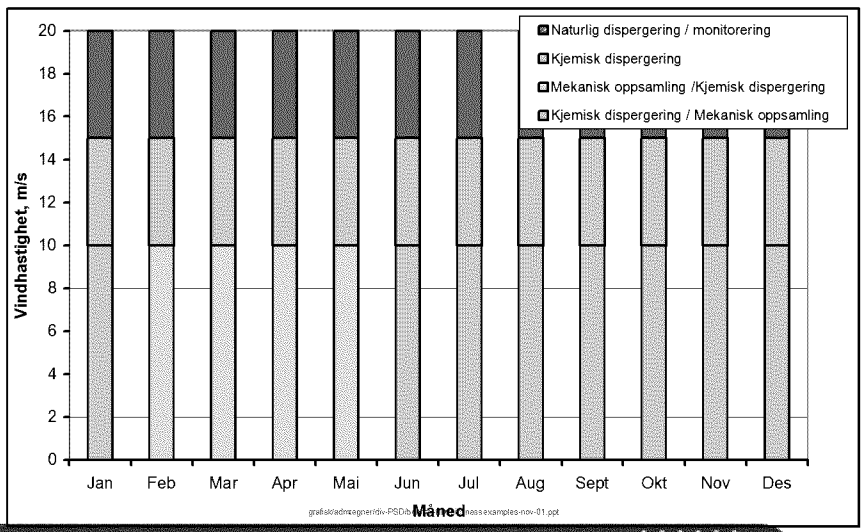
SINTEF Applied Chemistry 163 - 20/05/2011

Example of an action plan for the initial oil spill response options at offshore installations

(Example taken from the Balder / Jotun contingency plan)

Release size : 1000 – 2000 m^3 oil



SINTEF Applied Chemistry 169 - 20/05/2011

To: Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Wilson, Gregory
Sent: Fri 6/5/2015 6:30:35 PM
Subject: FW: Potential OSRP Requirement for Oil Toxicity Information as it Pertains to Dispersant Monitoring
DTox_final_report_bejarano_022814.pdf

From: Steve Lehmann - NOAA Federal [mailto:steve.lehmann@noaa.gov]
Sent: Friday, June 05, 2015 2:23 PM
To: Caplis, John
Cc: Debbie Payton - NOAA Federal; Matthiessen, Craig; Wilson, Gregory; David Moore
Subject: Re: Potential OSRP Requirement for Oil Toxicity Information as it Pertains to Dispersant Monitoring

John,

You are going to be one popular guy with industry. Greg and Craig are high-fiving themselves now because there is now someone other than EPA for industry to hate.

Assumptions:

1. RRTs and ACs can establish requirements for ecotoxicity testing and monitoring as part of their development of authorization of use plans and their subsequent adoption into ACPs and RCPs.

True, but I don't think that gives BSEE the freedom to do it under their OSPR regulations as a condition for pre-authorization. That said, DOI could make their approval conditional on satisfying BSEE regs. at the RRT level.

2. Ecotoxicity monitoring is primarily monitoring for TPH levels and comparing them to ecotoxicity benchmarks for levels of concern.

I am not a toxicologist, but establishing benchmarks and adding to the SSD data is not monitoring. It requires a battery of tests that can be expensive.

3. Ecotoxicity benchmarks are derived from SSDs for a toxicant (or group of similar toxicants).

Again, not a toxicologist, but toxicity data develops the SSD. The establishment of benchmarks or levels of concern are typically done by the stakeholders and not the industry. You might have to be specific as the species you want plan holders to test.

Question: Who would develop the SSDs? Industry or RRTs?

Most RRTs don't have qualified toxicologists on them for the development of SSD. If industry develops them, the RRTs (or government) would still have to check them, I suspect.

4. SSDs would be formulated using LC50 data on various toxicants such as an oil that is being transported or produced or the dispersant product being used. Industry would provide LC50 toxicology data for their oils when available as part of the OSRP requirements.

Question: Who determines what species should be used for the devleopment of SSDs?

See attached paper by Dr. Bejarano of RPI (a real toxicologist). Also this EPA FAQ is helpful. (http://www.epa.gov/caddis/da_advanced_2.html).

5. Authorization of use plans may establish the species types to be used in developing SSDs.

1. Your language focuses on the oil type rather than the dispersant type or the species present near the facility but NOT represented on the SSD. Why? Means a lot more testing.

2. The first sentence begins with a conditional clause, "Where Area Contingency Plans or Regional Contingency Plans have established the use of Total Petroleum Hydrocarbon (TPH)-based ecotoxicity benchmarks as part of the monitoring requirements for the sustained use of dispersants," but never satisfies that clause. Perhaps you meant, "...*you will include* the toxicity data for your oil that is necessary to develop the species sensitivity distributions (SSDs)..."

Just a quick answer, John. I'll give it some more thought.

Steve

Possible OSRP Language for their Facility Information Annex:

" (b) A listing of the types and characteristics of the oil handled, stored, or transported at each offshore facility.

(1) You must provide the following additional information on your oil properties and behaviors:

(2) Oil weathering data

(3) Dispersibility data

(4) Where Area Contingency Plans or Regional Contingency Plans have established the use of Total Petroleum Hydrocarbon (TPH)-based ecotoxicity benchmarks as part of the monitoring requirements for the sustained use of dispersants, **the toxicity data for your oil** that is necessary to develop the species sensitivity distributions (SSDs) identified in the those Area and Regional Contingency Plans. This requirement is limited to offshore facilities or leases physically located in areas where Area Committees or Regional Response Teams have established monitoring requirements in their Regional or Area Contingency Plans that include the use of TPH-based ecotoxicity benchmarks for a sustained use of dispersants that is generally consistent with your planned response to your WCD scenarios.

On Fri, Jun 5, 2015 at 10:51 AM, Caplis, John <john.caplis@bsee.gov> wrote:

***Please do not forward or share beyond a very limited number of internal SMEs you

deem appropriate to the conversation, as this is pre-decisional and regulatory sensitive info.***

Debbie, Craig, Steve, Greg,

We are toying with the idea of requiring plan holders to conduct and submit toxicity testing that would support the development of species sensitivity distributions necessary for the development of ecotoxicity benchmarks, as part of their OSRP requirements (as part of our pending OSRP regulatory update). You all are more knowledgable in this arena than I, so I wanted to get your expert opinions as well as verify that I am understanding how things might work in conjuction with both within the NRT Guidelines for Atypical Use of Dispersants and the evolution of Subpart J. As you will see, I have a few questions below, and am also interested in any thoughts, concerns, and suggested changes you might have, as we consider this possible requirement:

Assumptions:

1. RRTs and ACs can establish requirements for ecotoxicity testing and monitoring as part of their development of authorization of use plans and their subsequent adoption into ACPs and RCPs.

2. Ecotoxicity monitoring is primarily monitoring for TPH levels and comparing them to ecotoxicity benchmarks for levels of concern.

3. Ecotoxicity benchmarks are derived from SSDs for a toxicant (or group of similar toxicants).

Question: Who would develop the SSDs? Industry or RRTs?

4. SSDs would be formulated using LC50 data on various toxicants such as an oil that is being transported or produced or the dispersant product being used. Industry would provide LC50 toxicology data for their oils when available as part of the OSRP requirements.

Question: Who determines what species should be used for the devleopment of SSDs?

5. Authorization of use plans may establish the species types to be used in developing SSDs.

Possible OSRP Language for their Facility Information Annex:

" (b) A listing of the types and characteristics of the oil handled, stored, or transported at each offshore facility.

(1) You must provide the following additional information on your oil properties and behaviors:

(2) Oil weathering data

(3) Dispersibility data

(4) Where Area Contingency Plans or Regional Contingency Plans have established the use of Total Petroleum Hydrocarbon (TPH)-based ecotoxicity benchmarks as part of the monitoring requirements for the sustained use of dispersants, the toxicity data for your oil that is necessary to develop the species sensitivity distributions (SSDs) identified in the those Area and Regional Contingency Plans. This requirement is limited to offshore facilities or leases physically located in areas where Area Committees or Regional Response Teams have established monitoring requirements in their Regional or Area Contingency Plans that include the use of TPH-based ecotoxicity benchmarks for a sustained use of dispersants that is generally consistent with your planned response to your WCD scenarios.

So what do you all think about the assumptions, or the proposed requirement language? I am appreciative of any feedback you want to offer on anything you see in this email. (Please ignore the underlining, it doesn't have any significance).

John

--

Stephen Lehmann
NOAA Senior Scientific Support Coordinator

Emergency Response Division / Office of Response & Restoration

10 George St. Suite 220
Lowell, MA 01852-2293
Office: 978-654-6385

Fax: 978-654-6386
Mobile: 617-877-2806
Emergency (24/7): 206-526-4911

Email: steve.lehmann@noaa.gov
Website: http://response.restoration.noaa.gov/

DTox: a Worldwide Quantitative Database of the Toxicity of Dispersants and Chemically Dispersed Oil

A Final Report Submitted to

The Coastal Response Research Center

Submitted by

Dr. Adriana C. Bejarano

Research Planning, Inc.
1121 Park Street
Columbia, SC 29201

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Coastal Response Research Center

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UNIVERSITY of NEW HAMPSHIRE

NOAA

Abstract

The *Deepwater Horizon* oil spill revived much of the discussions on the use of dispersants as one of the tools considered in offshore oil spill response. Much of this discussion focused on concerns about the toxicity of dispersants and chemically dispersed oil to water column organisms. The ability to rapidly assess the toxicity of dispersants and chemically dispersed oil require unrestricted and rapid access to available toxicity data, a need shared by government, industry, consultants, and academic groups involved in oil spill response. While toxicity data on dispersants and both physically and chemically dispersed oil have been generated since the 1970s, the practical use of this information has been hindered by the lack of a centralized data repository. As a result, the Dispersant and Chemically Dispersed Oil Toxicity Database (DTox) is created to address that shared need of the oil spill community.

The main objectives of this project are to: 1) identify, evaluate, compile, and integrate all available toxicity data on dispersants and chemically dispersed oil, and 2) generate an interactive tool that can assist the oil spill response community in their assessments and management decisions regarding the use of dispersants. The ultimate goal of this effort is the synthesis of information in a meaningful way to improve scientific decision-making as well as to provide rapid access to centralized toxicity data. DTox includes information on over 35 data attributes (e.g., species scientific name, life stage tested, dispersant name, exposure type, oil weathering stage, exposure duration, etc.), compiled through a careful review of existing data extracted from the peer-review and gray literature. Data considered for inclusion in DTox are rigorously evaluated following a strict set of rules aimed at selecting the best available and suitable data that are further evaluated through detailed Quality Assurance/Quality Control (QA/QC) procedures, which included a review of at least 15% of all records in the database. Each data source in DTox is further evaluated and given an applicability score based on its relevance to oil spills, and not on its scientific merits. Key criteria in the determination of source applicability include exposure type, reported effects concentrations, and reported analytical chemistry. Data from 400 papers (peer-review and gray literature) were evaluated for their potential inclusion into the database, and data extracted from +160 of these sources. Information in DTox is integrated into a user-friendly tool that allows for on-the-fly data searches and data plotting in the form of Species Sensitivity Distributions, based on the specific needs of an end-user. This tool can assist with the development of risk estimates related to oil spills by allowing the selection of data that most closely match the needs of an end-user.

The effectiveness, usefulness, and transferability of DTox to oil spill response are evaluated through oil spill drills, dispersant-related workshops, and dispersant-related assessment. These exercises showed that, despite existing data limitations, DTox provides information that can be used to inform tradeoff decisions based on the current state of knowledge. Data in DTox have the potential to contribute to a better understanding of the biological effects of dispersants and oil in the aquatic environment, and can provided useful information to both environmental assessments and decision making efforts. Future efforts will focus on maintaining and updating DTox and expanding its use capabilities in oil spill response community.

Keywords: Dispersant, DTox, Oil spill response, Chemically dispersed oil, Species Sensitivity Distributions.

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This research was made possible by a grant from NOAA and the University of New Hampshire's Coastal Response Research Center (Contract No. 13-034) to Research Planning, Inc. None of these results have been reviewed by CRRC and no endorsement should be inferred.

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1.0 Introduction

During the *Deepwater Horizon* oil spill an unprecedented volume of dispersants was used as a response tool to accelerate the natural biodegradation of oil and help minimize the impacts of oil on sensitive nearshore and shoreline habitats and resources (Lubchenco et al., 2012). This exceptional use of dispersants raised concerns among the public and many scientists about the toxicity of dispersant and chemically dispersed oil to water column organisms. While aquatic toxicity testing of dispersants and chemically dispersed oil has been conducted under laboratory and field conditions for at least four decades (e.g., NRC, 1989, 2005, and more recent studies) the practical use of this information, particularly to communicate risks and to address misconceptions about the use of dispersants, was limited by the lack of a centralized data repository (a data gap identified by CRRC et al., 2012). While aquatic toxicity databases contain toxicity data on dispersants and petroleum products (e.g., CAFÉ-NOAA/ERD, AQUIRE-USEPA), a database solely dedicated to consolidating in a meaningful way decades of existing toxicity data on dispersants and both physically and chemically dispersed oil was nonexistent at the time. As a result, Dispersant and Chemically Dispersed Oil Toxicity Database (DTox) is developed to address the shared need of the national and international oil spill community for access to toxicity data. The main objectives of this project are to review and integrate all available toxicity data on dispersants and chemically dispersed oil into an interactive tool that can assist the oil spill response community in their management decisions regarding the use of dispersants.

While it is clear that additional research is needed to improve our understanding of the biological, toxicological, and ecological effects of dispersants and chemically dispersed oil to a wide range of aquatic species (CRRC et al., 2012), and despite data limitations, decades of research in this field can provide valuable information to the oil spill response community and practitioners. As evident during the *Deepwater Horizon* oil spill, the ability to assess the toxicity of chemically dispersed oils is a goal shared by oil spill responders, where a common requirement is the unrestricted and rapid access to the available toxicity data, compiled following a detailed Quality Assurance/Quality Control plan.

2.0 Objectives

The main objectives of this project are to identify, evaluate, compile, and integrate all available toxicity data on dispersants and both physically and chemically dispersed oil generated under laboratory and field conditions, and to generate an interactive tool that can assist the oil spill response community in management decisions regarding the use of dispersants. The ultimate goal of this effort is the synthesis of information in a meaningful way to improve scientific decision-making as well as to provide rapid access to centralized toxicity data. The specific objectives of this project are to:

1. Identify documents and peer-review and gray literature (e.g., field, laboratory, mesocosm, accidental oil spills) reporting toxicity data (acute and chronic) of dispersants and chemically dispersed oil;
2. Rigorously evaluate each data source for quality and potential for inclusion in the DTox database;

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3. Compile all quantitative information including all relevant fields (e.g., species, exposure conditions, oil type and weathering, etc.);
4. Integrate the above information into a tool that can be used by the end-user to guide management decisions regarding the use of dispersants; and
5. Test the suitability of the compiled quantitative data for use in spill response at two pilot study areas.

3.0 Methods

The identification of peer-review and gray literature documenting the toxicity of dispersants and physically and chemically dispersed oil was done via a combination of online searches, visits to web sites of government agencies, industry, and research institutions, and direct contact with leading researchers in the field. Hard copies or electronic versions of each data source were obtained and cataloged in EndNote® prior to their review. Each data source was rigorously evaluated for their potential for inclusion in DTox following the Quality Assurance/Quality Control (QA/QC) plan developed for this project (see Appendix A for details). Examples of data criteria are shown in Table 1.

Table 1. Examples of some of the criteria used to evaluate each data source for their potential inclusion in DTox. Studies not satisfying these requirements are not included.

Criteria	Requirement/Inclusions	Limitations/Exclusions
Dispersant	Documented commercial name	Not documented
Oil	Documented fresh/weathered oil name or source	Not documented
Species	Aquatic invertebrates, vertebrates, marine bacteria	Mammals, reptiles
	Documented taxonomic information verifiable against standard taxonomic sources	Species or common name not documented
Effect/ Response	Biological effect on live, whole organisms	Dead organisms; in-vitro studies
	Adverse acute or chronic effects	Beneficial, nutritional effects
Exposure conditions	Water only exposures	Sediment, other exposures
	Acceptable control survival (at least 70%), or acceptable control endpoints	Poor control survival or unacceptable control endpoints
	Documented experimental conditions (e.g., flow through, static)	Not documented
	Documented exposure durations conditions associated with biological effects (e.g., flow through, static)	Unverifiable duration, not reported
	Documented effects concentrations	Not documented

Data were entered into a carefully designed database template in a systematic and consistent fashion. Examples of database elements (see Appendix A for details) included: 1) species attributes: taxonomic group, common name, scientific name, life stage, species distribution; 2) experimental conditions and settings: study type, water type, oil name and weathering condition, dispersant name, dispersant-to-oil ratio, exposure type, exposure duration; 3) endpoints: acute,

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subacute, effects concentration, effects concentration units, analyte name, analytical methods; and 4) data source: author name, publication year, article title. Whenever possible, entries were standardized facilitating further sorting and treatment of the existing data. An additional field was created to score the applicability of each data source (e.g., High, Moderate, Low) to spill response. Source applicability is based on the relevance of each data source to oil spill response, and not on the overall scientific merit of individual sources (see Appendix A for details). Data entered into the database template went through several QA/QC evaluations to ensure that each record accurately represented the information and data of the original data source (see Appendix A for details). Critical steps of the QA/QC process included the review of currently accepted scientific species names, standardization of column content and applicability criteria, and identification of duplicate data (e.g., several papers by the same author(s) reported in several report/manuscripts). Identifying duplicate data is an important step because it affects the values per species plotted on Species Sensitivity Distributions (SSD) (see below). Consequently, duplicate data are not removed from the database, but are not used in SSD calculations. The revised dataset is then migrated into a database program (FileMaker® Pro 12) with expanded capabilities, allowing the development of an interactive, searchable, and user-friendly tool that allows for visual exploration and examination of data (suggested citation Bejarano and Dahlin, 2013).

4.0 Results

4.1 Compiled Toxicity Data

Over 400 papers from peer review and gray literature were initially screened for their potential inclusion into the database. The complete list of citations of all papers reviewed as part of this project was compiled into an EndNote® library. This library is available to the larger oil spill community through the PI and/or CRRC. Although many of the data sources originally reviewed contained important information, many are not included in DTox because these were not the original data source and, therefore, the quality of these papers could not be judged based on the information provided (see Appendix A for details). Of these initially screened papers, data were extracted from +160 sources amounting to +3500 rows of records. A graphic representation of the type of data currently in DTox is shown in Figure 1. To date, this database contains toxicity data for +100 oils, +120 dispersants, and +190 unique aquatic species, amounting to +3,500 toxicity records. The large majority of records are for species with subtropical distributions (+1,200 records), followed by temperate species (+900 records). Cold-water species and tropical species are the most underrepresented group by geography (+800 records combined). Most currently available toxicological records are for species (and life stages) found in the water column (+2,400 records), while a considerably lower number of records are available for species from the other two general habitats (benthos and epibenthos) (+1,500 records combined). When looking at the number of records by taxonomic group, most records are for fish (+1,500 records) followed by crustaceans (+1,400 records), while other groups, especially corals are underrepresented in the database. At least one third of all records are for 13 U.S. standard test species (+1,300 records), with data for mysid shrimp (*Americamysis bahia*) and inland silverside (*Menidia beryllina*) comprising nearly 50% of all standard test species records.

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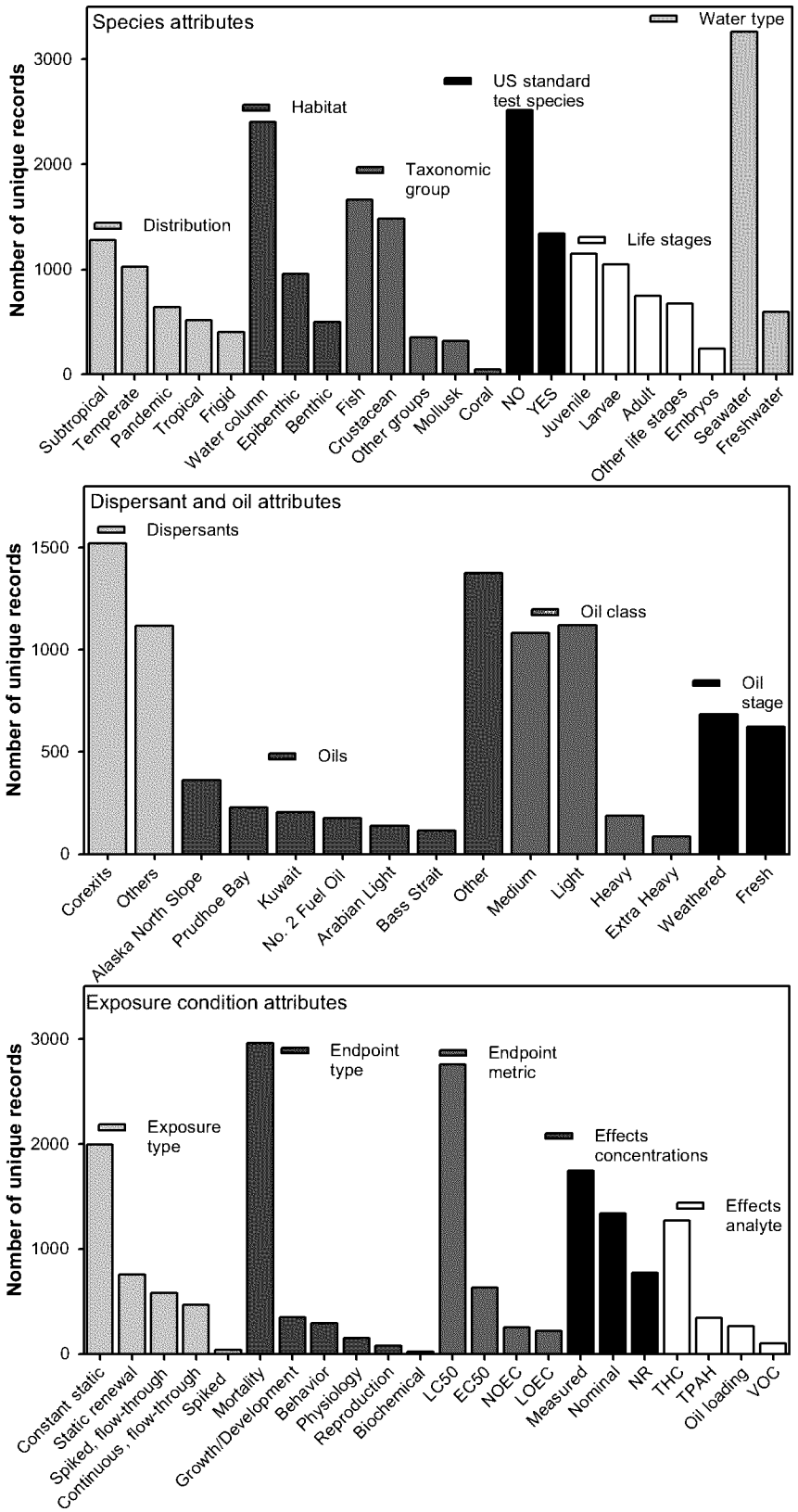

Figure 1. Breakdown of final QA/QC data and information currently in DTox by species attributes (top); oil/dispersant attributes (middle); and exposure conditions (bottom).

Based on the currently available information, it is clear that there was a surge of toxicity studies on dispersants and oil in the mid 1970s, declining drastically through the 1980s. Since the late 1980s, there have been a variable number of studies, as reflected in the number of records in DTox. Nearly one fifth of all records (+700 records) has been generated since 2010, likely driven by the *Deepwater Horizon* oil spill[1]. The most studied dispersants are the Corexits (+1,500 records; specifically Corexit 9500, Corexit 9527 and Corexit 7664), while the most studied oils are Alaska North Slope, Prudhoe Bay, and Kuwait oil (+700 records combined). The large majority of oil records (+2,000) are for light and medium oils (based on API gravity), while heavy and extra heavy oils are underrepresented in the database (+200 records combined). A large percentage of records (70%) are derived from 48- and 96-hour exposures (+2,500 records), and via static exposures (+2,400 records). Of the 171 peer-review and gray literature papers included in DTox, 37, 52, 72 were given High, Moderate and Low Applicability scores, respectively. Ten data sources were rejected.

It is important to note that there are additional data sources not currently in DTox (e.g., data currently under peer review, data unavailable because of confidentially agreements, data under litigation, older reports requiring company approval for release, etc.), and it is hoped that these data would be included in future updates of the existing database. Specifically, NOAA/BP data from the *Deepwater Horizon* oil spill are not currently available for inclusion into the database, but requests have been made to ensure that upon their release from embargo, these data will be entered into DTox following the same procedures and QA/QC plan developed during this project.

4.2 DTox-Version 1

The ultimate goal of this effort is the synthesis of information in a meaningful way to improve scientific decision-making as well as to provide rapid access to centralized toxicity data. As a result, a user-friendly tool was created to facilitate data querying. This tool is designed to allow the end-user to navigate through a series of screens where data selections can be made, narrowing the type and amount of information used in data plotting. Prior to the distribution of the first version of DTox to a selected number of end-users, a beta version of DTox was extensively tested both internally and externally by a number of individuals (testers). This step was critical to ensure that the tool met the requirements expected of an interactive tool. During the testing window, recommendations were made to improve the appearance and functionality of the tool, and a series of glitches and technical issues were identified and addressed. These early evaluations allowed the project team to address any outstanding issues and improve the presentation of the tool prior to its public release. The end-result is the production of a DTox-Version 1 tool (suggested citation Bejarano and Dahlin, 2013). Examples of the navigation windows of the first version of DTox are shown in Figure 2. Note that the first window includes a clear disclaimer, and a request for reporting of errors and inconsistencies. A window is also included to clearly acknowledge the funding source. More detailed information regarding DTox-Version 1 is provided in Appendix B, a document that is also included as a pdf within the interactive tool.

[1] Data generated through to support NRDA from the *Deepwater Horizon* oil spill are not currently included in the database.

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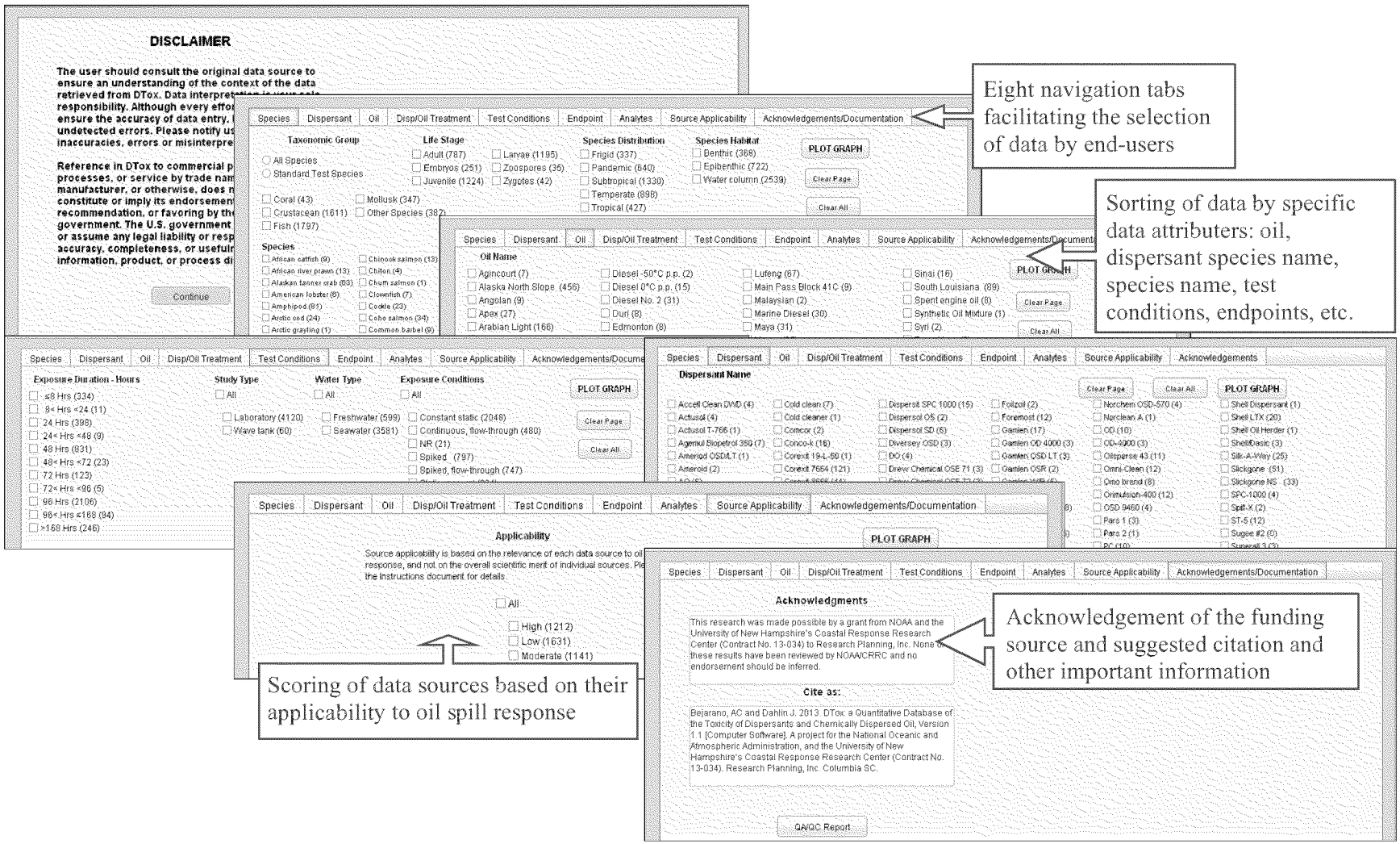

Figure 2. Examples of navigation tabs where the end-user can query the available data. A total of nine navigation tabs are currently available in DTox (Version 1).

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Following data selection from the navigation windows, the remaining data are plotted in separate windows in the form of Species Sensitivity Distributions (SSDs) (Figure 3). SSDs are probabilistic models that describe the relative sensitivity of species to a particular compound or compound mixture (Posthuma et al., 2002), where species are ranked, based on their relative sensitivity, from the least to the most sensitive. As a result, each dot on a SSD represents a unique species, specifically the geometric mean of reported toxicity values. In DTox, SSDs are generated for datasets with a minimum of 5 species by fitting the empirical toxicity data to a logistic function defined by $F(x) = \frac{1}{1 + e^{-(x-\mu)/\sigma}}$, $x \in R$, with parameters μ(location) and σ (scale). SSDs are advantageous in that these allow for comparison of the sensitivity of different species to the same type of exposure (e.g., dispersant only, oil only, chemically dispersed oil), and can be used to derive benchmarks or hazard concentrations (HC) (Posthuma et al., 2002). Some of the most commonly used HCs are the HC1 and HC5 equivalent to the concentrations at which 1% and 5%, respectively, of the species in the SSD may not be protected. When enough data are available for curve fitting, the SSDs also display the estimated HC1 and HC5 values from the logistic curve.

The current version of DTox (Version 1) allows for up to two SSDs per display window (Dispersant Only, Dispersant and Oil, Oil Only) based on the following data fields: exposure duration, dispersant name, or oil name. When only one curve is plotted, common names are displayed to facilitate data interpretation. For better visualization and interpretation of data, the queried data are displayed based on color coding the selections (e.g., by taxonomic group; by species distribution). All SSDs are plotted over a colored background representing a common scale used to rank the relative toxicity of contaminants (http://www.epa.gov/oppefed1/ecorisk_ders/toera_analysis_eco.htm#Ecotox) (see Figure 3 for details). Other features of DTox include a selection criteria tab that displays the selections made through the navigation tabs, and a report tab displaying the information used to plot the SSDs with the option of exporting both SSDs and summary data to a pdf file. DTox also contains the complete QA/QC plan used in the development of the tool (Appendix A), and a "How To" document (Appendix B), guiding end-users how to navigate and understand navigation tabs and query options, and providing examples on how to use outputs generated from this tool. This document also highlights some of the existing limitation with the current version of DTox. DTox also contains the EndNote® library with the complete list of citations of all papers reviewed as part of this project.

Throughout the development of DTox, care was taken to address individuals with disabilities (Section 508 29 U.S.C. '749d) particularly by selecting color palettes (whenever possible) designed to be readable by individuals with color blindness. A stand-alone executable file of DTox (Versions 1), which can be run in desktop and laptop computers, was made available to a selected number of end-users. As mentioned previously, prior to the distribution of DTox (Version 1), the tool was extensively tested both internally and externally by a number of testers. While these early evaluations allowed the project team to address issues prior to its public release, it is acknowledged that the organization of copious amounts of toxicity data into a practical, versatile, and logical system was challenging. However, the tool may still contain issues not currently identified. During training sessions with end-users (see Section 7.1) the PI encouraged participants to report any issues with the tool so that these can be addressed in future

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iterations of DTox. To date, comments have been provided which are summarized in Table 2. Development of additional access forms (e.g., html) may be developed in consultation with NOAA, as this agency may be in charge of the long-term maintenance and future updates of this database.

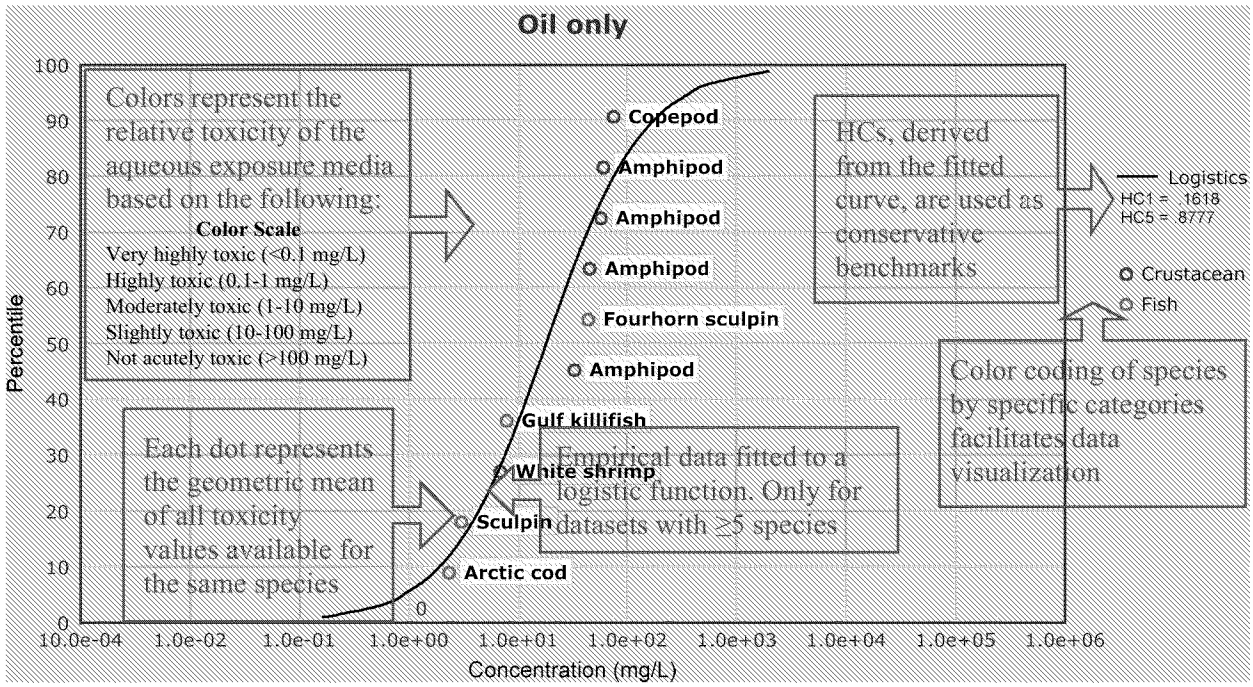

Figure 3. Example of a SSD generated following data queries, where dots represent the empirical data. Hazard Concentrations, HC1 and HC5, represent the benchmark concentrations assumed to be protective of 99% and 95%, respectively, of the species in the SSD.

Table 2. Strengths and limitation of DTox (Version 1) based on feedback provided by end-users.

Strengths
Easy to use (e.g., check boxes, tabs) and intuitive design
Clear display of data in separate tabs according to attributes
Total count of records (in parentheses) are informative
Helpful "Clear Page" and "Clear All" button on each tab
Warning appears when there are not enough data
Single and double plots are informative and well designed
The summary query tab is helpful, particularly when many data selections are made
Both plots and raw data used in plots are easily exported
Well documented tool (complete QA/QC and Instructions documents)
Limitations
Too many selection options
Applicability and life stage are not a shading options
Only common names are displayed. Scientific names should be an option
Names do not appear in double plots
Not enough information displayed on graph output section
Goodness of fit tests are not available (as pointed out by the authors)

4.2.1 DTox-Query Demonstration

In this section a series of queries are performed to demonstrate the usability of DTox (additional queries are presented in Section 4.3).

- Query 1a: Dispersant – Corexit 9500 and Corexit EC9500A; Oil – Prudhoe Bay and Alaska North Slope; Exposure conditions – Constant static, Flow through, Static renewal; Exposure duration – 96-hours; Endpoint metric– LC50, EC50; Concentration – Measured; Analyte – All options containing Total Hydrocarbon Content (THC); Applicability – Moderate, High.
- Query 1b: Identical as Query 1a, but without dispersant selection.
- Query 1c: Identical as Query 1a, but changing Exposure conditions to – Spiked, Spiked-flow-through.

As shown in Figure 4 (Top), the concentration assumed to be protective of 95% of the species in the SSD (HC5) is 0.1 milligrams of total hydrocarbons per liter (mg THC/L) in aqueous exposures to Prudhoe Bay and Alaska North Slope oils that were chemically dispersed with Corexit 9500 and Corexit EC9500A. By comparison, aqueous exposures to the same physically dispersed oils (without dispersants) (Figure 4, Middle) produce an HC5 of 0.3 mg THC/L. While the estimated HC5 values from aqueous exposures to chemically dispersed oil are smaller than those from physically dispersed oil, these two curves are likely not different from each other. These results are consistent with previous conclusions (NRC, 1989, 2005) indicating that there is no strong scientific evidence that the toxicity of chemically dispersed oil is substantially greater than that of physically dispersed oil. Note that Figure 4 (Middle) displays several amphipod species. A tab within DTox (not shown) allows the end-user to determine which amphipod species (scientific name) are included. In this case, *Anonyx nugax*, *Boeckosimus edwardsi*, *Gammarus setosus* and *Onisimus littoralis*.

Data in DTox are also queried to compare the impact of exposure conditions (static-Query1a vs. spiked-Query1b) on toxicity values. As shown in Figure 4 (Bottom), the concentration assumed to be protective of 95% of the species in the SSD (HC5) is 1.66 mg THC/L for spiked exposures, which is an order of magnitude larger (less toxic) than the HC5 value from constant exposures (0.1 mg THC/L). As a result, assessments based on toxicity data from tests performed under constant static exposures may overestimate toxicity, when compared to assessments based on spiked exposures. The latter type of laboratory settings represents more realistic field environmental exposures because these address the dilution that occurs in open waters by reproducing under laboratory conditions rapid changes in concentrations in the water column (Aurand and Coelho, 2005; Clark et al., 2001; George-Ares et al., 1999; NRC, 1989, 2005; Singer et al., 1995).

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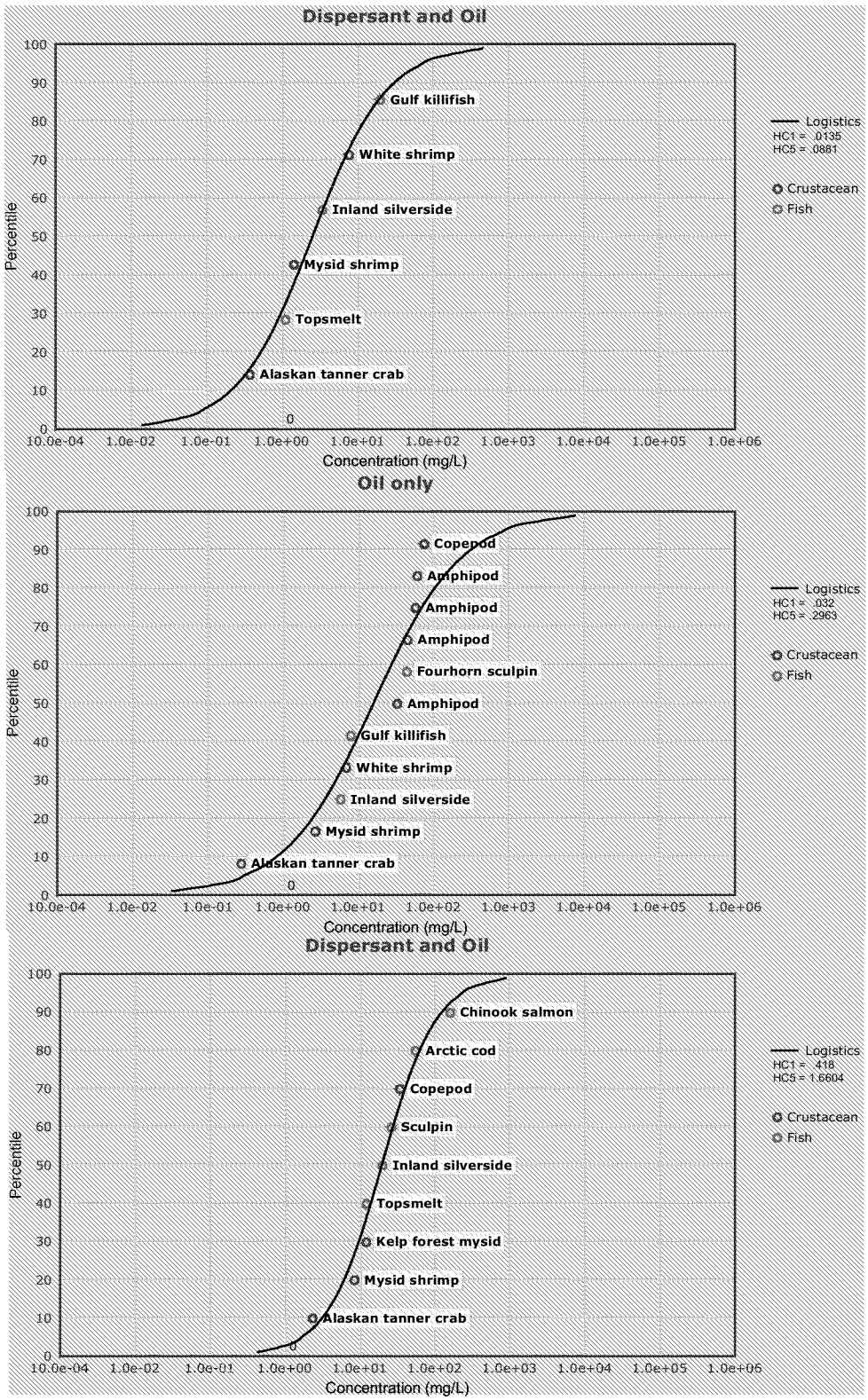

Figure 4. Example of a SSD generated following data queries in DTox. Dots represent the available empirical data. Hazard concentrations, HC1 and HC5, represent the benchmark concentrations assumed to be protective of 99% and 95%, respectively, of the species in the SSD. Top: Query 1a; Middle Query 1b; Bottom: Query 1c. See text for details.

4.3 DTox Applicability to Oil Spill Response and Planning

A database is only useful for storing information if people can correctly and efficiently query, update, and manipulate existing data to inform decisions or to perform assessments. Consequently, critical steps in assessing the effectiveness and usefulness of DTox dealt with its transferability to drills, or real oil spill situations, as well as its ability to provide information that can help inform decisions based on the current state of knowledge. To assess the applicability and transferability of this tool in spill response, two scenarios with different biological and oceanographic conditions are used to test the usefulness of DTox. The location and oil spill volume associated with each of these scenarios was provided by NOAA/ERD, and were based on either planned or past oil spill drills. Testing the applicability and transferability of DTox consists of performing data queries and selecting the appropriate receptor species with associated toxicological data, or user-specified query criteria, from which levels of concern for representative groups of species in these two areas are derived.

Steps involved in assessing the suitability of this database include:

1. Describing a spill scenario, including the location of the spill;
2. Determining the species/groups of species at risk, or species of concern;
3. Selecting the appropriate environmental and search criteria;
4. Conducting data query/queries considering Steps 1-3;
5. Deriving potential levels of concern or risk estimates; and
6. Describing data gaps and sources of uncertainty.

Note: The drills below are for demonstration purposes only and should not be taken out of context. Results and conclusions should not be used beyond the scope of this exercise, which is intended to demonstrate the applicability of DTox in oil spill response and planning.

4.3.1 Drill 1: Bay of Fundy, Maine

Spill scenario (Drill). "At 1200 ADT on Tuesday, June 18, 2013, the tank vessel *M/T NERITINA*, with a full cargo of 1,092,000 barrels (bbl) of Kuwait crude oil is transiting inbound in the Bay of Fundy collided with a cargo vessel. This collision resulted in spill of 35,000 bbl (~4,775 tonnes/1.47 million US gallons) of crude from the *M/T NERITINA*, with a potential secondary release of 50,000 bbl." This scenario is identical to the Canadian/U.S. Joint Response Team full scale exercise for the Atlantic Region (CANUSLANT) (June 17-20, 2013).

Resources at Risk. The islands of coastal Maine support a high diversity and abundance of marine life including birds and marine mammals. Nearshore areas also support productive commercial fisheries for fish and invertebrate species. Because of the ecological importance of nearshore waters to numerous marine species, the use of dispersants is not taken lightly as there are several federally threatened and endangered species (protected under the Endangered Species Act), as well as species of special concern, and species of local significance. A summary of these biological resources of concern is summarized in Table 3.

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Table 3. Biological resources at risk from a release of oil from the *M/T NERITINA*, with focus on nearshore/offshore waters. U.S. Status: FT = Federal threatened; FE = Federal endangered; ST = State threatened; SE = State endangered, SC= State species of special concern. Canada Status: CA-FE = federal endangered; CA-FSC: federal species of special concern.

Species Group	Species Subgroup (Status)	Seasonal Presence	Comments
Birds	Arctic terns (ST)	Nests May-Jun	
	Atlantic puffin (ST)	Nests Apr-Aug	
	Double-crested cormorant	Nests Apr-Jul	
	Harlequin ducks (ST)	Wintering Oct-Mar	
	Leach's storm petrel (SC)		
	Least tern (FE, SE)	Nests May-Aug	
	Piping plover (FT; CA-FT; SE)	Nests May-Aug	
	Razorbill (ST)	Mar-Sep; nests May-Jun	
	Red knot	Migration Jun-Jul	
	Roseate tern	Nests May-Aug	
Marine mammals	Atlantic white-sided dolphin	Calve Jun-Jul	
	Fin whale (FE; CA-FSC)	Peak abundance Apr-Oct	Most frequently found in waters over the continental shelf
	Gray seals	Pup Dec-Feb	
	Harbor porpoise	Calve May-Jun	Found throughout the Bay of Fundy
	Harbor seals	Pup May-Jun	
	Harp seals	Jan-May	
	Humpback whale (FE; CA-FSC)	Moderate abundance Summer	Most frequently found in waters over the continental shelf
	Minke whale		
	North Atlantic right whale (FE, CA-FE)	Peak abundance May-Sep	Found in shallow nearshore waters
	Sei whale (FE, CA-FE)	Peak abundance May-Sep	Most frequently found in waters over the continental shelf
Fish	American plaice		
	Atlantic cod		
	Atlantic halibut		
	Atlantic herring		Offshore spawning areas
	Atlantic salmon (FE; CA-FE)	Apr-Nov	Coastal/inland Maine critical habitat for this species under ESA. Present in the outer Bay of Fundy
	Bluefin tuna	Migration July	
	Halibut		
	Winter and Witch flounder		
Invertebrates	American lobster	Inshore migration Summer	Species of local economic importance
	Northern shrimp	Spawn Nov-May	
	Rock crabs		
	Sea scallop		

One of the main resources of concern in the area is the American lobster (*Homarus americanus*), which is an iconic commercial species harvested since the 18th century. While most life stages of this species are associated with the substrate (benthic), three of the four stages of

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lobster larvae are found in the water column (pelagic) between late spring to early fall (May to October), where they are transported by surface water from offshore to coastal waters before settling to the bottom (MacKenzie and Moring, 1985). Recent work by Incze (2010) reported, based on a spatially explicit population model, that larvae stages I-III are generally found in the top 15 meters (m) of the water column concentrating in the coastal shelf (<50 m to 100 m isobaths), with vertical distribution varying depending on water column stratification. A related paper (Annis, 2005) also documented that post-larvae (stage IV) concentrate in the upper 2 m of the water column, spending the large majority of their time near the surface (0-0.5 m) closer to shore. Consequently, an oil spill of large magnitude coinciding with peak distributions of larvae in the top few meters of the water column may have impacts on a fraction of the lobster population. While there are reasonable concerns regarding the potential impact of oil to early life stages of lobster, only a small number of studies (Capuzzo et al., 1984; Wells, 1972; Wells and Sprague, 1976) have documented their sensitivity to physically dispersed oil.

Modeled Expected Environmental Concentrations. For the purpose of this exercise, two scenarios for this ***drill*** are run to characterized potential oil concentrations associated with this release using the General NOAA Operational Modeling Environment (GNOME) (Beegle-Krause, 2001; NOAA/ERD, 2013): 1) a scenario allowing the released oil to disperse physically without the use of dispersants; and 2) a scenario treating the released oil with dispersants, under the assumption that 50% of the oil is effectively dispersed. Note that this is an ***extreme*** case of dispersant effectiveness, and is intended here to provide a worst-case exposure condition of aquatic organisms to chemically dispersed oil. While dispersant effectiveness under field conditions is highly variable, dispersant effectiveness has been reported to vary between 5% and 30% (NRC, 2005). The hypothetical spill of Kuwait oil is assumed to take place offshore in an area between the 60 and 200 m isobaths.

GNOME was run under the following environmental conditions.

- Light to Medium crude (API 34)
- Environmental conditions:
  - Wind: variable, range 2 to 12 knots from various directions
  - Mixed layer: 10 m depth
  - Breaking wave height: variable, range 0.009 to 0.33 m
  - Contour depth: 0 to 5 m

GNOME modeled oil trajectories (Figures 5 and 6) showed that physically dispersed oil would impact coastal shorelines north east of Blacks Harbour within 48 hours post release, with large quantities of oil entering the western section of Bay of Fundy 48 to 96 hours post release. At 96 hours post release, oil would reach south eastern sections of the Bay (e.g., Roosevelt Campobello International Park, Clark Gregory Nature Preserve). By comparison, modeled trajectories of the oil chemically treated with dispersants showed generally the same trends, except that the extent of shoreline oiling would be substantially lower. However, larger amounts of oil are entrained in the top few meters of the water column. Under the chemically dispersed scenario, peak oil concentrations in the water column would be localized north of Grand Manan Island.

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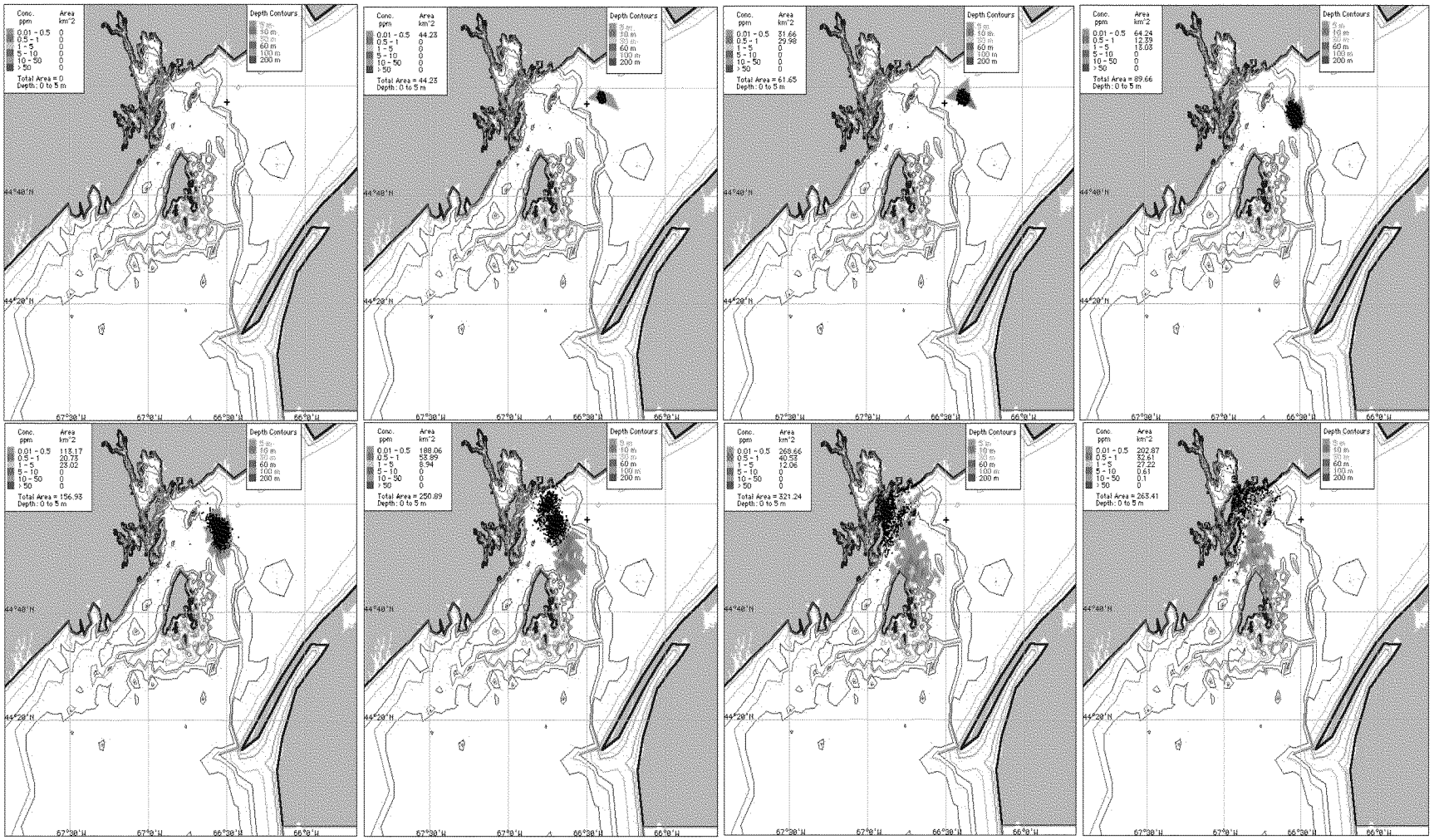

Figure 5. Spill trajectory snap shots of a physically dispersed plume of Kuwait crude oil (1.47 million gal) released into Bay of Fundy by the tank vessel *M/T NERITINA* ***(drill)***. Top and bottom, and left to right, represent GNOME model outputs 0, 3, 6, 12, 24, 48, 72, and 96 hours post release. Colors represent modeled oil concentrations in the top 5 m of the water column. Data provided by A. Mearns, NOAA ERD.

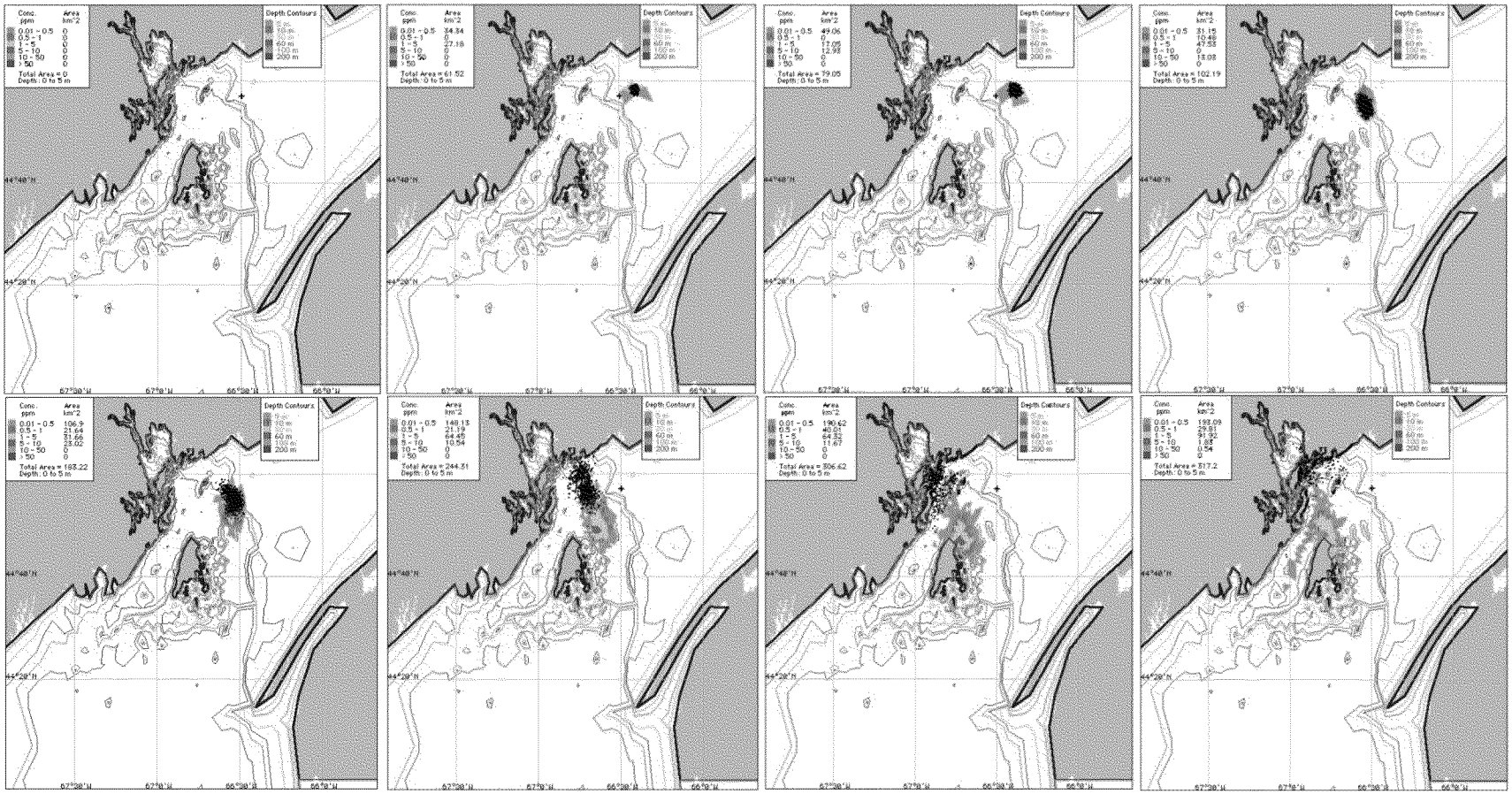

Figure 6. Spill trajectory snap shots of a chemically dispersed plume of Kuwait crude oil (1.47 million gal) released into Bay of Fundy by the tank vessel *M/T NERITINA* ***(drill)***. Top and bottom, and left to right, represent GNOME model outputs 0, 3, 6, 12, 24, 48, 72, and 96 hours post release. Colors represent modeled oil concentrations in the top 5 m of the water column. Data provided by A. Mearns, NOAA ERD.

Oil budgets for the two scenarios of this ***drill*** (Figures 7) indicated that physically dispersed oil would remain in large quantities floating on the water surface during the first 24 hours post release (48% of the oil released), following by large quantities of oil stranding on shoreline habitats (up to 25% of the oil released) between 48 and 96 hours post release. Under this scenario, 37% of the oil would evaporate, and up to 30% would be physically dispersed into the water column. By comparison, a relatively small amount of the released oil (4%) would be present on the water surface following chemical treatment of oil slicks. Under this scenario, a large proportion of the released oil (60%) would disperse into the water column (mostly into the top 10 m of the water column) within the 24 hours post release, but a relatively small proportion (13%) would impact coastal shorelines. Under this scenario, 19% of the oil would dissipate via evaporation.

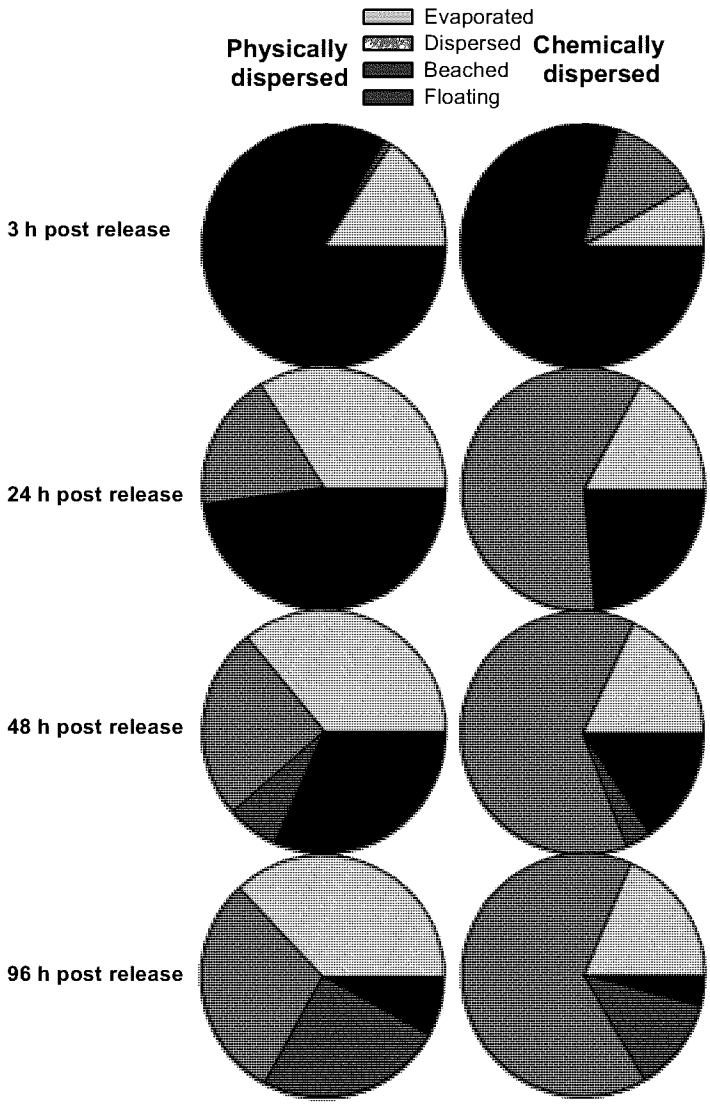

Figure 7. Oil budgets comparison as a function of time between the physically and chemically dispersed scenarios from a release of Kuwait crude oil (1.47 million gal) into Bay of Fundy by the tank vessel *M/T NERITINA* ***(drill)***. Note that the chemically dispersed scenario assumes an extremely high dispersant effectiveness (50%), which is intended here to provide a worst-case exposure condition to aquatic organisms. Data from GNOME provided by A. Mearns, NOAA ERD.

Two summary statistics are obtained from GNOME to characterize oil concentrations for this ***drill***. These are the average and maximum (worst-case) concentrations in the top 5 m of the water column for each 30 min interval over the entire model run period (0 to 96 hours). Average and maximum (worst-case) modeled oil concentrations in the water column (covered in detail in a later section) under the physically dispersed scenario are generally low (Figure 8) (Average: mean 0.29 mg/L, median, 0.30 mg/L, maximum 0.43 mg/L; Maximum (worst-case): mean 1.29 mg/L, median, 1.54 mg/L, maximum 2.19 mg/L). By comparison, the average and maximum modeled oil concentrations in the water column under the chemically dispersed scenario are in the 1.5- 3 mg/L range, with some exceptions (Average: mean 0.79 mg/L, median, 0.89 mg/L, maximum 1.97 mg/L; Maximum: mean 2.39 mg/L, median, 2.56 mg/L, maximum 3.62 mg/L).

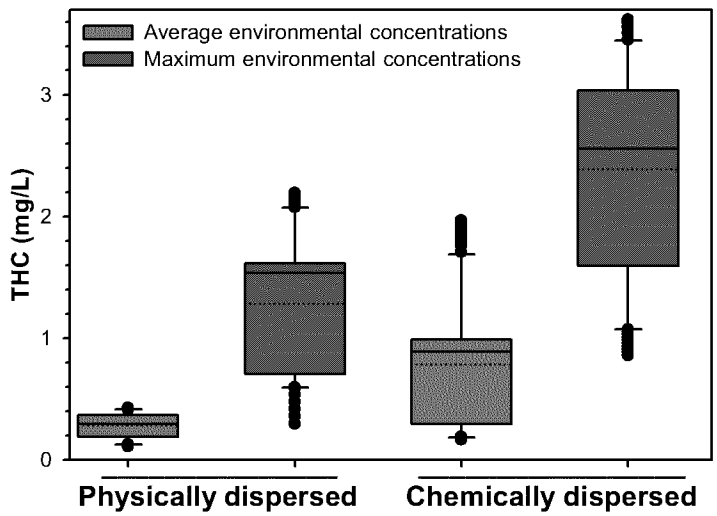

Figure 8. General box-plot overview of the expected oil concentrations of physically and chemically dispersed scenarios from a release of Kuwait crude oil (1.47 million gal) into Bay of Fundy by the tank vessel *M/T NERITINA (**drill**)*. Data from GNOME. Note that the chemically dispersed scenario assumes an ***extremely high*** dispersant effectiveness (50%), and intended here to provide a worst-case exposure condition to aquatic organisms. Oil concentrations are the average and maximum concentrations in the top 5 m of the water column for each 30 min interval over the entire model run period (0 to 96 hours). The length of the box represents the distance between the 25th and the 75th percentile concentrations, while the whiskers represent the 5th and 95th percentile concentrations. The solid and dashed horizontal lines in the box represents the median and mean respectively. The closed circles indicate outliers.

Estimated Environmental Concentrations of Concern. A query was performed in DTox to facilitate the understanding of the potential impact of physically and chemically dispersed oil on lobster larvae. To ensure reproducibility of the analyses presented here, a complete list of relevant fields queried and selected in DTox is provided below (Figure 9):

- Query #1: Life stage – embryos, larvae, juvenile; Habitat – water column; Taxonomic group – fish and crustaceans; Dispersant/Oil Treatment – Oil only, and Dispersant and Oil; Exposure duration – 96-hours (*assumed to be a worst case exposure*); Exposure conditions – Spiked, Spiked-flow-through; Endpoint metric – LC50, EC50; Effects

concentration analyte – All options containing Total Hydrocarbon Content (THC); Concentration –Measured; Paper Applicability– Moderate, High

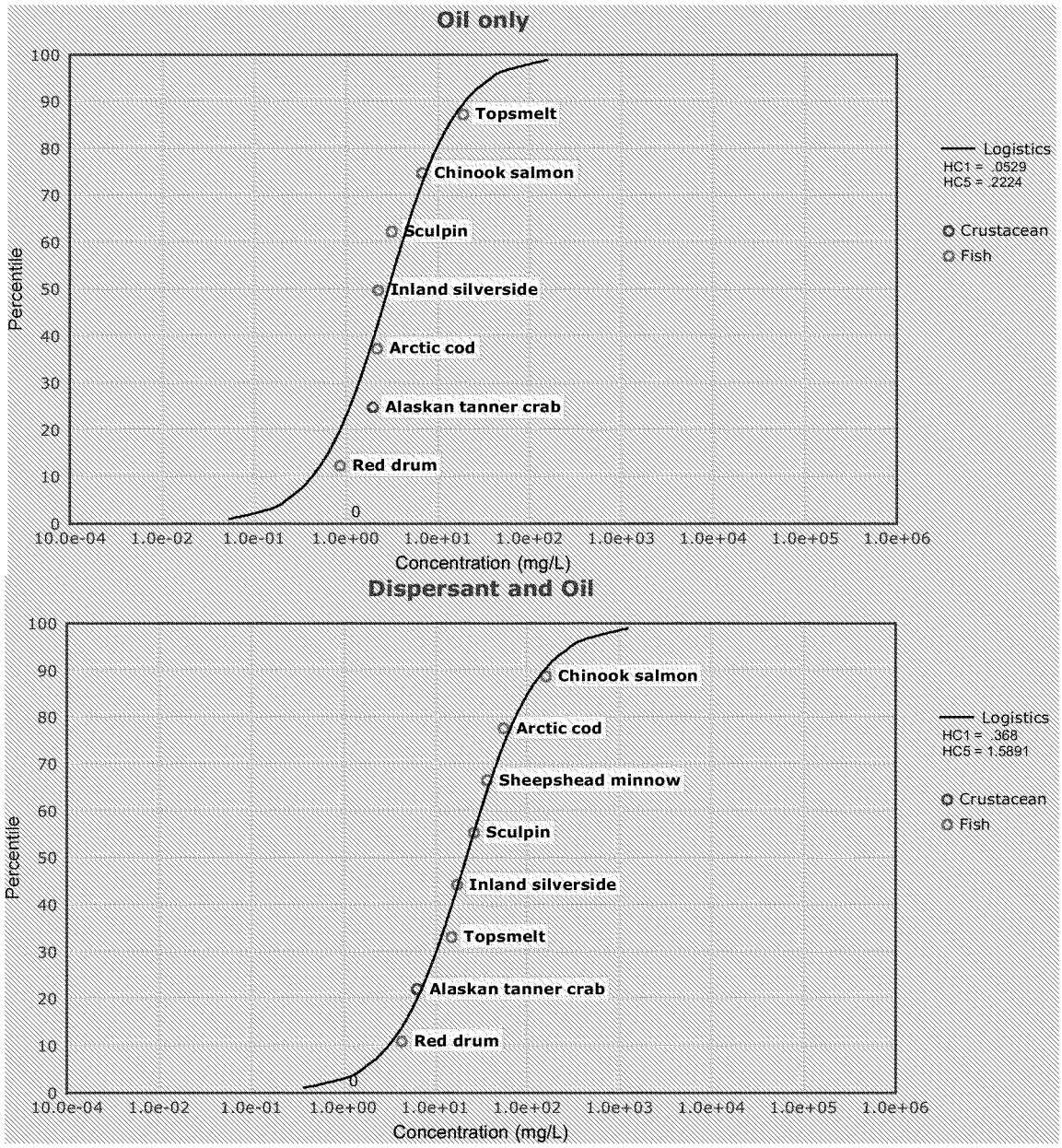

Figure 9. SSD generated following a data query in DTox for the ***drill*** in Bay of Fundy involving the tank vessel *M/T NERITINA*.

For the purpose of this ***drill***, the SSD with the most conservative 5 percentile hazard concentration (HC5=0.22 mg/L) (Figure 9, top) is used in further interpretations. Note that the only toxicity data available for larvae of the American lobster are from Wells and Sprague (1976) who reported a 96-h LC50 (based on measured reported concentrations) of 0.86 mg/L to first-stage larvae. HC values of the most conservative plot are also protective of first-stage larvae.

Potential Environmental Impacts. Average and maximum (worst-case) oil concentrations for the physically dispersed ***drill*** scenario overlap 5% and 40%, respectively, of the most conservative 96h-SSD (Figure 10). A different pattern is observed with the ***drill*** scenario involving chemical dispersion of the released oil. Average and maximum (worst-case) oil concentrations for the chemically dispersed scenario overlap 20% and 60%, respectively, of the most conservative 96h-SSD. Under the chemical dispersion scenario, 60% and 97% of the average and maximum (worst-case) oil concentrations, respectively, exceeded the HC5. Exposures above the HC5 are limited to the first 60-70 hours post release for the average scenario, and >90 hours post spill for the maximum oil concentrations scenario. All of these exceedances are limited to the top 10 m of the water column, mostly within the top 2 m (data not shown).

While these comparisons are useful, without a spatial context these can lead to overestimation of risks. The areal extent of the water surface with modeled oil concentrations is also further analyzed for the chemically dispersed scenario. As shown in Figure 11, the areal extent of the concentration bracket exceeding the HC5 (0.5-1 mg/L, 1-5 mg/L and >5 mg/L) grew from 27.18 km^2 3 hours post release to 124 km^2 120 hours post release. By contrast, most of the areal extent of the impacted water surface had concentrations in the 0.01-0.5 mg/L range (range: 34 km^2 3 hours post release to 193 km^2 120 hours post release). As shown in this exercise, the area of potential impact is relatively small (0.07% of the Gulf of Maine/Bay of Fundy system, 180,000 km^2) and concentrated into an area 24 times the size of a standard football field. This information (and Figure 7) demonstrate that while there is an increased risk to water column organisms from dispersant use to mitigate the impacts of this particular ***drill*** (albeit concentrated into a relatively small area and to depths <10 m), the greatest environmental tradeoff is the reduced impact to shoreline habitats (physically vs. chemically dispersed oil on shorelines, 368,088 gal vs. 183,456 gal, respectively), and reduced amounts of floating oil (physically vs. chemically dispersed oil on water surface 117,306 gal vs. 60,270 gal, respectively) which can pose adverse risks to surface marine species (e.g., birds and marine mammals).

As mentioned before, one of the main resources of concern is the American lobster, which under this spill scenario may be exposed to potentially toxic oil concentrations in the top few meters of the water column. The extent of potential adverse lethal and sublethal effects to this species and its local population depends on both the encounter rate of oil at concentrations above those assume to cause adverse effects, and exposure duration to those oil concentrations. Under the assumption that larvae are evenly distributed in the top 10 m of the entire Bay of Fundy area, and assuming that the entire area with concentrations ≥0.01 mg/L (physically dispersed scenario1,188 km^2; chemically dispersed scenario 1,294 km^2) would overlap the distribution of larvae, an estimated 0.7% of the lobster larvae in the entire Bay of Fundy would encounter oil in the water column.

While potential toxicological consequences to water column organisms may be expected, these assessments are conservative as the benchmark used here is biased towards overprotection or marine species (i.e., based on 96-h exposure toxicity data). This degree of conservatism added to the fact that oil biodegradation is not taken into account suggests that oil concentrations would likely be lower than those predicted by the GNOME model.

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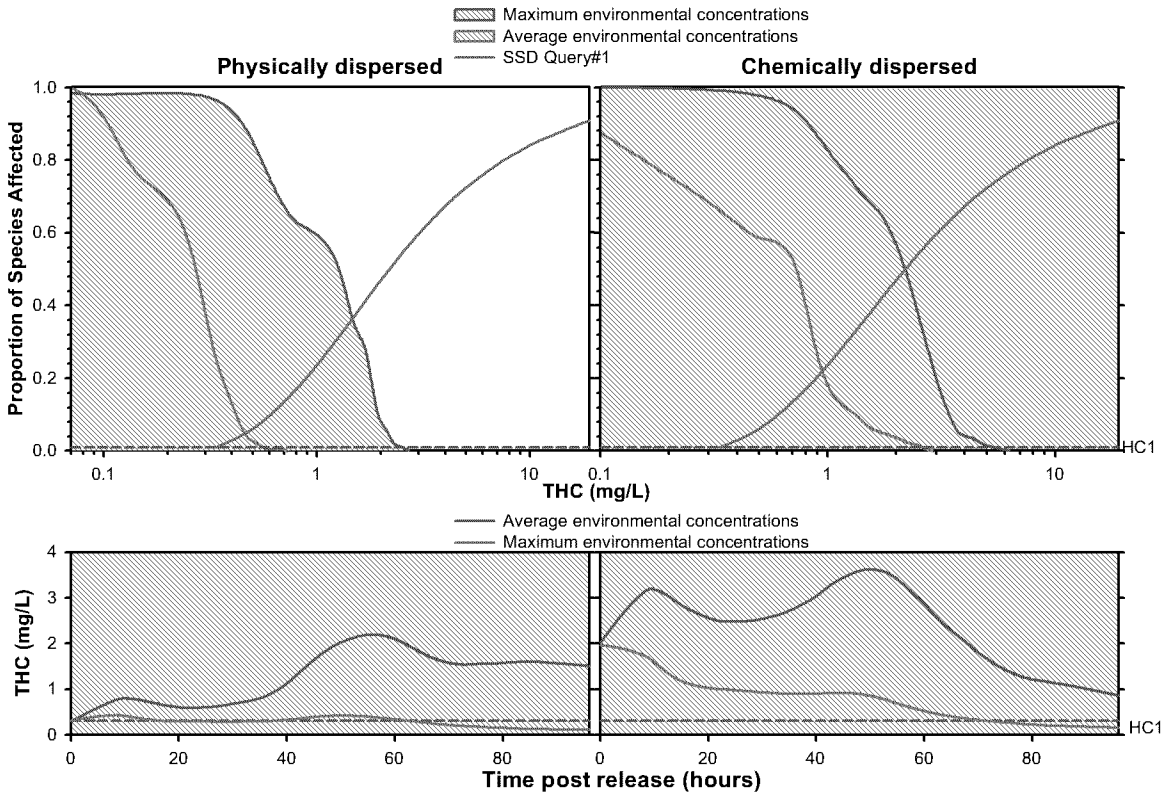

Figure 10. Cumulative average and maximum (worst-case) modeled oil concentrations relative to 96 h-SSDs (top), and average and maximum modeled oil concentrations as a function of time post release for a physically (left) and chemically dispersed (right) plume of a Kuwait crude oil into Bay of Fundy by the tank vessel M/T NERITINA (***drill***). As a reference, the benchmark for this drill is HC5=0.22 mg/L

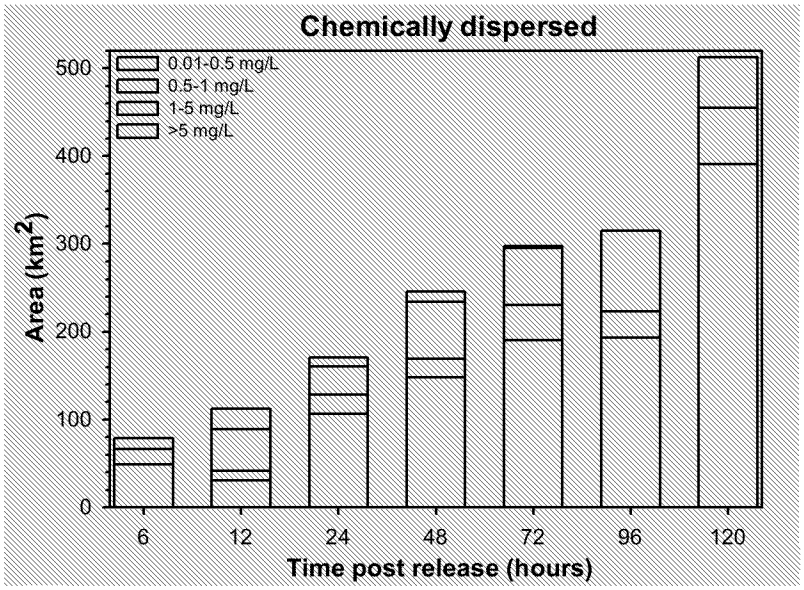

Figure 11. Water surface area impacted by a spill of Kuwait crude oil (1.47 million gal) into Bay of Fundy (***drill***), as a function of time post release (hours), and average oil concentrations. As a reference, the benchmark for this drill is HC5=0.22 mg/L.

4.3.2 Drill 2: Area offshore from Charleston Harbor, South Carolina

Spill scenario (Drill). On May 23, 2013 at 5:00 pm EDT a spill of 5,000 bbl (210,000 gal) of Qua Iboe Nigerian Crude is released offshore from Charleston Harbor, South Carolina. Qua Iboe Nigerian Crude (API 34) is a light to medium weight crude oil, which may coat intertidal habitats, as well as wildlife on the water surface. The oil may also result in water column and benthic impacts if mixed into the water column by waves, or if it strands in large amounts in shallow, sheltered areas with limited water exchange.

Resources at Risk. During spring and summer, shoreline habitats along the South Carolina coast support a high number of nesting seabirds, and beaches provide nesting habitat for several species of sea turtles. Marshes in the area provide important habitat for a variety of shorebirds, as well as terrestrial and aquatic mammals (mink, river otter, beaver, and raccoon). Nearshore and offshore areas also support productive commercial fisheries for fish and invertebrate species. Because of the ecological importance of nearshore waters to numerous marine species, the use of dispersants is not taken lightly as there are several federally threatened and endangered species (protected under the Endangered Species Act), as well as species of special concern, and species of local significance. These biological resources of concern are summarized in Table 4.

Table 4. Biological resources at risk from a release of oil off Charleston Harbor, South Carolina, with focus on nearshore/offshore waters. U.S. Status: FT = Federal threatened; FE = Federal endangered; ST = State threatened; SE = State endangered, SC= State species of special concern.

Species Group	Species Subgroup (Status)	Seasonal Presence	Comments
Birds	American oystercatchers		Largest wintering concentration on the east coast
	Bufflehead		Present in coastal and offshore areas
	Brown pelicans		Present in coastal and nearshore areas
	Cormorants		
	Great blue heron	Nesting peak May-Aug	
	Gull-billed terns and	Nesting peak Apr-Aug	
	Black skimmers	Nesting peak Apr-Aug	
	Least tern (FE; ST)		Present in marshes, and on tidal flats in the area
	Piping plover (FT; ST)		Most frequently found during winter
Reptiles	Green sea turtle (FE; SE)	Present year-round, peak Apr-Dec Nesting May-Aug Hatching July-Oct	Found in offshore waters
	Leatherback sea turtle (FE; SE)	Present year-round, peak Apr-Dec Nesting Mar-Jul Hatching May-Oct	Present in nearshore and offshore waters
	Loggerhead sea turtle (FT; ST)	Present year-round, peak Apr-Dec	Present in nearshore and offshore waters

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Species Group	Species Subgroup (Status)	Seasonal Presence	Comments
		Nesting Jun-Nov Hatching Jul-Dec	
Marine mammals	Bottlenose dolphin	Present year-round, Breeds year-round	Found in shallow nearshore waters and offshore waters
	Mink whale		Most frequently found in waters over the continental shelf. Occasionally present
	Humpback whale (FE; SE)		Most frequently found in waters over the continental shelf. Occasionally present
	North Atlantic right whale (FE)	Calving Nov-Mar	Found in shallow nearshore waters
Fish	Atlantic croaker	Larvae and juveniles may be present	Most frequently found in tidal creeks
	Atlantic menhaden	Eggs/larvae/post-larvae may be present	Adults most frequently found in offshore waters throughout the water column
	Red drum	Larvae and juveniles may be present	Adults most frequently found in coastal waters
	Red snapper	Eggs/larvae Jun-Oct Juveniles may be present	
	Shortnose sturgeon (FE)		Found in coastal rivers
	Spanish mackerel		Most frequently found in coastal and offshore waters
	Summer flounder	Larvae and juveniles may be present	Adults most frequently found in coastal waters
	Southern flounder	Larvae and juveniles may be present	Adults most frequently found in coastal waters
	Spot	Larvae and juveniles may be present	Adults most frequently found in coastal waters
Invertebrates	American oysters		Spawn in tidal creeks and on sheltered tidal flats
	Blue crab	Larvae and juveniles may be present	Found in offshore waters
	Brown shrimp	Eggs/larvae may be present Spawning Jan-Dec	Found in offshore waters
	Pink shrimp		Found in offshore waters. Not very common.
	Spiny lobster		Found in offshore waters
	Stone crab	Spawning Mar-Oct, peak May-Aug Larvae and juveniles may be present	Adult oyster, including females incubating eggs, found on bars and mud flats
	White shrimp	Spawning May-Jun	Found in offshore waters
		Larvae/juveniles may be present	

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While the area off South Carolina harbors a high diversity of aquatic species, their exposure to physically and chemically dispersed oil depends on their spatial distribution and on their habitat distribution within the water column. Consequently, the primary resources of concern are those commonly found offshore at the water surface or in the upper few meters of the water column. Specific examples include adults and early life stages of commercially important free-swimming shellfish (brown shrimp, white shrimp, and blue crab), and fishery resources that spawn in the water column (e.g., Atlantic menhaden).

Modeled Expected Environmental Concentrations. For the purpose of this exercise, two scenarios for this ***drill*** are run to characterize potential oil concentrations associated with this release using GNOME) (Beegle-Krause, 2001; NOAA/ERD, 2013): 1) a scenario allowing the released oil to disperse physically without the use of dispersants; and 2) a scenario treating the released oil with dispersants, under the assumption that 80% of the oil is effectively dispersed. Note that this is an ***extremely high*** case of dispersant effectiveness, and is intended here to provide a worst-case exposure condition of aquatic organisms to chemically dispersed oil. While dispersant effectiveness under field conditions is highly variable, dispersant effectiveness has been reported to vary between 5% and 30% (NRC, 2005).

GNOME was run under the following environmental conditions.

- Light to Medium crude (API 34)
- Environmental conditions:
  - Wind: 15 knots from the South
  - Mixed layer: 5 m depth
  - Breaking Wave Height: 1 m
  - Contour depth: 0 to 5 m

GNOME modeled oil trajectories (Figures 12 and 13) showed that physically dispersed oil would impact coastal shorelines north east of the harbor (e.g., Sullivan's Island and Isle of Palms) within 24 hours post release, with large quantities of oil entering Charleston Harbor between 24 and 48 hours post release. Coastal habitats south west of the harbor (e.g., Morris Island and Folly Beach) would be oiled >24 hours post release. By comparison, modeled trajectories of the oil that is chemically treated with dispersants showed generally the same trends, except that the extent of shoreline oiling would be substantially lower. However, larger amounts of oil are entrained in the top few minutes of the water column.

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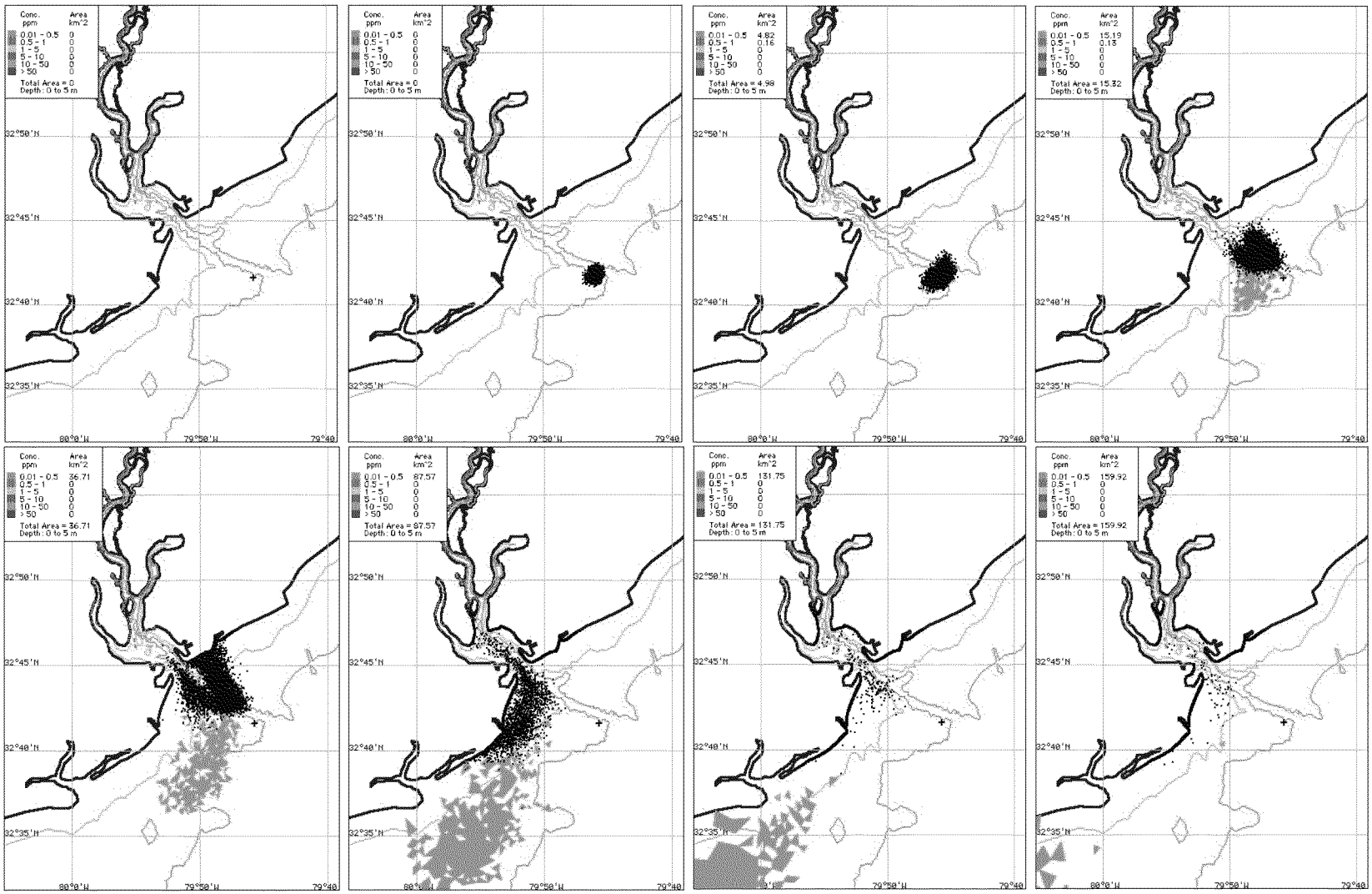

Figure 12. Spill trajectory snap shots of a physically dispersed plume of Qua Iboe Nigerian crude oil (210,000 gal) (***drill***) released offshore from Charleston Harbor. Top and bottom, and left to right, represent GNOME model outputs 0, 3, 6, 12, 24, 48, 72, and 96 hours post release. Colors represent modeled oil concentrations in the top 5 m of the water column. Data provided by A. Mearns, NOAA ERD.

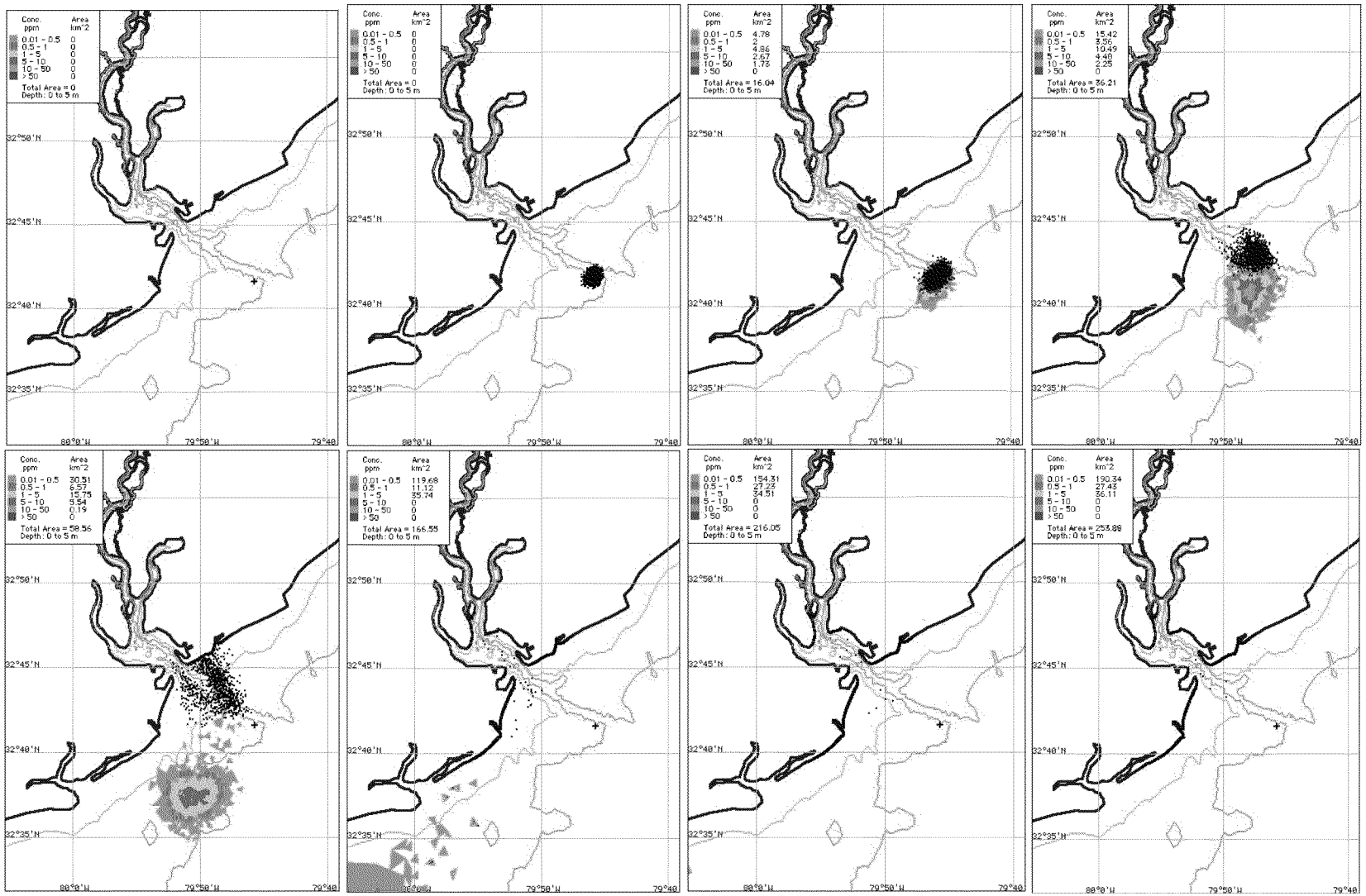

Figure 13. Spill trajectory snap shots of a chemically dispersed plume of Qua Iboe Nigerian crude oil (210,000 gal) (***drill***) released offshore from Charleston Harbor, assuming an extremely high dispersant effectiveness (80%). Top and bottom, and left to right plots represent GNOME model outputs 0, 3, 6, 12, 24, 48, 72, and 96 hours post release. Colors represent modeled oil concentrations in the top 5 m of the water column. Data provided by A. Mearns, NOAA ERD.

Oil budgets for the two scenarios of this ***drill*** (Figure 14) indicated that physically dispersed oil would remain in large quantities floating on the water surface during the first 24 hours post release (>50% of the oil released), following by large quantities of oil stranding on shoreline habitats (>30% of the oil released) between 48 and 96 hours post release. Under this scenario, 35% of the oil would evaporate, and <5% would be physically dispersed into the water column. By comparison, a relatively small amount of the released oil (14%) would be present on the water surface following chemical treatment of oil slicks. Under this scenario, a large proportion of the released oil (65%) would disperse into the water column (mostly into the top 5 m of the water column) within the 24 hours post release, but a relatively small proportion (11%) would impact coastal shorelines. Under this scenario, 20% of the oil would dissipate via evaporation.

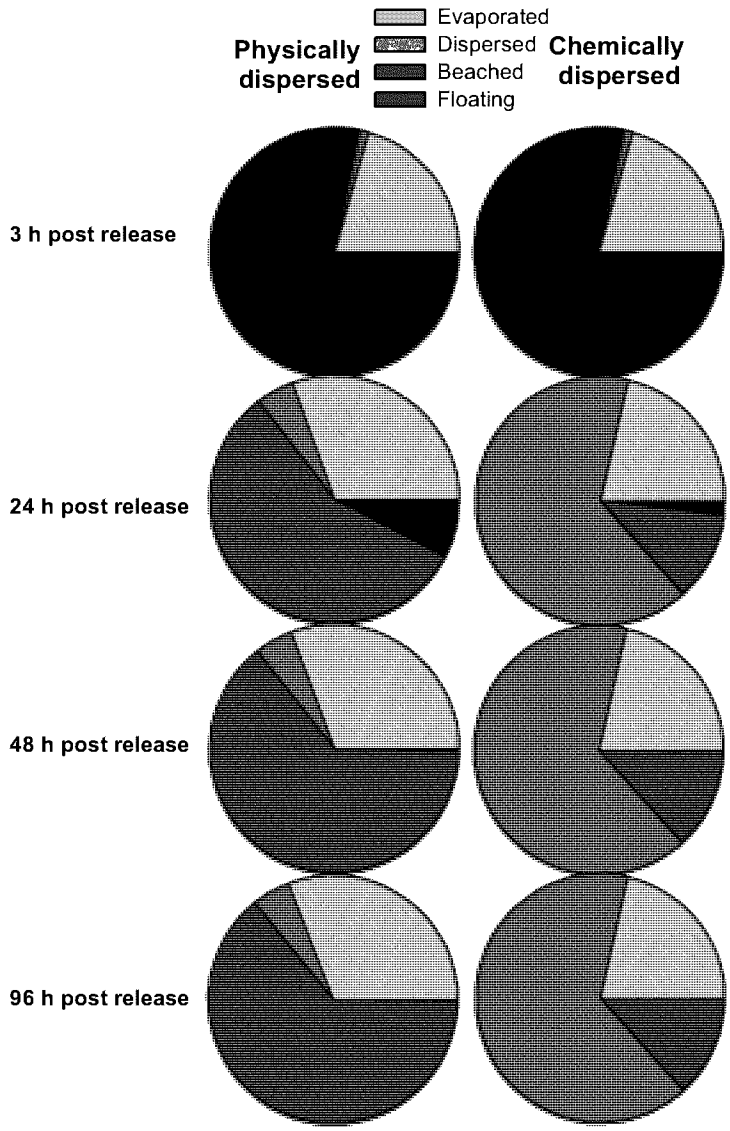

Figure 14. Oil budgets comparison as a function of time between the physically and chemically dispersed scenarios from a release of Qua Iboe Nigerian crude oil (210,000 gal) (***drill***) offshore from Charleston Harbor. Note that the chemically dispersed scenario assumes an extremely high dispersant effectiveness (80%)%), which is intended here to provide a worst-case exposure condition to aquatic organisms. Data from GNOME provided by A. Mearns, NOAA ERD.

Two summary statistics are obtained from GNOME to characterize oil concentrations of hydrocarbon for this ***drill***. These are the average and maximum (worst-case) concentrations in the top 5 m of the water column from each 30 min interval over the entire model run period (0 to 96 hours). Average and maximum (worst-case) modeled oil concentrations in the water column (cover on detailed in a later section) under the physically dispersed scenario are generally low (Figure 15) (Average: mean 0.07 mg/L, median, 0.05 mg/L, maximum 0.28 mg/L; Maximum (worst-case): mean 0.374 mg/L, median, 0.27 mg/L, maximum 0.73 mg/L). By comparison, the average and maximum (worst-case) modeled oil concentrations in the water column under the chemically dispersed scenario are in the 1- 3 mg/L range, with some exceptions (Average: mean 0.96 mg/L, median, 0.63 mg/L, maximum 3.2 mg/L; Maximum (worst-case): mean 2.92 mg/L, median, 1.59 mg/L, maximum 13.15 mg/L).

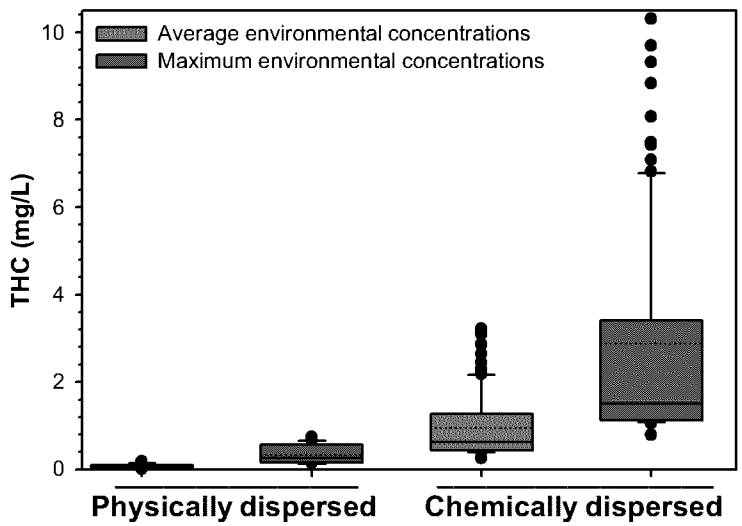

Figure 15. General box-plot overview of the expected oil concentrations physically and chemically dispersed scenarios from a release of Qua Iboe Nigerian crude oil (210,000 gal) (***drill***) offshore from Charleston Harbor. Note that the chemically dispersed scenario assumes an ***extremely high*** dispersant effectiveness (80%), and intended here to provide a worst-case exposure condition to aquatic organisms. Oil concentrations are the average and maximum concentrations in the top 5 m of the water column for each 30 min interval over the entire model run period (0 to 96 hours). The length of the box represents the distance between the 25th and the 75th percentile concentrations, while the whiskers represent the 5th and 95th percentile concentrations. The solid and dashed horizontal lines in the box represents the median and mean respectively. The closed circles indicate outliers.

Estimated Environmental Concentrations of Concern. Two queries are performed in DTox to facilitate the understanding of the potential impact of physically and chemically dispersed oil on species of interest off Charleston Harbor, South Carolina: selected species query, and shrimp query regardless of their global distribution. To ensure reproducibility of the analyses presented here, a complete list of relevant fields queried and selected in DTox is provided below (Figure 16):

- Query #1: Species – all shrimp-like species, plus sheepshead minnow, gulf killifish and longnose killifish (species of the genus, *Fundulus*), Inland silverside, and Red drum (25 species total); Exposure duration – 96-hours (*assumed to be a worst case exposure*); Endpoint metric – LC50; Oil name – All light and medium oils; Dispersant name – Corexit 9500, EC9500A, 9527, and EC9527A; Effects concentration analyte – all options containing Total Hydrocarbon Content (THC); Concentration – Measured; Paper Applicability – Moderate, High

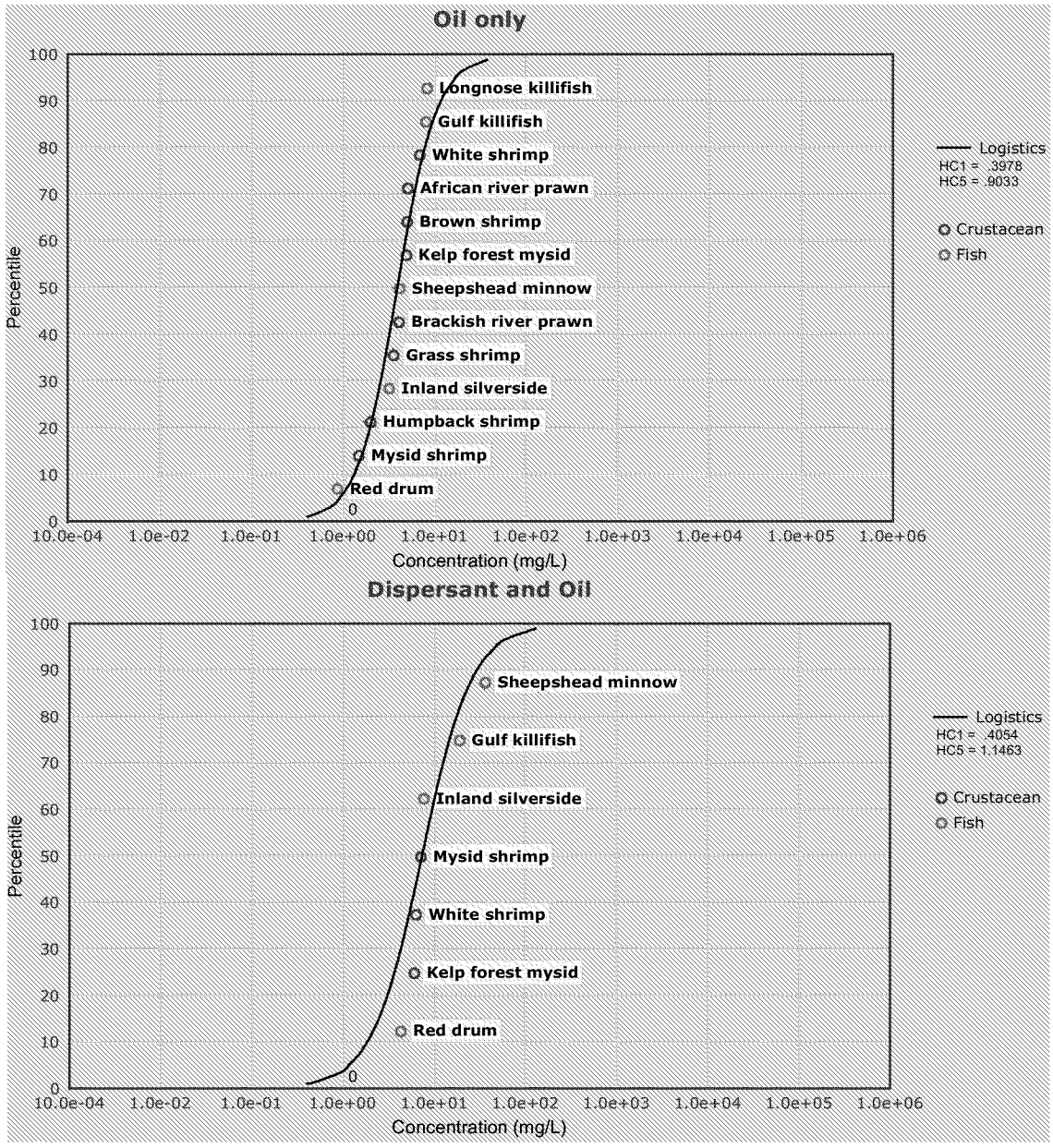

Figure 16. SSD generated following a data query in DTox for the ***drill*** off Charleston Harbor.

For the purpose of this ***drill***, the SSD with the most conservative hazard concentration (HC1=0.4 mg/L) (Figure 16, top) is used in further interpretations.

Potential Environmental Impacts. Average and maximum (worst case) oil concentrations for the physically dispersed ***drill*** scenario overlap 0% and 10%, respectively, of the most conservative 96h-SSD (Figure 17). A different pattern is observed with the ***drill*** scenario involving chemical dispersion of the released oil. Average and maximum (worst case) oil concentrations for the chemically dispersed scenario overlap 40% and 70%, respectively, of the most conservative 96h-SSD. Under the chemical dispersion scenario, 60% and 95% of the average and maximum (worst case) oil concentrations, respectively, exceeded the HC1. Exposures above the HC1 are limited to the first 40-50 hours post release for the average scenario, and >90 hours port spill for the maximum (worst case) oil concentrations scenario. All of these exceedances are limited to the top 5 m of the water columns (data not shown).

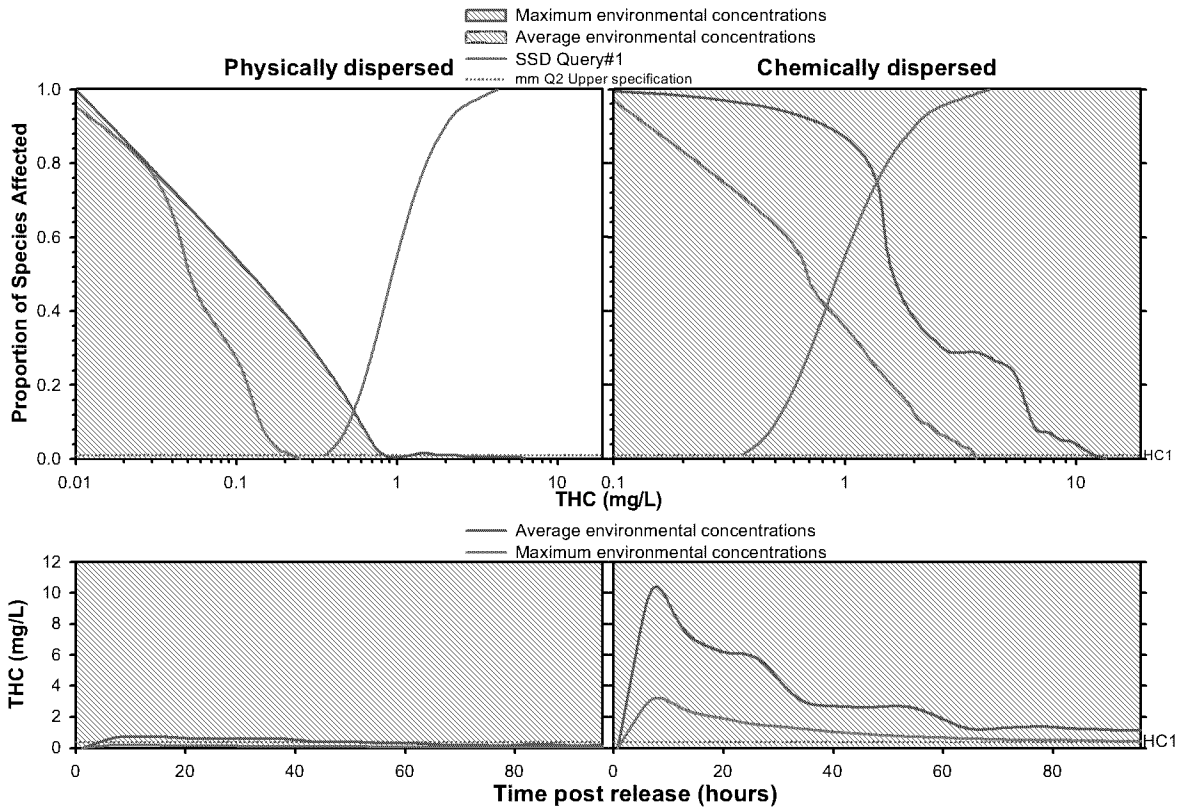

Figure 17. Cumulative average and maximum (worst-case) modeled oil concentrations relative to 96 h-SSDs (top), and average and maximum modeled oil concentrations as a function of time post release for a physically (left) and chemically dispersed (right) plume of a Qua Iboe Nigerian Crude spill off Charleston Harbor, SC (***drill***). As a reference, the benchmark for this drill is HC1=0.4 mg/L.

While these comparisons are useful, without a spatial context, these can lead to overestimation of risks. The areal extent of the water surface with modeled oil concentrations is also further analyzed for the chemically dispersed scenario. As shown in Figure 18, areal extent of the concentration bracket containing and exceeding the benchmarks (0.5-1 mg/L, 1-5 mg/L and >5 mg/L) grew from 11 km^2 6 hours post release to 63 km^2 120 hours post release. By contrast, most of the areal extent of the impacted water surface had concentrations in the 0.01-0.5

mg/L range (range: 5 km^2 6 hours post release to 190 km^2 120 hours post release). As shown in this exercise, the area of potential impact is relatively small and concentrated into an area 12 times the size of a standard football field. To put the information above into perspective (see also Figure 14) under the physical dispersion scenario, 85 km of coastal shoreline would be directly impacted, with maximum estimated oil stranded concentrations up to 47 gallons of oil per meter of shoreline (A. Mearns, pers. comm.). By comparison, under the chemical dispersion scenario, 64 km of coastal shoreline would be directly impacted, with maximum estimated oil stranded concentrations up to 10 gallons of oil per meter of shoreline. This information, and data presented in Figure 14, demonstrate that while there is an increased risk to water column organisms from dispersant use to mitigate the impacts of this particular spill (***drill***) (albeit concentrated into a relatively small area and to depths <5 m), the greatest environmental tradeoff is the reduced impact to shoreline habitats (both on extent and degree of oiling), and reduced amounts of floating oil which can pose adverse risks to surface marine species (e.g., birds and marine mammals).

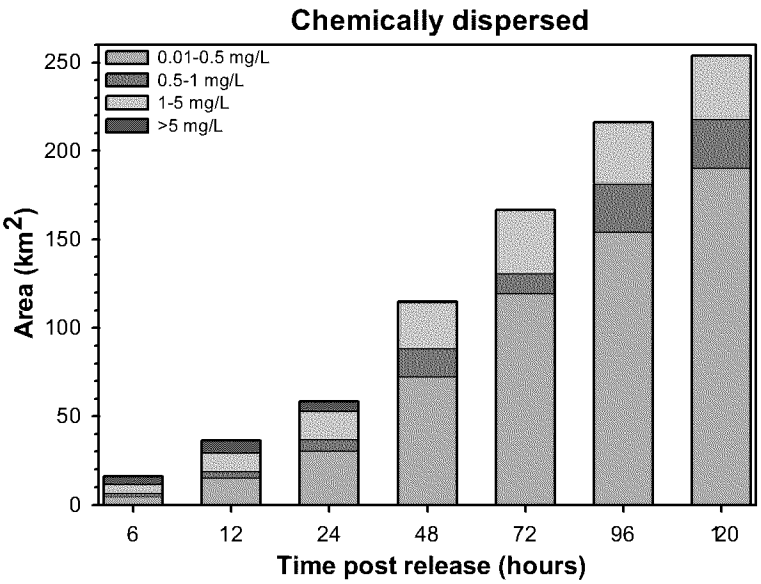

Figure 18. Water surface area impacted by a spill of Qua Iboe Nigerian Crude off Charleston Harbor, SC (***drill***), as a function of time post release (hours), and average oil concentrations. As a reference, the benchmark for this drill is HC1=0.4 mg/L.

While potential toxicological consequences may be expected from worst-case oil concentrations (e.g., maximum oil concentrations), these assessments are conservative as the benchmark used here is conservative and biased towards overprotection or marine species (i.e., based on 96 h exposure toxicity data). This degree of conservatism added to the fact that oil biodegradation is not taken into account suggests that oil concentrations would likely be lower than those predicted by the model.

5.0 Discussion and Importance to Oil Spill Response and Damage Assessment and Restoration

5.1 DTox - Data Compilation, Demonstration, and Application

The primary intent of the exercises presented in Section 4.3 is to demonstrate the applicability of DTox as a tool to aid assessment performed during an oil spill response (spills or drills), and not to support or discourage the use of dispersants as a countermeasure to respond to off shore oil spills. Important to note is the fact that both drill scenarios involved large releases of oil and high dispersant effectiveness, leading to exceedances of benchmark values. It is also important to note that a conservative approach is used, by deriving benchmark values derived from 96-h toxicity data, which is assumed to be a worst case exposure scenario. Specific data limitations identified though drills in Section 4.3 include:

Drill #1:

- Queried data does not contain data on the species of interest (American lobster)
- There are insufficient data for Kuwait crude oil and the queried data contain only a few records for a related oil (Forties)
- Larvae and other early life stages of crustaceans are underrepresented in the database

Drill #2:

- Queried data contained toxicity data for species found in the Charleston Harbor area, including species listed in Table 4. However, queried data does not contain toxicity data for other relevant species of concern
- There are insufficient data for Qua Iboe Nigerian Crude
- Larvae and other early life stages of crustaceans are underrepresented in the database

One of the greater limitations encountered during the development of SSDs to support decision-making for these two drills is the lack of toxicity data for shorter exposures (e.g., <24 hours). Data for spiked flow-through exposures, which are intended to address the dilution that occurs in field conditions, are also limiting. These types of information are important because oil concentrations are expected to peak immediately after release, especially immediately after chemical treatment with dispersants, and these conditions are not adequately addressed in most tests for which toxicity data are available. Another great limitation is that the large majority of studies on oil toxicity typically report measured concentrations of the exposure media on the basis of petroleum hydrocarbons, without providing a detailed chemical characterization of the fractions that most contribute to toxicity, polycyclic aromatic hydrocarbons (PAHs). Despite existing data limitations, the exercises about showed that DTox provides information that can be used to inform tradeoff decisions based on the current state of knowledge.

As discussed above, one of the greatest limitations of the existing toxicity data and, consequently, on the results and applicability of this project to oil spill response and damage assessment and restoration, deals with the lack of data derived from environmentally realistically exposures. This issue is not new and has been extensively discussed in the past (Aurand and Coelho, 2005; Barron and Ka'aihue, 2003; NRC, 2005; Singer et al., 1995). Consequently, deriving toxicity data from laboratory conditions that address dilution, water mixing, and changing exposure concentrations over time, continues to be a large data gap. Equally important is the reporting of toxicity data on the basis of measured exposure concentrations (specially for a complex mixture such as oil), instead of nominal concentrations, as this is the only reliable metric that allows for appropriate characterizations of potential risks (e.g., Coelho et al., 2013; NRC, 1989, 2005). The importance of reporting measured concentrations was not taken lightly during the development of DTox, as reflected in the applicability score given to each data source.

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Another source of data uncertainty emerging from this project is related to toxicity of dispersants and physically and chemically dispersed oil to untested species (see for example Section 4.3), or to species protected under the Endangered Species Act. While lack of toxicity data on a number on important species or species of special interest is a source of concern, the approach implemented in DTox, namely the use of SSDs, can facilitate derivation of conservative benchmark values that may protect many of the untested species. As demonstrated here and in related studies using and applying SSDs in oil research (Barron et al., 2013; Bejarano et al., 2013; de Hoop et al., 2011), the use of these SSDs can provide a mechanism by which existing toxicity data can help assess risks to untested species. Another important use of SSDs (shown here and discussed in Barron et al., 2013) is that it allows for visualization of toxicity data for many standard test species, supporting the notion that these species are appropriate surrogate for many non-standard test species and untested species. However, future toxicity testing should not only focus on standard toxicity test species, but also on other test species easily reared and maintained under laboratory conditions. Additional toxicity data of value to the oil spill community and of interest for future updates of DTox also include toxicity testing on different life stages of the same species. In addition and as discussed above, toxicity data for short exposures is lacking in the literature. In Dtox, <10% of all records are derived from exposures <8 hours, while 83% of all records came from standard exposure durations used in toxicity testing (24, 48, 72, and 96 hours combined), mostly from 96 hour exposures (50% of all records).

Despite data deficiencies and uncertainties, existing toxicity data now compiled in DTox provide useful information to end-users and oil spill practitioners, so long as this information is used within the context of what is environmentally realistic to occur under field conditions. With that caveat in mind, the existing knowledge on the toxicity of dispersants and chemically dispersed oil can be useful in informing assessments and decisions regarding dispersant use.

The effectiveness, usefulness, and transferability of DTox to oil spill response are evaluated through two oil spill drills (Section 4.3), dispersant-related workshops, and dispersant-related assessment (Section 7). These exercises show that, despite existing data limitations, DTox provides information that can be used to inform tradeoff decisions based on the current state of knowledge. The data in DTox have the potential to contributed to a better understanding of the biological effects of dispersants and oil in the aquatic environment, and can provided useful information to both, environmental assessment and decision making efforts. Future efforts will focus on maintaining and updating data in DTox, and on expanding its capabilities for use by the oil spill community.

6.0 Technology Transfer

A critical step that facilitated the success of this project was the engagement of industry, government agencies, and academia in contributing to the development of this database, as well as to their transferability to several related purposes. Data currently in DTox were used to support two NOAA efforts. The first effort involved a dispersant workshop where there were discussions on the current state of knowledge regarding the toxicity of dispersants and chemically dispersed oil. Through several examples and using data primarily from DTox, concerns regarding potential toxicological effects were addressed. The second effort involved data compilation to support an oil spill drill between Canada and the U.S. (CANUSLANT, June

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17-20, 2013). Data from Dtox were used to compare the relative sensitivity of American lobster larvae to naturally and chemically dispersed oil, relative to the sensitivity of other species for which larvae data are available in DTox. This analysis showed that American lobster larvae are relatively sensitive, compared to other species of larvae, as it falls within the lower end of the SSD curve. This information was used during internal discussions within the Unified Command during the drill. Data from DTox have also been used to support the preparation of a biological assessment on the pre-approved use of dispersants. These data, transferred in the form of data summaries and figures, provided some of the scientific bases for assessments of potential adverse effects to aquatic species, included those under the Endangered Species Act. Additional efforts were undertaken to transfer this wealth of knowledge to oil spill responders including the government, industry, and academics via web-based seminars (three in total), and presentations at national conferences (see Section 7).

As discussed above, DTox has been used to facilitate the communication of risks with the public and the scientific community concerned about the use of dispersants. DTox also has the potential to contribute to discussions taking place during consensus Ecological Risk Assessment (ERA) workshops where agency scientists and responders discuss the tradeoffs of the use of dispersant and other response options. In past ERA workshops, participants had to rely on adhoc compilations of toxicity data for oil and dispersed oil.

The results of this project and the practical application of information gathered through this effort are currently being prepared in the form of manuscripts to be published in peer-review journals. Run-time versions of DTox were distributed to end-users (in the form of a downloadable file) engaged with oil spill research and response.

7.0 Achievement and Dissemination

7.1 Workshops

Bejarano A.C. and A. Mearns. The Toxicological Effects of Dispersant Use in Oil Spill Response: Facts versus Fiction. Hawaii Dispersant Workshop. Honolulu, May 5, 2013. *Number of attendees: 20.*

7.2 Off-Site Training Seminars

Bejarano A.C. DTox for Scientific Support Coordinators (NOAA, Emergency Response Division). November 5, 2013. *Number of attendees*: 10.

Bejarano A.C. DTox for End-Users (Federal and State Agencies, Industry, Academics, International end-users). December 18, 2013. *Number of attendees*: 10.

Bejarano A.C. DTox for Scientists (NOAA, Assessment and Restoration Division). January 6, 2014. *Number of attendees*: 9.

7.3 Presentation

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Bejarano, A.C, V. Chu, J. Dahlin, J. Farr. 2013. DTox: A Quantitative Database of the Toxicity of Dispersants and Chemically Dispersed Oil. SETAC. Nashville, TN, USA. (Poster)

Bejarano, A.C, V. Chu, J. Dahlin, J. Farr. 2014. DTox: A Quantitative Database of the Toxicity of Dispersants and Chemically Dispersed Oil. 2014 International Oil Spill Conference. Savannah, GA, USA. (Oral; accepted February, 2014)

7.4 Publication

Bejarano, A.C., J. Clark, G.M. Coelho. 2014. Issues and Challenges with Oil Toxicity Data and Implications for their Use in Decision Making: a Quantitative Review (accepted in *Environmental Toxicology and Chemistry*)

Bejarano, A.C, V. Chu, J. Dahlin, J. Farr. 2014. DTox: A Quantitative Database of the Toxicity of Dispersants and Chemically Dispersed Oil. Proceedings of the 2014 International Oil Spill Conference. Savannah, GA, USA. (accepted February, 2014).

Bejarano, A.C and M. Barron. 2014. Development and Practical Application of Oil and Dispersant Interspecies Correlation Models for Aquatic Species (in prep).

Bejarano, A.C, A. Mearns, V. Chu, J. Farr. 2014. Use and Application of Acute Toxicity Data in Spill Response with Focus on the Use of Dispersants (in prep).

7.5 Other Forms of Dissemination

Computer Software: Bejarano, A. C. and J. Dahlin. 2013. DTox: a Quantitative Database of the Toxicity of Dispersants and Chemically Dispersed Oil, Version 1.1 [Computer Software]. A project for the National Oceanic and Atmospheric Administration, and the University of New Hampshire's Coastal Response Research Center (Contract No. 13-034). Research Planning, Inc. Columbia SC.

Internet information dissemination http://www.researchplanning.com/projects/dtox-worldwide-quantitative-database-toxicity-dispersants-chemically-dispersed-oil/, which includes a link to a training video.

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References

Annis, E.R., 2005. Temperature effects on the vertical distribution of lobster postlarvae (*Homarus americanus*). Limnology and oceanography 50, 1972-1982.

Aurand, D., Coelho, G., 2005. Cooperative aquatic toxicity testing of dispersed oil and the "Chemical response to Oil Spills: Ecological Effects Research Forum (CROSERF)". Technical Report. EM&A Inc., Lusby, MD, p. 79.

Barron, M.G., Hemmer, M.J., Jackson, C.R., 2013. Development of aquatic toxicity benchmarks for oil products using species sensitivity distributions. Integr. Environ. Assess. Manage. 9, 610-615.

Barron, M.G., Ka'aihue, L., 2003. Critical evaluation of CROSERF test methods for oil dispersant toxicity testing under subarctic conditions. Mar. Pollut. Bull. 46, 1191-1199.

Beegle-Krause, J., 2001. General NOAA Oil Modeling Environment (GNOME): a new spill trajectory model, International Oil Spill Conference. American Petroleum Institute, pp. 865-871.

Bejarano, A.C., Dahlin, J., 2013. DTox: a Quantitative Database of the Toxicity of Dispersants and Chemically Dispersed Oil, Version 1.1 [Computer Software]. A project for the National Oceanic and Atmospheric Administration, and the University of New Hampshire's Coastal Response Research Center (Contract No. 13-034). Research Planning, Inc, Columbia SC.

Bejarano, A.C., Levine, E., Mearns, A., 2013. Effectiveness and potential ecological effects of offshore surface dispersant use during the Deepwater Horizon oil spill: a retrospective analysis of monitoring data. Environ. Monit. Assess. 185, 10281-10295.

Capuzzo, J.M., Lancaster, B.A., Sasaki, G.C., 1984. The effects of petroleum hydrocarbons on lipid metabolism and energetics of larval development and metamorphosis in the american lobster (*Homarus americanus* Milne Edwards). Marine Environmental Research 14, 201-228.

Clark, J.R., Bragin, G.E., Febbo, R., Letinski, D.J., 2001. Toxicity of physically and chemically dispersed oils under continuous and environmentally realistic exposure conditions: Applicability to dispersant use decisions in spill response planning, Proceedings of the 2001 International Oil spill Conference, American Petroleum Institute, Tampa, FL, USA, pp. 1249-1255.

Coelho, G., Clark, J., Aurand, D., 2013. Toxicity testing of dispersed oil requires adherence to standardized protocols to assess potential real world effects. Environ. Pollut. 177, 185-188.

CRRC, RPI, NOAA, 2012. The Future of Dispersant Use in Oil Spill Response Initiative http://www.crrc.unh.edu/workshops/dispersant_future_11/Dispersant_Initiative_FINALREPORT.pdf (last accessed 18.10.13), p. 252.

de Hoop, L., Schipper, A.M., Leuven, R.S., Huijbregts, M.A., Olsen, G.H., Smit, M.G., Hendriks, A.J., 2011. Sensitivity of polar and temperate marine organisms to oil components. Environ. Sci. Technol. 45, 9017-9023.

ED_001324_00007355-00042

George-Ares, A., Clark, J., Biddinger, G., Hinman, M., 1999. Comparison of test methods and early toxicity characterization for five dispersants. Ecotoxicol. Environ. Saf. 42, 138-142.

Incze, L., Xue, H., Wolff, N., Xu, D., Wilson, C., Steneck, R., Wahle, R., Lawton, P., Pettigrew, N., Chen, Y., 2010. Connectivity of lobster (*Homarus americanus*) populations in the coastal Gulf of Maine: part II. Coupled biophysical dynamics. Fisheries Oceanography 19, 1-20.

Lubchenco, J., McNutt, M.K., Dreyfus, G., Murawski, S.A., Kennedy, D.M., Anastas, P.T., Chu, S., Hunter, T., 2012. Science in support of the Deepwater Horizon response. Proceedings of the National Academy of Sciences 109, 20212-20221.

MacKenzie, C., Moring, J.R., 1985. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) --American lobster. . U.S. Fish Wildl. Serv. Biol. Rep. 82(11.33). U.S. Army Corps of Engineers, p. 19.

NOAA/ERD, 2013. General NOAA Operational Modeling Environment (GNOME model) http://response.restoration.noaa.gov (accessed December 18, 2013).

NRC, 1989. Using oil spill dispersants on the sea. National Academy Press, Washington, DC.

NRC, 2005. Oil spill dispersants: efficacy and effects. National Academy Press, Washington, DC.

Posthuma, L., Suter II, G.W., Traas, T.P., 2002. Species sensitivity distributions in ecotoxicology. Lewis, Boca Raton, FL.

Singer, M., Tjeerdema, R., Aurand, D., Clark, J., Sergy, G., Sowby, M., 1995. CROSERF: Toward a standardization of oil spill cleanup agent ecological effects research, Arctic and marine oil spill program technical seminar. Ministry of Supply and Services, Canada, pp. 1263-1270.

Wells, P., 1972. Influence of Venezuelan crude oil on lobster larvae. Marine Pollution Bulletin 3, 105-106.

Wells, P.G., Sprague, J.B., 1976. Effects of crude oil on American lobster (*Homarus americanus*) larvae in the laboratory. Journal of the Fisheries Board of Canada 33, 1604-1614.

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Appendix A- Quality Assurance Quality Control Plan (Revised)

DTox: a Worldwide Quantitative Database of the Toxicity of Dispersants and Chemically Dispersed Oil

A-1 Project Description

The ability to rapidly assess the toxicity of physically and chemically dispersed oils is a goal shared by government, industry, consultants, and academic groups involved in oil spill response. One common need of the oil spill community is the unrestricted and rapid access to available toxicity data on dispersants and chemically dispersed oils. However, there are no centralized data repositories gathering decades of existing toxicity data. The end-result of this project, the Dispersant and Chemically Dispersed Oil Toxicity Database (DTox), addresses that shared need of the oil spill community, and contributes to a better understanding of the biological effects of dispersants and dispersed oil. This quantitative data compilation provides the basis for a more thorough assessment of levels of concern for dispersants and chemically dispersed oil, and helps improve risk estimates during oil spills or drills by allowing the selection of data that most closely match the needs of the end-user. The ultimate goal of this effort is the synthesis of information in a meaningful way to improve scientific decision-making as well as to provide rapid access to centralized toxicity data. To meet the goals of this project, a Quality Assurance Plan was designed to meet the following objectives:

- Outline the procedures and data management implemented during the development of this project to ensure that data selection and data entry, storage, and management are of high quality;
- Provide a means by which the quality of information produced can be maintained throughout the project;
- Provide a sound basis for documenting, evaluating, and verifying the accuracy of data selection and entry;
- Provide guidelines for the preparation and review of project plans and reports; and
- Provide the means that would allow the end-user assess the quality of data compilation efforts.

A-2 Objectives

The main objectives of this project are to identify, evaluate, compile, and integrate all available worldwide toxicity data on dispersants and chemically dispersed oil generated under laboratory and field conditions, and to generate an interactive tool that can assist the oil spill response community in management decisions regarding the use of dispersants.

The specific objectives of this project are to:

1. Identify documents, peer-review and gray literature (e.g., field, laboratory, mesocosm, accidental oil spills), reporting the toxicological effects (acute and chronic) of dispersants and chemically dispersed oil;
2. Rigorously evaluate each data source for their quality and potential for inclusion in the DTox database;
3. Compile all quantitative information including all relevant fields (e.g., species, exposure conditions, oil type and weathering, etc.);

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4. Integrate the above information into a tool that can be used by the end-user to guide management decisions regarding the use of dispersants; and
5. Test the suitability of the compiled quantitative data for use in spill response at two pilot study areas.

This effort focuses on aquatic fauna, primarily invertebrates and fish, including all life stages, and includes all pertinent information regarding experimental methods and settings including, oil and dispersant type, oil weathering stage, dispersant to oil ratios, and exposure duration, type (continuous vs. spiked) and concentrations (e.g., oil, PAHs or TPHs). Information from each study also includes analytical chemistry methods and the reported analyte(s). Each paper is carefully evaluated to ensure inclusion of good quality research.

A-3 Quality Assurance

Data included in DTox are evaluated following a strict set of rules aimed at selecting the best available and suitable data. Data entered into the database went through Quality Assurance and Quality Control (QA/QC) procedures including periodic reviews of the database to ensure accurate data entry. Specific QA/QC procedures are described below for each of the main objectives of this project.

Papers initially considered for inclusion in the database met the following minimum criteria:

- Articles published in English; except when information in another language could be accurately translated;
- Full scientific articles, numbered government reports, and independent consultant and industry reports (abstracts are not considered);
- Data should be from original scientific publications and peer review literature (primary source) rather than from reviews or unverifiable sources; a few exceptions are made, but data source penalized via applicability (see below)
- Species' common and/or scientific name, oil source, and dispersant type should be clearly stated;
- Biological test methods should be described, or reference made to an appropriate published method;
- Effects endpoints of treatment tests should be acceptable relative to control tests; studies that do not discuss or mention the use of controls where included on a case by case basis; and
- Methods for the chemical analysis used to quantify exposure concentrations associated with toxicological effects should be described or referenced.

The implementation of these selection criteria led to the exclusion of large amounts of information. Additional data are reconsidered for inclusion by relaxing the selection criterion, but potential data inaccuracies are noted within the database (see below for details). All papers and documents evaluated for potential inclusion in DTox are classified as follows:

- A1: Meets the selection criteria. A1 papers and documents are evaluated and included in the database;

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- A2: One or more of the selection criteria are questionable. A2 papers are be kept aside for further consideration and, if included in the database, potential data inaccuracies are be clearly noted;
- Rejected: Does not meet the selection criteria or does not contain data valuable to the goals of this project.

A-3.1 Data Compilation

Data entry followed a systematic, consistent, and accurate review process of the available literature. A carefully designed database template was developed, which included all the relevant database fields (data elements) and as many standardized data entries as possible (Table A-1). Data element definitions and descriptions are summarized in Table A-2. One of the fields within this template was created to enter the applicability of each paper (e.g., high, moderate, low). Applicability is judged based on source-specific considerations including. A brief summary of the criteria used in the assessment of applicability is as follows:

High:
- Papers reporting effects concentrations based on measured analytes (particularly those involving oil exposures)
- Dispersant to oil ratios consistent with typical recommended formulations
- Exposure conditions following existing recommendations for oil spill research

Moderate:
- Papers reporting effects concentrations based on measured analytes (particularly those involving oil exposures)
- Papers reporting effects concentrations for dispersant only exposures as nominal
- Dispersant to oil ratios consistent with typical recommended formulations
- Exposure conditions following standard toxicity testing laboratory practices

Low:
- Papers only reporting effects concentrations as nominal (particularly those involving oil exposures)
- Papers not clearly stating if the reported effects concentration are nominal or measured
- Papers with missing critical information (e.g., exposure conditions, analytical methods)
- Papers reporting only No Observed Effects Concentration (NOEC) or Lowest Observed Effects Concentration (LOEC)
- Papers with toxicity data from unverifiable sources

Note: Source applicability is assigned to individual papers and not to individual records. A paper reporting toxicity data based on oil loading rates (nominal exposures) also reporting effects concentrations based on measured analytes would have the same applicability assigned to each record entered in DTox. Also it is important to note that paper applicability is based on the relevance of its data to spill response, and not on the overall scientific merit of individual papers.

When entering data into the database template, the following rules are implemented:

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- To ensure completeness and accuracy, information is entered as not reported (NR) when information is not available, or not applicable (NA) when the field does not apply (e.g., toxicity testing with dispersant only has a NA dispersant to oil ratio);
- To ensure accuracy in data entry, all numbers between zero and one are reported with a preceding zero (e.g., 0.5 not .5);
- Periods are only used to represent a decimal points;
- Effects concentrations are entered as they appear in the original document (no rounding up or down is allowed);
- Drop down menus and standardized terminology are used for unique information (e.g., COREXIT 9500);
- Non-standardized data entry fields are entered exactly as they appear in the original source. Examples include: common name, scientific name, effects concentration, water temperature and complete citation; however, current scientific names are checked and replaced are needed, noting changes in reported versus final scientific names (see below);
- Units of numeric data are entered based on a standardized values (e.g., mg/L for effects concentrations, hours for exposure duration);
- Data sources with detailed data chemistry are noted within the database, and chemistry data entered into a separate form;
- Unique citations are assigned a numeric code that matches the citation's code of the bibliographic database (EndNote®); this unique numeric code provides the link between the data entered and the bibliographic citation; and
- A "Notes" field should include only relevant data not captured within other database fields.

Upon completion of data entry, global changes are applied to "new" data fields in the database. Examples include species (global) distribution, habitat, and water depth. Consideration was given to potential changes in habitat and water depth by species-specific life stages. Species distribution databases were consulted to accurately enter this information by species. Additionally, common and species names are checked, and global changes made including standardization of common names and assignment of official species names (e.g., *Mysidopsis bahia* changed throughout to *Americamysis bahia*). Any changes made to the original data source are clearly documented.

As part of the QA/QC components of this project, periodic reviews of the database are made to ensure accurate data entry. A minimum of 15% of all data sources are reviewed for accuracy and completeness. Critical steps of the QA/QC process includes the review of currently accepted scientific species names, standardization of column content and applicability criteria, and identification of duplicate data (e.g., several papers by the same author(s) reported in several report/manuscripts).

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Table A-1. List of standardized data entry fields. In all cases, not applicable (NA), not reported (NR) can be entered in the field cell. Non-standardized data entry fields include: effects concentration and complete citation. In brackets [], descriptive information related to a particular entry field. See Table A-2 for details.

Field Type	Field Name	Examples
Effects Database		
Species	Common name	Inland silverside
	Scientific name	*Menidia beryllina*
	Taxonomic group	Crustacean, fish, coral, mollusk, other[1]
	Life stage	Adult, juvenile, larvae, egg
	Species distribution	Tropical, subtropical, temperate, frigid, pandemic
	Species habitat[2]	Benthic, water column, epibenthic
	US standard test species	Yes, No
Experimental conditions and settings	Study type	Laboratory, field, mesocosm, wave tank
	Water type	Freshwater, seawater
	Dispersant/Oil Treatment	Dispersant only, Dispersant and Oil, Oil only
	Oil name	Alaska North Slope crude oil, South Louisiana crude oil
	API gravity	[Oil specific. Most data from NOAA's ADIOS (Automated Data Inquiry for Oil Spills)]
	Oil class (based on API gravity)	Light, Medium, Heavy, Extra-heavy
	Oil stage	Fresh, weathered, biodegraded
	Dispersant name	COREXIT9500, DISPERSIT, [including mechanical dispersion]
	Dispersant to oil ratio	1:10, 1:20
	Exposure conditions	Continuous, spiked, flow through, field
	Exposure duration (h)	24 hour, 96 hour
	Temperature (°C)	6 °C, 25 °C
Endpoints	Endpoint	Mortality, growth/development, behavior [grouped by endpoint type]
	Endpoint metric- Acute[3]	Acute: LC50, EC50, LOEC; Chronic: EC50, LOEC
	Qualifier	>, <, NA [these are qualifiers associated with the reported effects concentration]
	Effects concentration (mg/L)	200
	Effects concentration range	[Minimum|Maximum or Lower|Upper confidence interval of the reported effects concentration]
	Effects concentration analyte[4]	Total PAHs, TPHs, THCs
	Reported effects concentration	Measured, nominal
	Analyte endpoint	Initial, Final
	Analytical methods	Fluorometry, GC-MS
Data Source	Complete citation	Author, Year, Title, Journal/Agency
	Endnote Reference Locator	[value assigned to each citation entry in Endnote]
Other	Paper selection criteria	A1: Meets the selection criteria A2: One or more of the selection criteria are questionable Rejected
	Paper applicability	Low, Moderate, High, Rejected

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Field Type	Field Name	Examples
	Detailed analytical chemistry	Yes, No [if yes, data extracted and entered into chemical database]
	Duplicates	[It includes individual records identified as duplicates. Duplicates are not included in SSD calculations]
	Notes	[It includes any important information not captures in preceding fields]
Chemistry Database		
Analyte	General compounds	Total Petroleum Hydrocarbons, Polycyclic Aromatic Hydrocarbons
	Analyte name	n-Pentadecane (C15), Benzo(a)anthracene
	CAS#	50-32-8
Experimental conditions and settings	Dispersant/Oil Treatment	Dispersant only, Dispersant and Oil, Oil only
	Dispersant name	COREXIT9500, DISPERSIT, [including mechanical dispersion]
	Oil name	Alaska North Slope crude oil, South Louisiana crude oil
	Oil stage	Fresh, weathered, biodegraded
	Source type	Source oil, exposure media
	Concentration qualifier	>, <, NA
Analytical endpoint	Concentration (mg/L)	200
	Analytical methods	Fluorometry, GC-MS
Data Source	Complete citation	Author, Year, Title, Journal/Agency
	Endnote Reference Locator	[value assigned to each citation entry in Endnote]
Other	Notes	[It includes any important information not captured in preceding fields]

[1] Other include: bacteria (e.g., *Vibrio*), aquatic plants (e.g., giant kelp), phytoplankton, and echinoderms.
[2] Specific to the life stage of the tested species. For example, adult oysters would be categorized as inhabiting the epibenthos, while their larvae would be more likely found in the water column; [3] LC50: median lethal concentration, EC50: median effects concentration, NOEC: No Observed Effect Concentration, LOEC: Lowest Observed Effect Concentration;
[4] PAH: polycyclic aromatic hydrocarbons; TPH: total petroleum hydrocarbons; THC: total hydrocarbons content.

Table A-2. Key data element definitions.

Element Definition	Definition
Species common and scientific name	Refers to the species used in toxicity testing within each data source. Typically reported as common name and/or scientific name. Scientific names are checked against currently accepted names. Other information associated with species includes their taxonomic group, and the life stage used in toxicity testing. Both the global distribution of the tested species, and the habitat of the tested life stage are entered manually (typically not reported within data sources) based on information reported on global databases. Species are also assigned to whether these correspond to U.S. standard test species.
Water type	Refers to the nature of the water used in toxicity testing (freshwater or seawater).
Study type	Refers to the physical location where toxicity tests were conducted. It includes exposures under laboratory, field (e.g., outdoor uncontrolled conditions), mesocosm or wave tank conditions.
Dispersant/Oil Treatment	Refers to the type of aqueous exposure media used in toxicity

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Element Definition	Definition
	testing. It includes oil only (e.g., physically dispersed oil, or water accommodated fraction), dispersant and oil (e.g., chemically dispersed oil, or chemically enhanced water accommodated fraction), dispersant (e.g., dispersant in aqueous solution).
Oil name	Refers to the oil type (typically reported) used in toxicity testing within each data source. Other information associated with each oil entered into the database includes oil class categories (light, medium, heavy, extra-heavy) assigned based on API gravity (most information from NOAA/ADIOS).
Oil condition	Refers to the nature of the oil used to derive the exposure media. It includes fresh, weathered (naturally or artificially) or biodegraded oil.
Dispersant name	Refers to the dispersant product (typically reported) used in toxicity testing within each data source. Entered as reported, typically commercial name. Other information associated with each dispersant, if used in combination with oil, includes the dispersant to oil ratio (DOR) used to prepare the aqueous exposure media.
Exposure conditions and other related exposure information	Refers to the type of experimental design used to conduct toxicity testing. Examples include: Constant static (with or without open vessels) – Refers to toxicity tests performed in the absence of low. Aqueous exposure media typically remains unchanged throughout the duration of the test. Static or semi-static renewal– Refers to the a test without continuous flow of solution, but with renewal of aqueous exposure media Flow through test– Refers to the continuous or very frequent passage of aqueous exposure media through a test chamber with no recycling. Spiked, pulsed, and spiked, flow-through (with or without open vessels) – Refers to initial spike in concentrations in the exposure media, which is allowed to decline over the duration of the exposure period. Other information associated with the exposure conditions include exposure duration and water temperature (not always reported).
Endpoints and other related endpoint information	Endpoint refers to the biological metric used to characterize toxicity. For the purpose of this database, endpoints are grouped by– Mortality (primarily LC50 data); Growth and Development (e.g., blue sac disease, embryo abnormalities) (primarily EC50 data); Reproduction (e.g., fecundity, fertilization inhibition, percent Hatch) (primarily EC50 data); Biochemical (e.g., CYP1A induction, EROD activity) (primarily EC50 data); Physiology (e.g., Heart rate, Impaired byssal activity, Impaired shell-closure) (primarily EC50 data); and Behavior (e.g., feeding rate, impaired swimming) (primarily EC50 data). Endpoints include: LC50 – Median lethal concentration that kills 50% of the exposed organisms at a specific time interval; EC50 – Median effects concentration that causes an response in 50% of the exposed organisms at a specific time interval;

Element Definition	Definition
	LOEC (Lowest Observed Effect Concentration)– The lowest concentration that causes a response statistically different from the control; and NOEC (No Observed Effect Concentration)– The highest concentration that causes a response statistically different from the control. Whenever available information is also included on control Endpoints– How test treatments compared to controls.
Effects Concentration and other related information	Effects Concentrations (mg/L) refer to the mean reported value. Note: All concentration information is standardized to a single consistent concentration unit (mg/L). Whenever reported, the database also includes: Minimum or lower confidence interval of the effects concentrations (mg/L)– Either the minimum or the lower confidence interval of the reported value; and Maximum or upper confidence interval of the effects Concentrations (mg/L) – Either the maximum or the upper confidence interval of the reported value. Information is also included on whether or not the effects concentrations were derived from measured or nominal concentrations of the exposure media. Analytes include: total polycyclic aromatic hydrocarbons (PAHs), total hydrocarbon content (THC), among other analyte types. If available, information is also entered on the analytical method used to characterize the exposure media: Fluorometry, GC-MS
Data Source	Refers to the source from which toxicity data are obtained. It includes a complete citation (author, year, title, journal/agency)

A-3.2 Tool Development

Data were initially entered into a spreadsheet and later migrated into a database program (FileMaker® Pro 12) with expanded capabilities. The database contains multiple data formats, including graphs and relational tables that reflect the nature of the data, and is flexible enough to allow incorporation of ongoing and future studies. The format and structure of this interactive database has the characteristics of a sister database CAFÉ (Chemical Aquatic Fate and Effects Database, NOAA/ERD), allowing current CAFÉ users to query data in DTox without additional training. A similar data structure also allows for potential integration of DTox with CAFÉ.

Integration of the data template into FileMaker® Pro 12 required the following, in operational order:

- Set field requirements to identify data errors during and after data import into FileMaker® Pro 12;
- Establish data check routines to identify legitimate and illegal field combinations (e.g., oil exposures only should not have a dispersant name), check for blank cells that should have either numeric or text entries, ensure that tables (e.g., DTox and chemistry table) are properly linked based on a common numeric code link (e.g., unique EndNote® citation number);
- Verify that 100% of the data fields have converged into FileMaker® Pro 12

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- Design tools and reports that address the needs of end-users with disabilities (e.g., color blind) (Section 508 29 U.S.C. '749d) by selecting colors suggestions for color blind, as well as font size and style options;
- Run tests and other assessment procedures on the user interface tool, data queries and database products (reports, graphs) to make sure these meet the goals of the database. These test involved the selection of a variety of likely end-user scenarios (e.g., queries with few to several end-user requirement specifications);
- Additional tests aimed at improving system performance, response time, and vulnerability;
- Perform an internal review of an alpha version of the database within project team, including potential RPI end-users and members of CAFÉ's development team;
- This phase of the QA/QC plan also included detailed documentation of decisions and procedures (e.g., data entry, tracking and manipulation), as well documentation of assumptions, theory, and parameterization used in developing Species Sensitivity Distribution curves (SSDs) (see below); and
- As part of the QA plan, computer file back-up procedures were regularly undertaken.

A beta version of the interactive database was designed and tested internally and externally for input and suggestions on improvement, prior to its dissemination among selected end-users. This process allowed the project team to address and improve the tool prior to its public release.

Key attributes of this database include:

- Easy to follow layout;
- Query screens to allow for user-specific data inclusion/exclusion;
- Interactive standard navigation buttons containing the most common search attributes;
- Search results displayed in tables and graphics;
- Appearance and functionality;
- A "How To" document detailing how to perform data queries, and a copy of the most recent QA/QC Plan; and
- A copy of the EndNote® library containing the complete list of citations of all papers reviewed as part of this project.

A-3.2.1 Data Queries and Species Sensitivity Distributions

The first version of DTox contains several navigation windows allowing data selection by the end-user. Following data selection, the remaining data are plotted in separate windows in the form of Species Sensitivity Distributions (SSDs). SSDs are constructed by calculating the geometric mean of reported toxicity for each individual species (by scientific name). Data included in geometric mean calculations are:

- Data with effects concentrations qualifiers equal to NA
- Effects concentrations with qualifiers $\geq$, $\leq$, $>$ or $<$ are not included in calculations
- Data identified as duplicates are not included in calculations
- Data from Rejected papers are not included in calculations

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- SSDs are only generated for datasets with a minimum of 5 species

Additional details on SSDs include:

- SSDs are generated by fitting the empirical toxicity data to a logistic function defined by $F(x) = \frac{1}{1 + e^{-\frac{x-\mu}{\sigma}}}$, $x \in R$, with parameters μ(location) and σ (scale);
- Fitted SSDs do not include a "Goodness of Fit" test;
- Two Hazard concentrations (HC) (HC1 and HC5 equivalent to the concentrations at which 1% and 5%, respectively, of the species in the SSD may not be protected) are included for plots with a minimum of 5 species;
- Up to two SSDs are plotted per display window (Dispersant Only, Dispersant and Oil, Oil Only);
- 1 SSD per display window includes common names;
- 2 SSDs per display window omits common names;
- Data are displayed based on color coding selections; and
- All SSDs are plotted over a colored background representing a common scale of relative toxicity.

Scale
Very highly toxic (<0.1 mg/L)
Highly toxic (0.1-1 mg/L)
Moderately toxic (1-10 mg/L)
Slightly toxic (10-100 mg/L)
Not acutely toxic (>100 mg/L)

A-3.2.2 Tool Testing and Distribution

A stand-alone executable file (beta version) of the interactive database was further tested internally, and shared with external potential users and volunteers for input and suggestions on improvement, prior to its dissemination among selected end-users. This process allowed the project team to address and improve the tool prior to its public release. A stand-alone executable file of the first version of DTox was made available and shared with a selected number of end-users. End-users were asked to provide feedback and to report issues, which will be considered in future updates of the tool.

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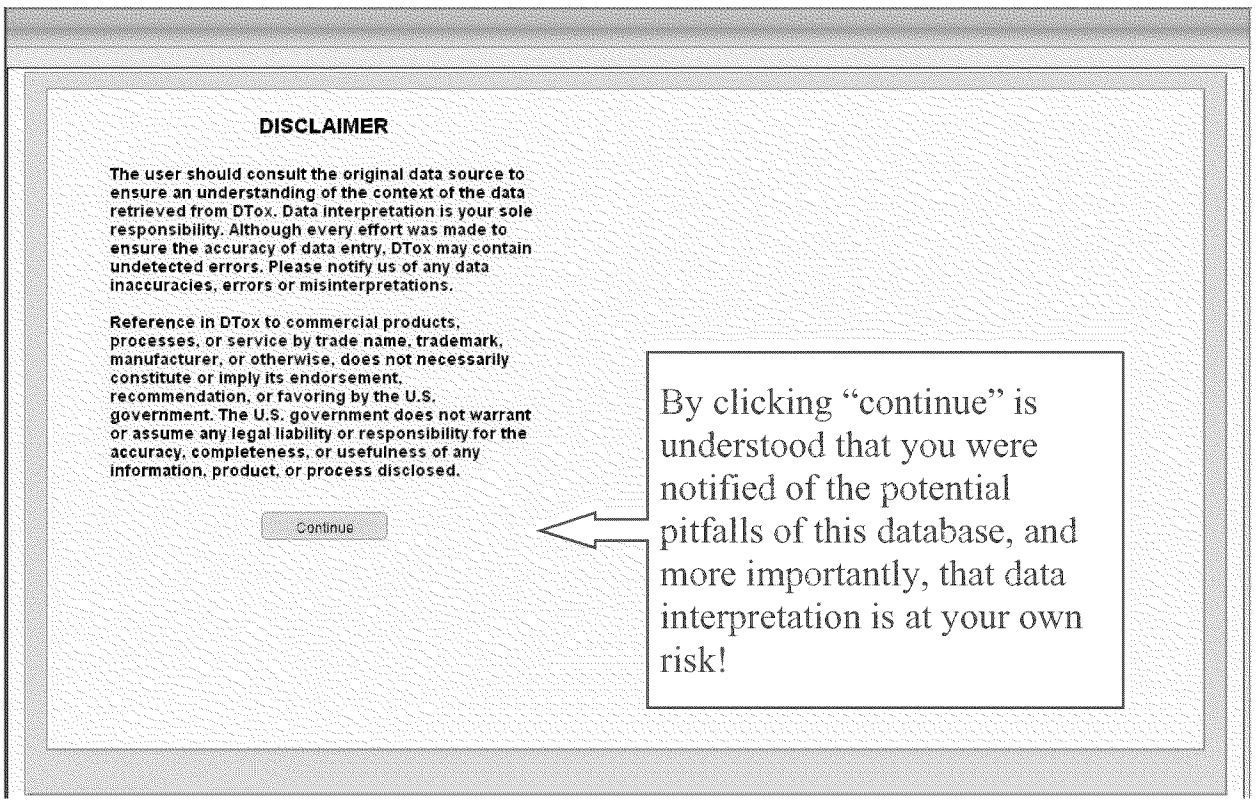
Appendix B- HOW TO "DTox" Version 1.

This document provides a brief overview on how to navigate through DTox. Before you start querying DTox, please read through the information presented here as it is intended to facilitate the use of this tool.

Performing queries in DTox-

Below you will find a series of screens shots through which you would have to navigate to perform the desired queries

1. **Disclaimer**

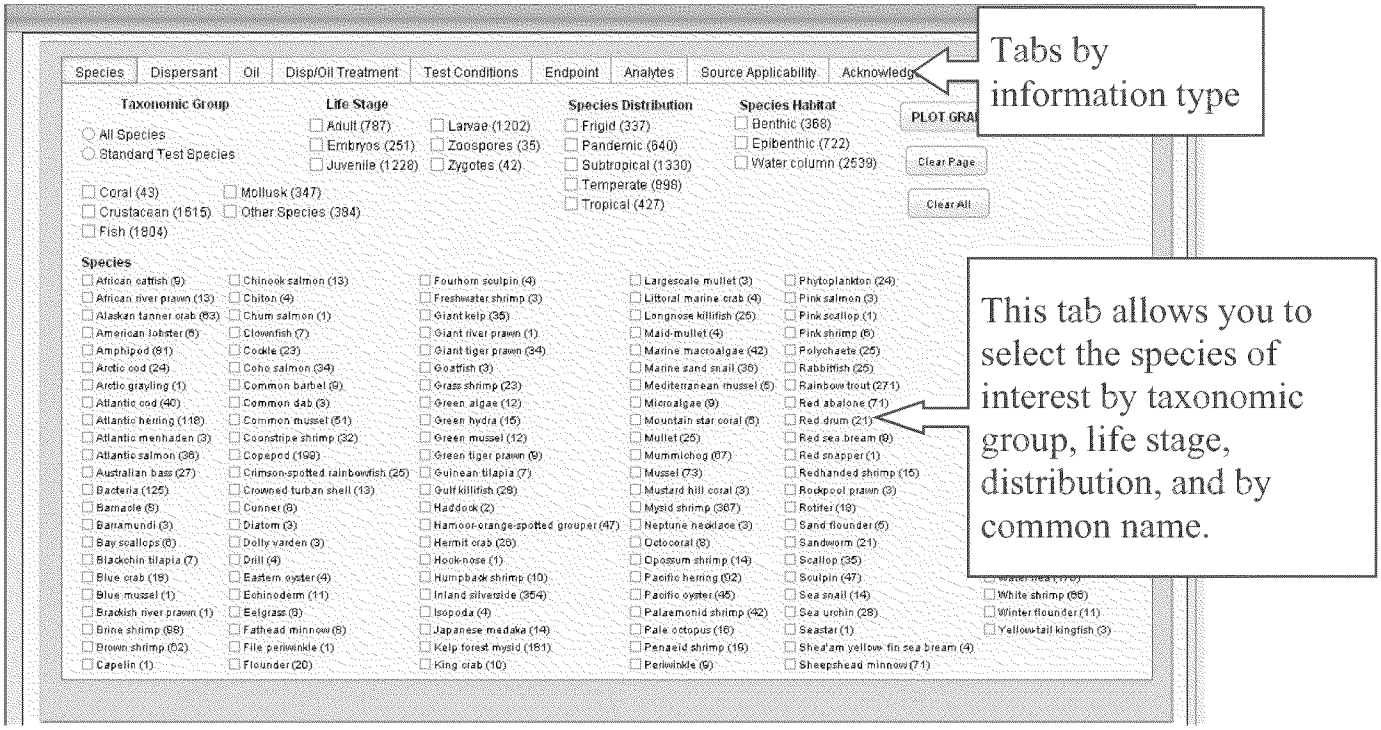


2. **Data selection**

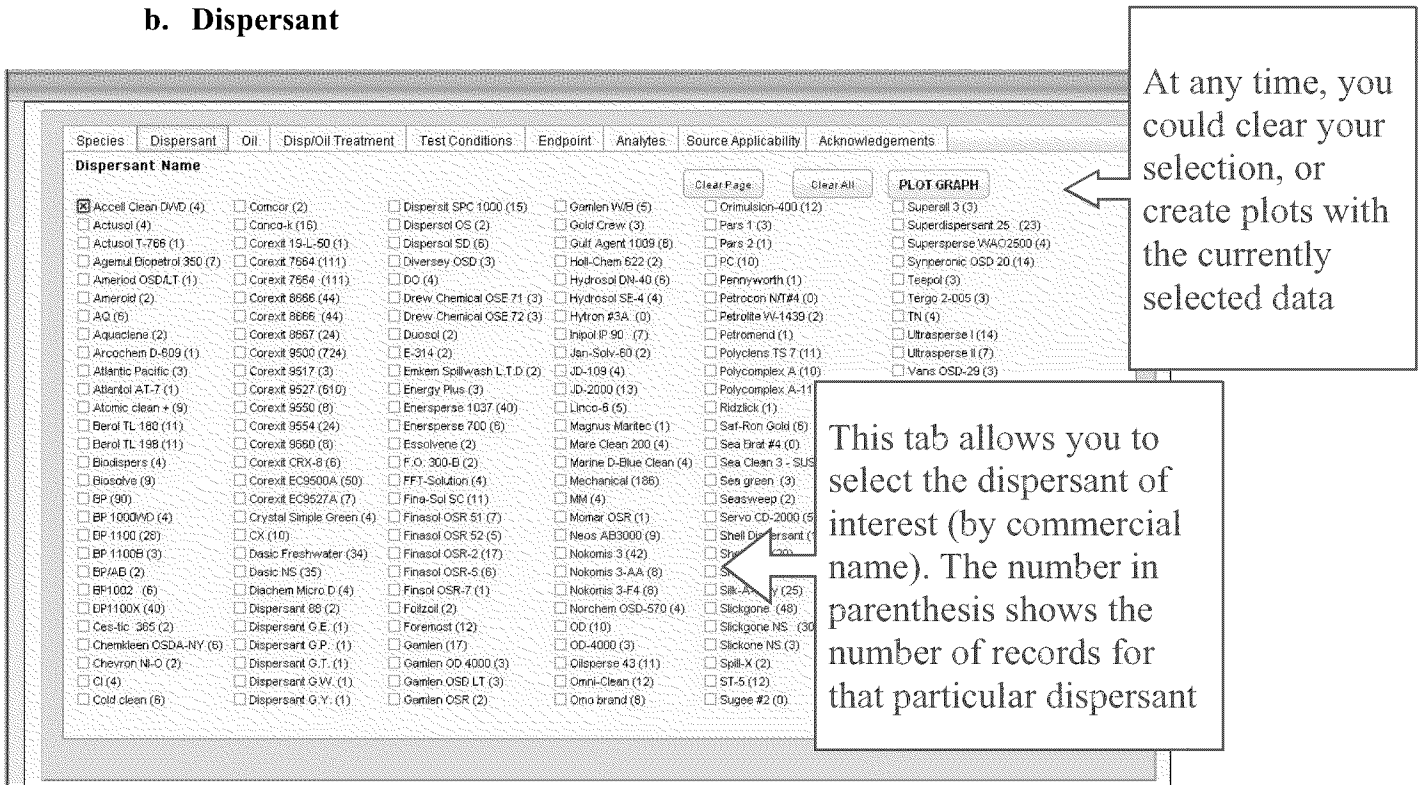
There are several windows allowing the selection of the type of data you want included in your query. **Note** that if selections are not made, by default, the program will select all the available data.

   a. **Species**

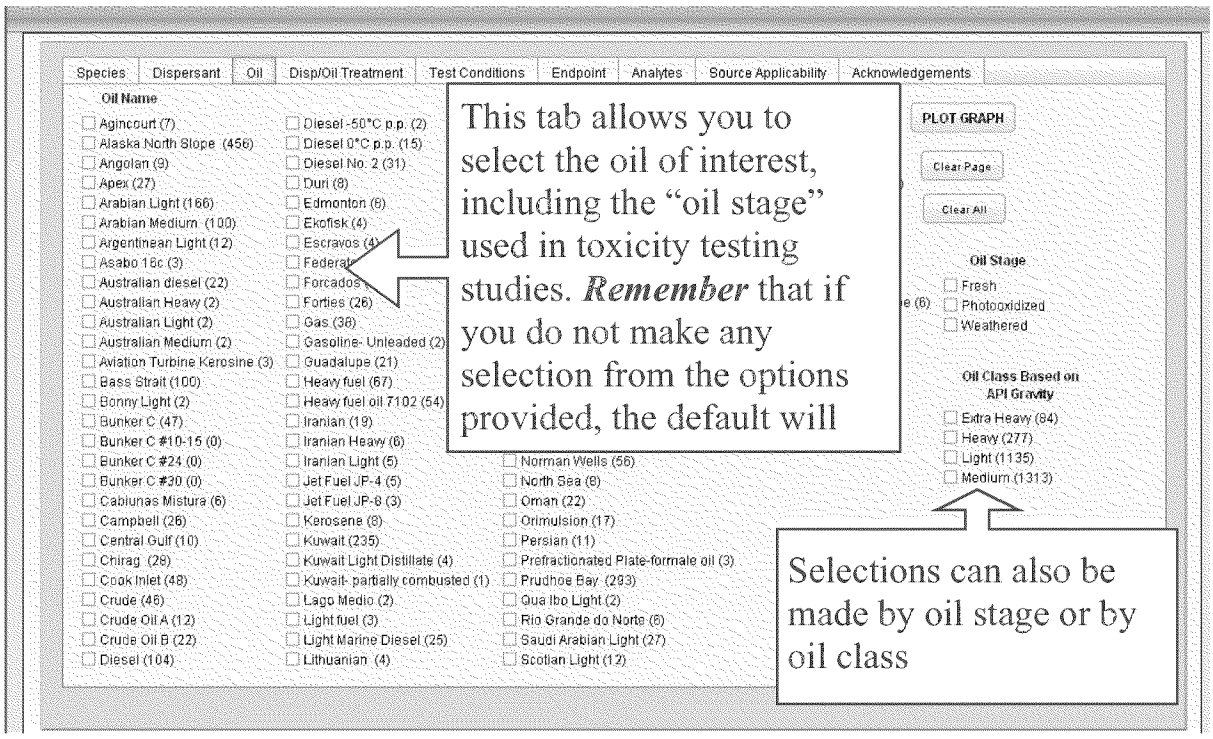
Note that while only common names are listed, these correspond to "unique" scientific names.



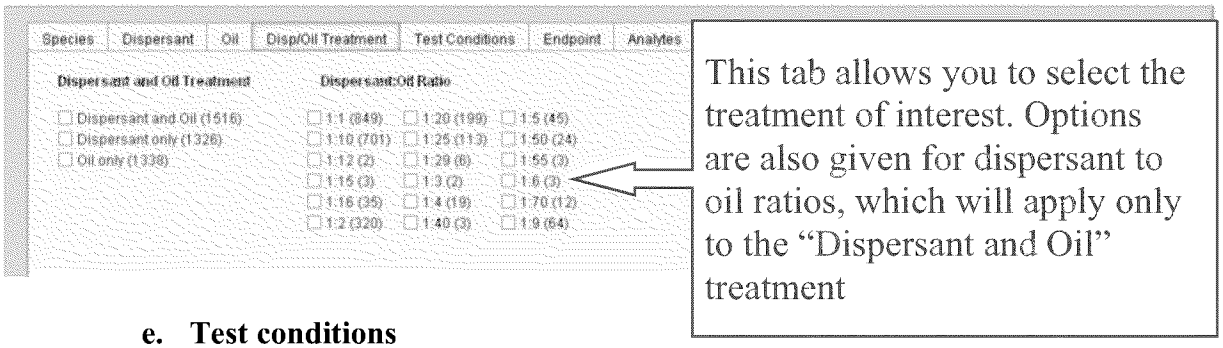
b. Dispersant



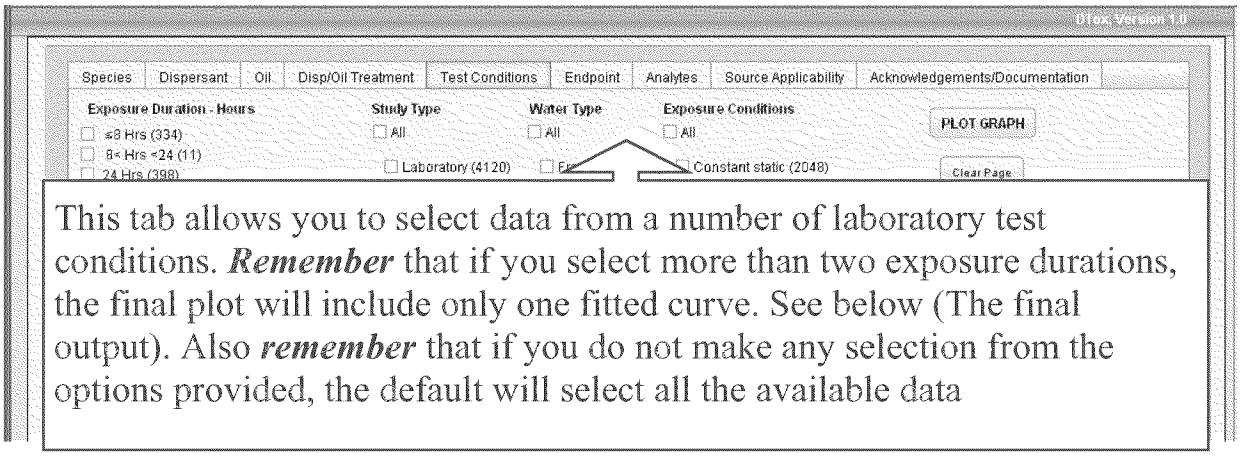
c. Oil



d. Dispersant/oil treatment

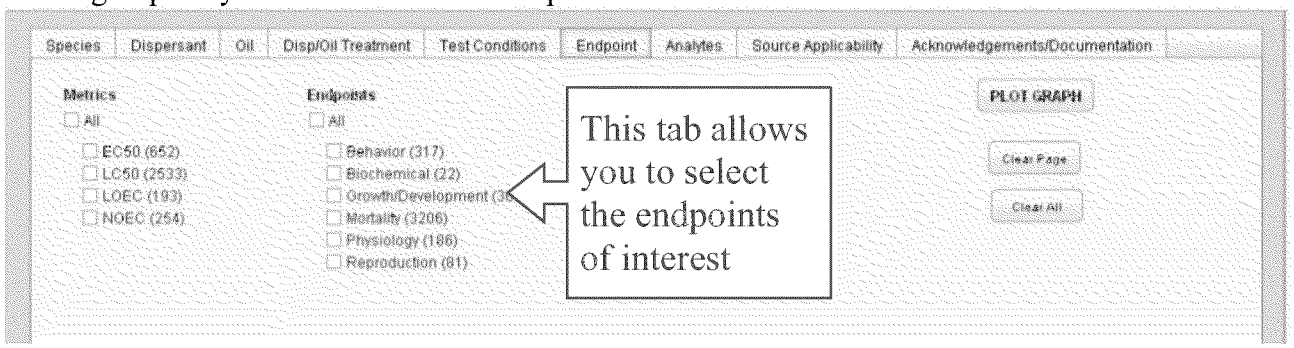


e. Test conditions

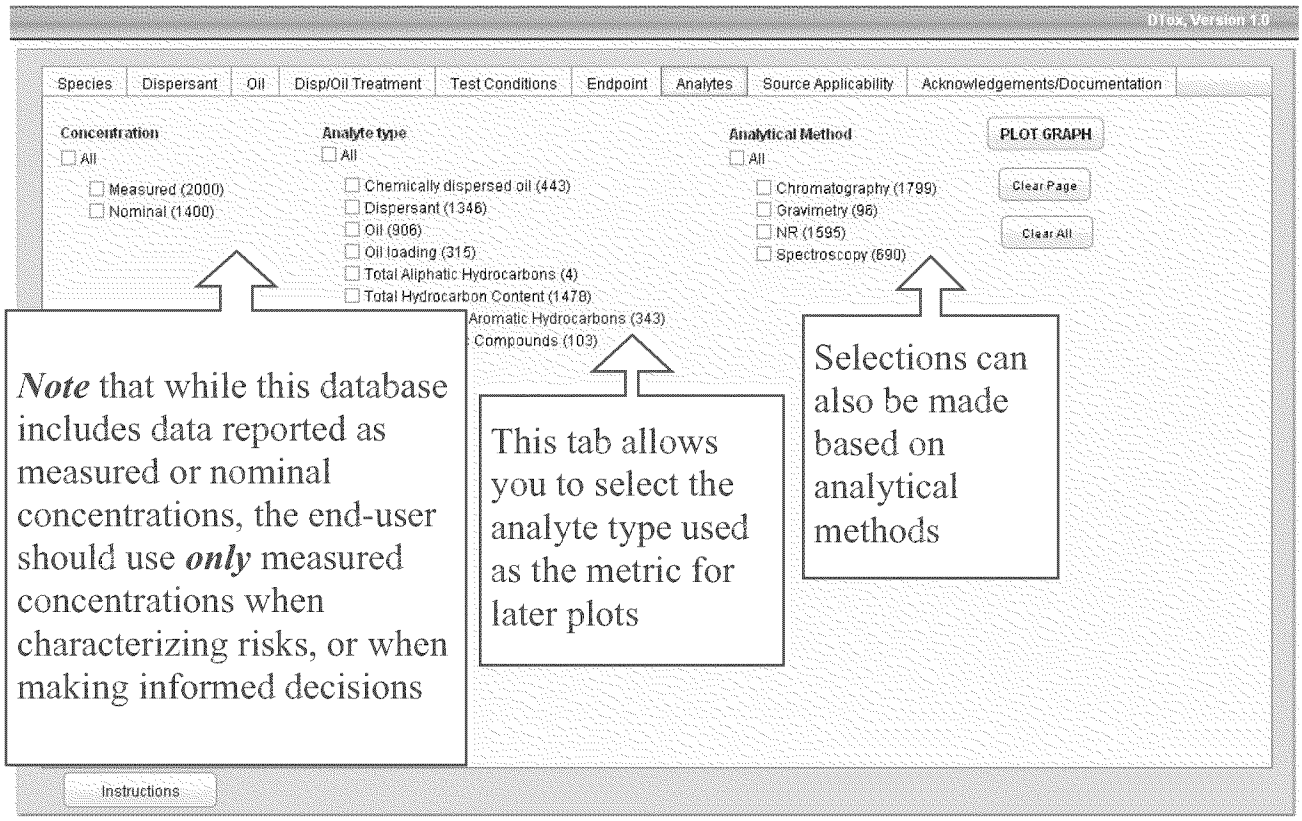


f. Endpoints

Toxicity metrics included in DTox include the most commonly reported types, grouped by lethal and sublethal endpoints.



g. Analytes



h. Source applicability

A detailed Quality Assurance/Quality Control plan was written prior to the development of this tool. A brief summary of the criteria used in the assessment of applicability[2] is shown below:

High:

[2] "Applicability" is meant to indicate the applicability or usability of these data to spill response, and to the specific goals of this project. Assigning "applicability" to each data source is not to be interpreted as a judgment of the scientific quality of each data source.

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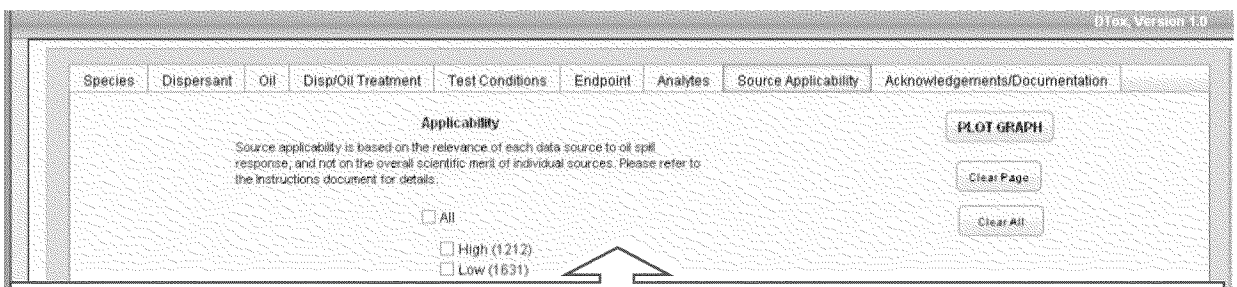
- Papers reporting effects concentrations based on measured analytes (particularly those involving oil exposures)
- Dispersant to oil ratios consistent with typical recommended formulations
- Exposure conditions following existing recommendations for oil spill research

Moderate:
- Papers reporting effects concentrations based on measured analytes (particularly those involving oil exposures)
- Papers reporting effects concentrations for dispersant only exposures as nominal
- Dispersant to oil ratios consistent with typical recommended formulations
- Exposure conditions following standard toxicity testing laboratory practices

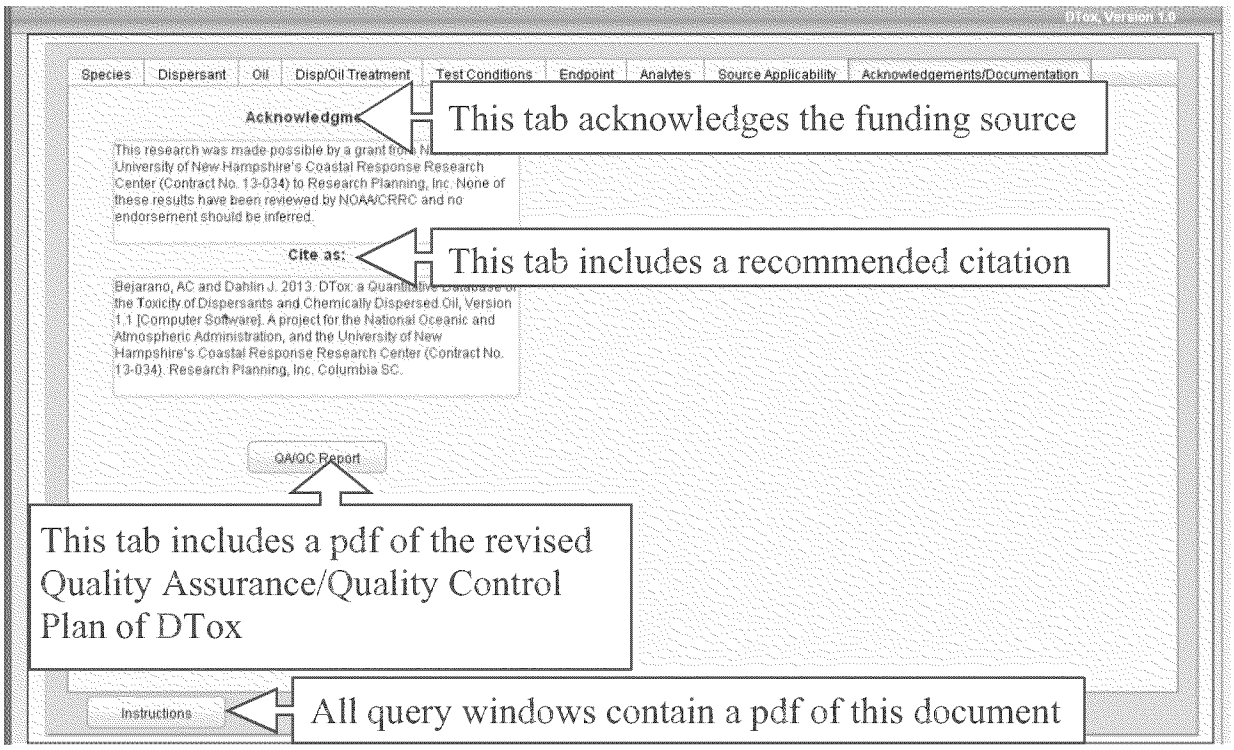
Low:
- Papers only reporting effects concentrations as nominal (particularly those involving oil exposures)
- Papers not clearly stating if the reported effects concentration were nominal or measured
- Papers with missing critical information (e.g., exposure conditions, analytical methods)
- Papers reporting only NOEC, LOEC effects concentrations
- Papers with toxicity data from unverifiable sources

Note: Source applicability is assigned to individual papers and not to individual records. A paper reporting toxicity data based on oil loading rates (nominal exposures) also reporting effects concentrations based on measured analytes would have the same reliability assigned to each record entered in DTox.



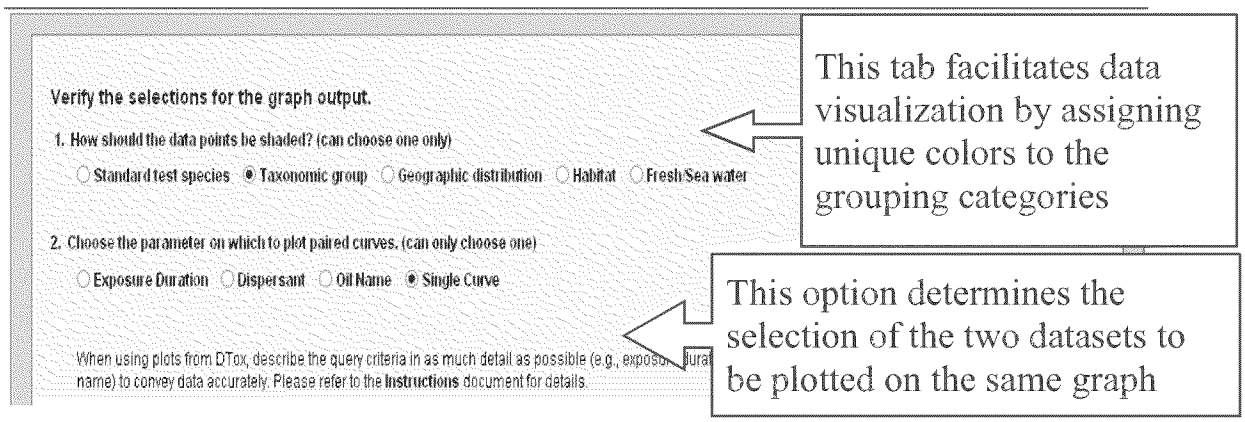
Each data source in the DTox was given an applicability score, based on the scientific value of these data to spill response. The end-user is encouraged to use the two higher applicable sources (Moderate/High) when characterizing risks or when making informed decisions

i. Acknowledgements and Documentation



3. Data plotting options

Once you have gone through the data selection tabs, your will get to chose how you want your data plotted. **Note** that only two curves can be plotted simultaneously on the same window. If more than three options are selected, only two will be plotted. For example, under exposure duration select two (e.g., 24 h and 96 h). Press "Plot Graph" to see the plotted output. This may take a few seconds… Following the step above, you will see the internal query being performed. You may need to wait a few seconds while the plots are generated.



4. The final output

Queried data are combined to generate Species Sensitivity Distributions (SSDs). SSDs describe the sensitivity of aquatic species to the exposure media, where each point on the curve represents the geometric mean of all toxicity data available for a uniquely identified species (e.g.,

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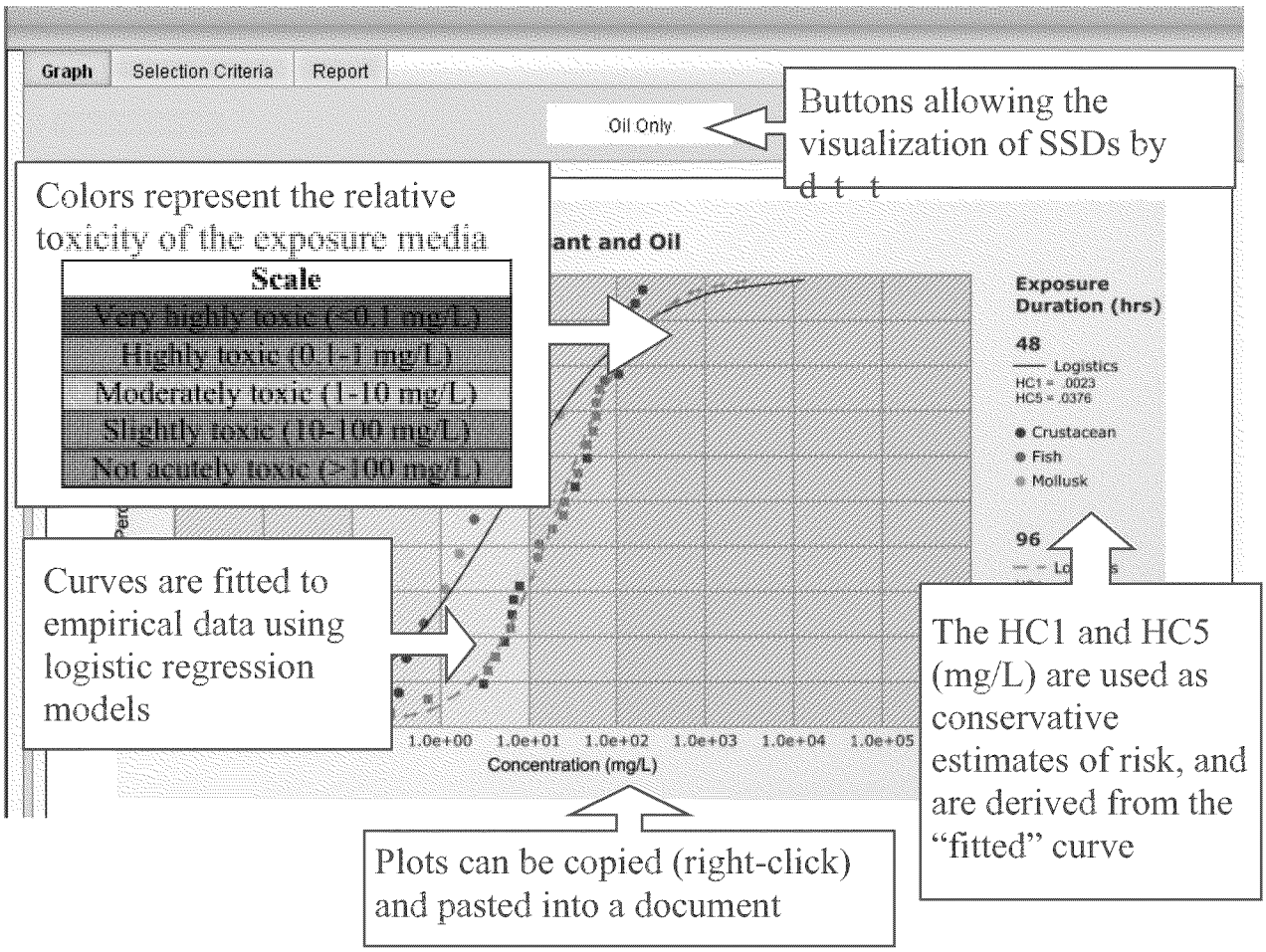
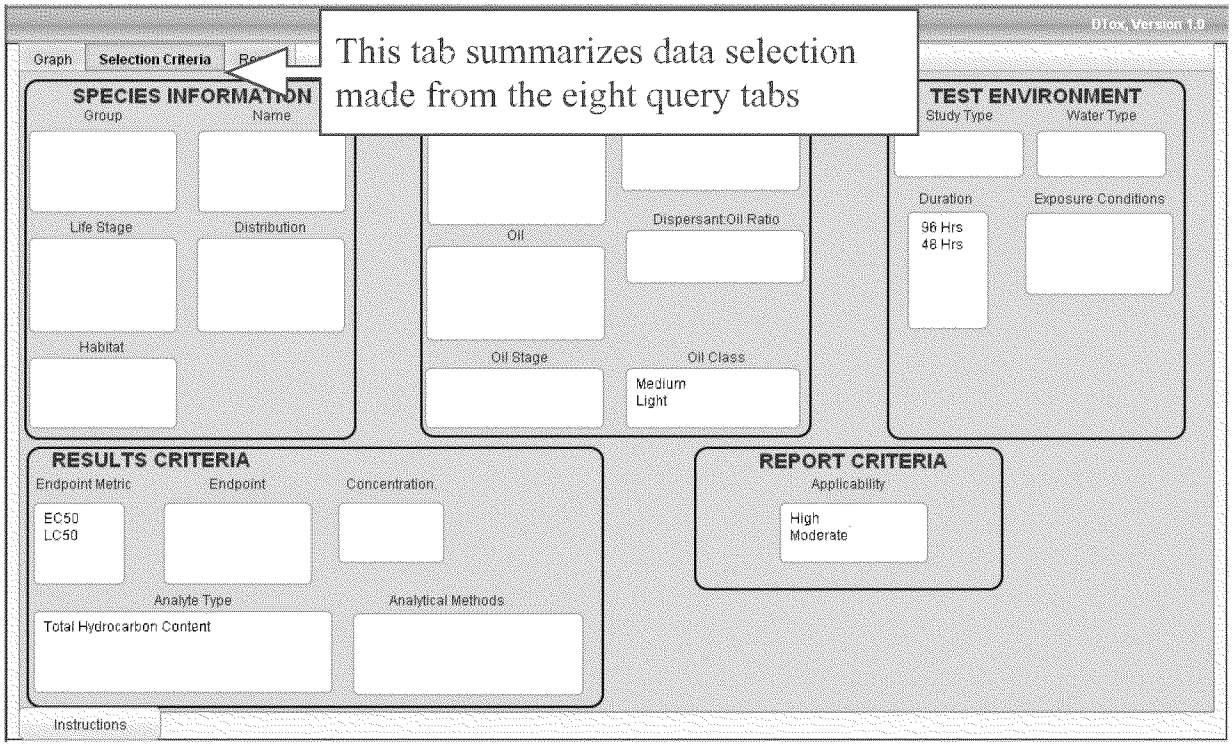
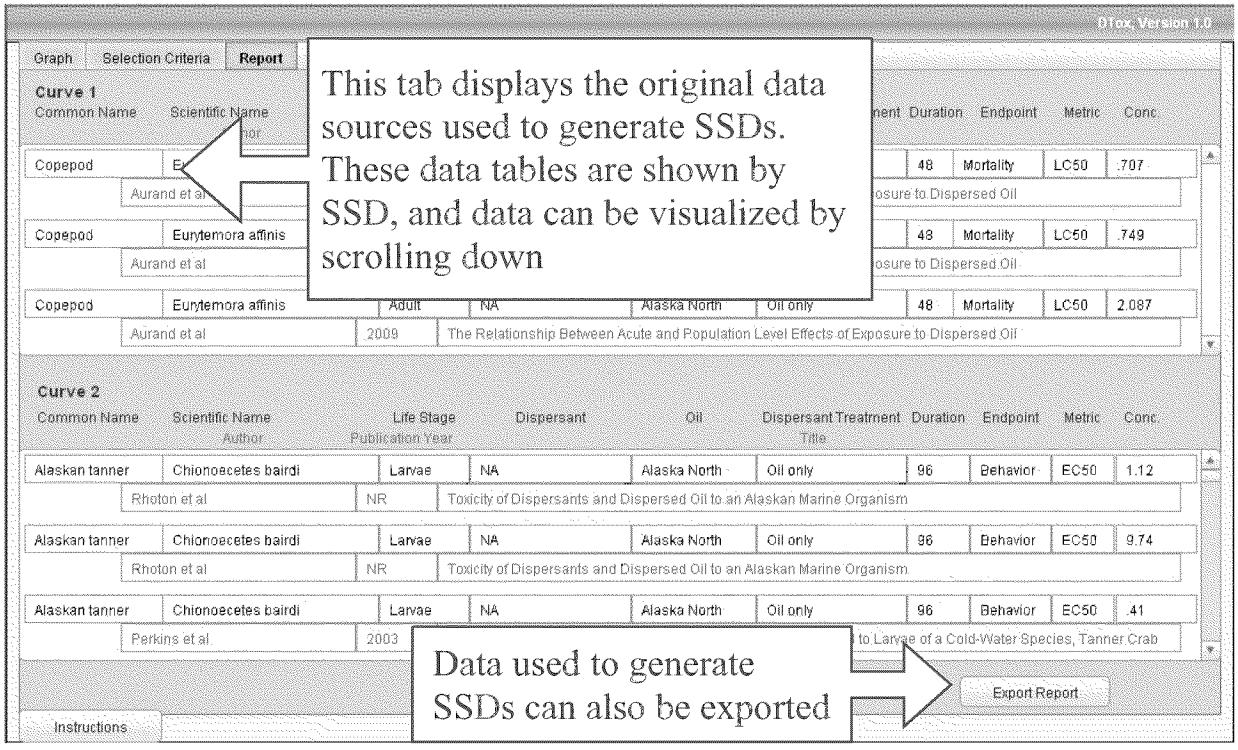
calculated by scientific name). SSDs are generated by ranking the relative sensitivity of individual from the least to the most sensitive, and are useful in that benchmark concentrations (hazardous concentration, HC) can be derived as a measure of risk. Here the 1st and 5th percentiles of the SSD (HC1 and HC5, respectively; in mg/L) are used as benchmark concentrations under the assumption that these would be protective of 99% and 95%, respectively, of the species on the SSD.

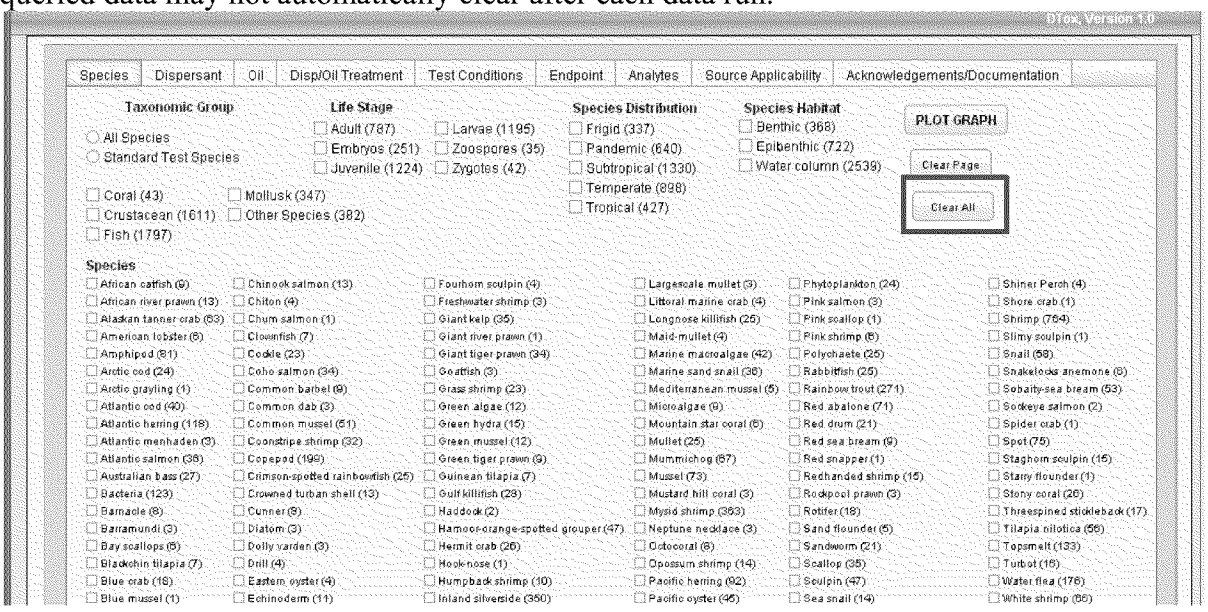



DTox Version 1.0
Graph
Selection Criteria
This tab summarizes data selection made from the eight query tabs
SPECIES INFORMATION
Group
Name
Life Stage
Distribution
Habitat
Oil
Dispersant:Oil Ratio
Oil Stage
Oil Class
Medium
Light
TEST ENVIRONMENT
Study Type
Water Type
Duration
Exposure Conditions
96 Hrs
48 Hrs
RESULTS CRITERIA
Endpoint Metric
Endpoint
Concentration
EC50
LC50
Analyte Type
Analytical Methods
Total Hydrocarbon Content
REPORT CRITERIA
Applicability
High
Moderate
Instructions


DTox Version 1.0
Graph
Selection Criteria
Report
This tab displays the original data sources used to generate SSDs. These data tables are shown by SSD, and data can be visualized by scrolling down
Curve 1
Common Name
Scientific Name
Duration
Endpoint
Metric
Conc
Copepod
Aurand et al
48
Mortality
LC50
.707
Copepod
Eurytemora affinis
48
Mortality
LC50
.749
Copepod
Eurytemora affinis
Adult
NA
Alaska North
Oil only
48
Mortality
LC50
2.087
Aurand et al
2009
The Relationship Between Acute and Population Level Effects of Exposure to Dispersed Oil
Curve 2
Common Name
Scientific Name
Author
Life Stage
Publication Year
Dispersant
Oil
Dispersant Treatment
Title
Duration
Endpoint
Metric
Conc
Alaskan tanner
Chionoecetes bairdi
Larvae
NA
Alaska North
Oil only
96
Behavior
EC50
1.12
Rhoton et al
NR
Toxicity of Dispersants and Dispersed Oil to an Alaskan Marine Organism
Alaskan tanner
Chionoecetes bairdi
Larvae
NA
Alaska North
Oil only
96
Behavior
EC50
9.74
Rhoton et al
NR
Toxicity of Dispersants and Dispersed Oil to an Alaskan Marine Organism
Alaskan tanner
Chionoecetes bairdi
Larvae
NA
Alaska North
Oil only
96
Behavior
EC50
.41
Perkins et al
2003
Data used to generate SSDs can also be exported
Export Report
Instructions

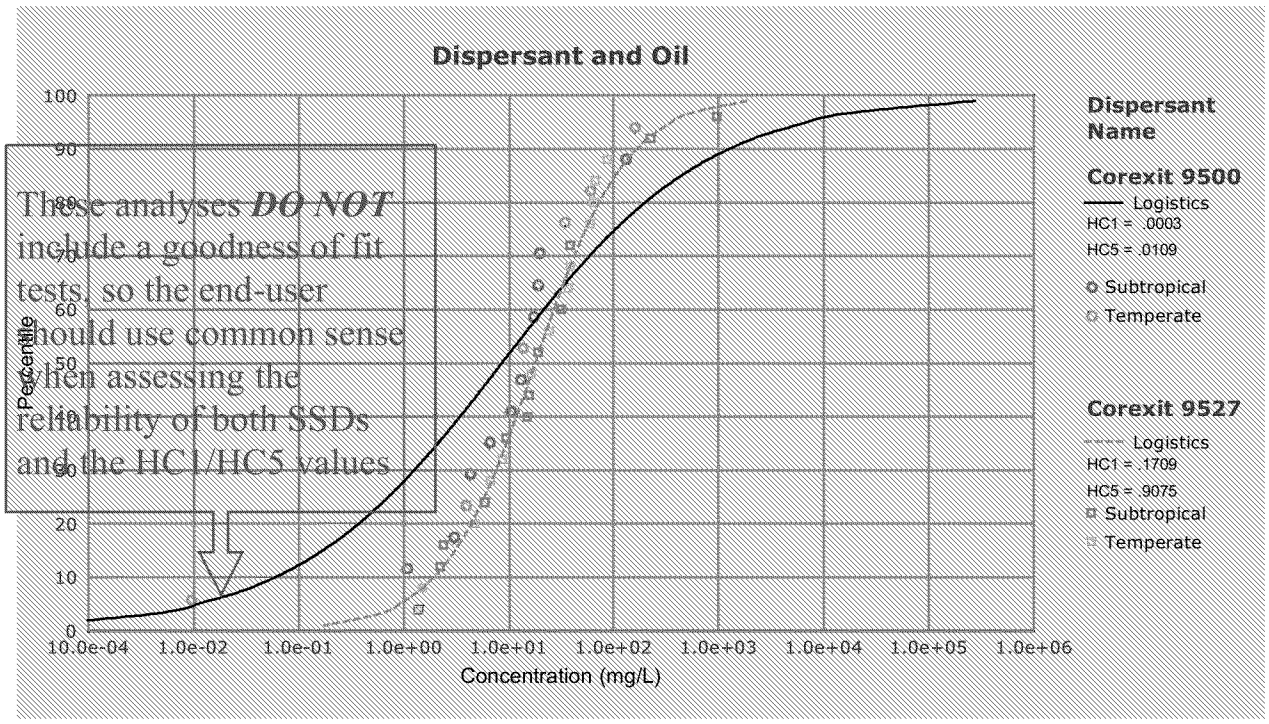
Note 1:

To ensure optimal performance and query replicability, press "clear all" after each query run. This is highly recommended step when performing multiple queries as the table containing the queried data may not automatically clear after each data run.



Note 2:

A note of caution…



Zip File Bonus!.

The zip file containing the executable file of DTox also includes the EndNote® library, with all the references evaluated during the development of this tool

Name			
Recover.log			
DTOX.fmpur			
DTox_COMPRESSED.enl			
DTox_COMPRESSED.enlx			
zlib1.dll			
XText.dll			
XGrfx.dll			
XFC.dll			
xerces-c_3_0.dll	1,839 KB	Application Extension	3/21/2013 1:47 PM
XDraw.dll	526 KB	Application Extension	3/21/2013 1:47 PM
XCore.dll	91 KB	Application Extension	3/21/2013 1:47 PM
XalanMessages_1_11.dll	47 KB	Application Extension	3/21/2013 1:47 PM
xalan-c_1_11.dll	1,797 KB	Application Extension	3/21/2013 1:47 PM
ViewSystem.dll	745 KB	Application Extension	3/21/2013 1:47 PM
ToolkitPro1122vc90U.dll	6,254 KB	Application Extension	3/21/2013 1:47 PM
Support.dll	1,990 KB	Application Extension	3/21/2013 1:47 PM
ssleay32.dll	235 KB	Application Extension	3/21/2013 1:47 PM
SkiaDLL.dll	467 KB	Application Extension	3/21/2013 1:47 PM
ProofReader.dll	522 KB	Application Extension	3/21/2013 1:47 PM
openssl.dll	365 KB	Application Extension	3/21/2013 1:47 PM
OmniThread.dll	29 KB	Application Extension	3/21/2013 1:47 PM
OmniORB4.dll	1,203 KB	Application Extension	3/21/2013 1:47 PM
OmniDynamic4.dll	1,451 KB	Application Extension	3/21/2013 1:47 PM
NSViews.dll	51 KB	Application Extension	3/21/2013 1:47 PM
MFCX.dll	108 KB	Application Extension	3/21/2013 1:47 PM
libsasl.dll	198 KB	Application Extension	3/21/2013 1:47 PM
libetpan.dll	481 KB	Application Extension	3/21/2013 1:47 PM
libeay32.dll	1,114 KB	Application Extension	3/21/2013 1:47 PM
libcurl.dll	201 KB	Application Extension	3/21/2013 1:47 PM
FMWrapper.dll	117 KB	Application Extension	3/21/2013 1:47 PM
FMRSRC.dll	9,539 KB	Application Extension	3/21/2013 1:47 PM
FMOLE.dll	103 KB	Application Extension	3/21/2013 1:47 PM
FMEngine.dll	4,391 KB	Application Extension	3/21/2013 1:47 PM
DBEngine.dll			
DTox.exe			
HowTo_DTox.pdf			

Pdfs of this document and the QA/QC plan are also in the DTox folder

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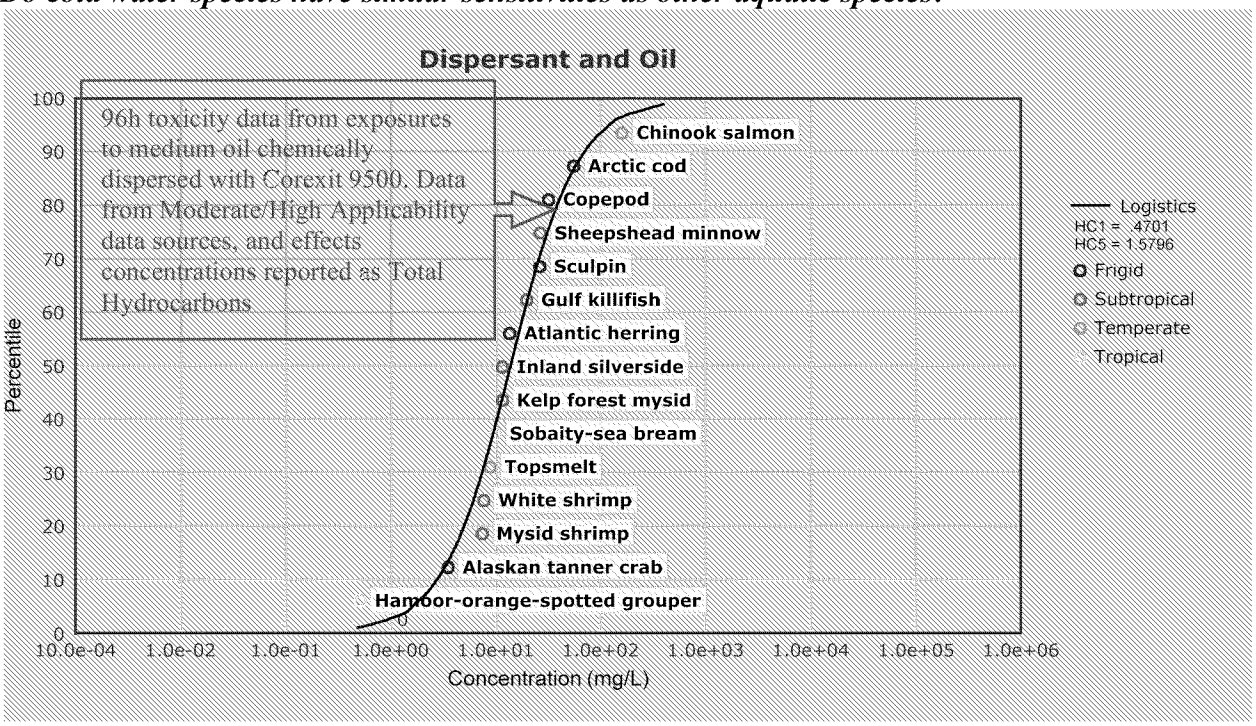
How to use outputs from DTox:
Data in DTox has several practical applications, including their use to address and answer basic questions:

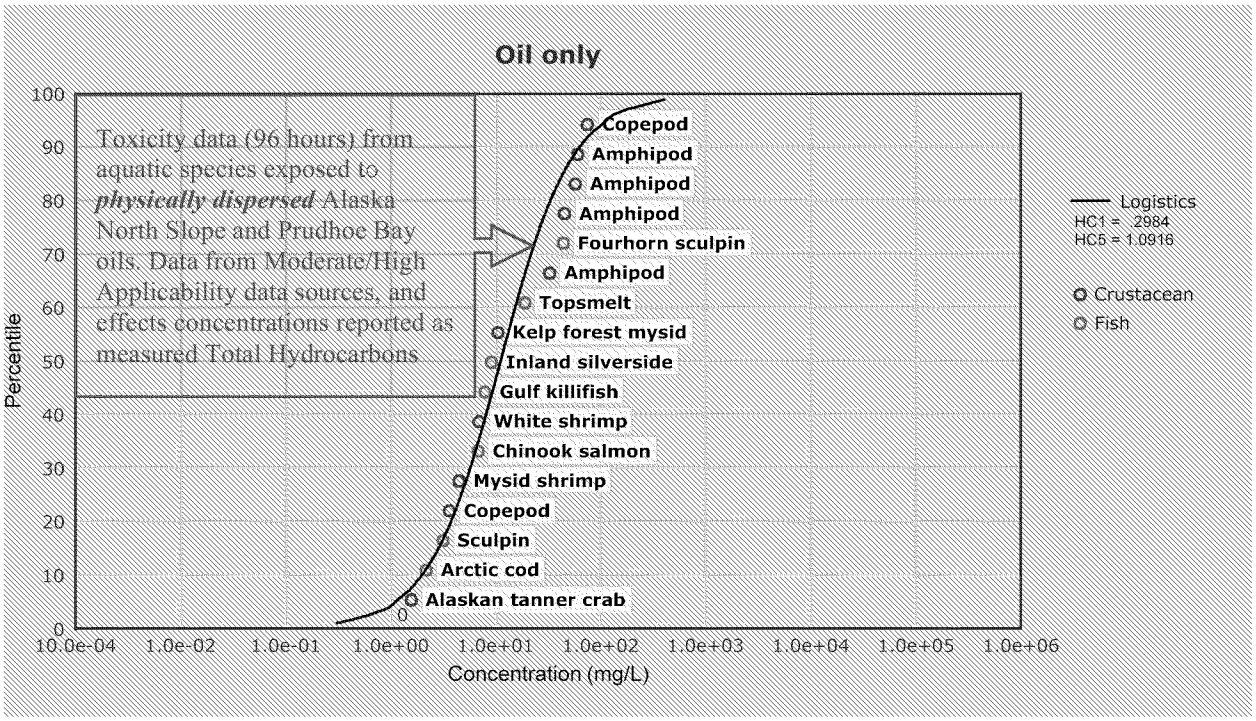
Do cold water species have similar sensitivities as other aquatic species?

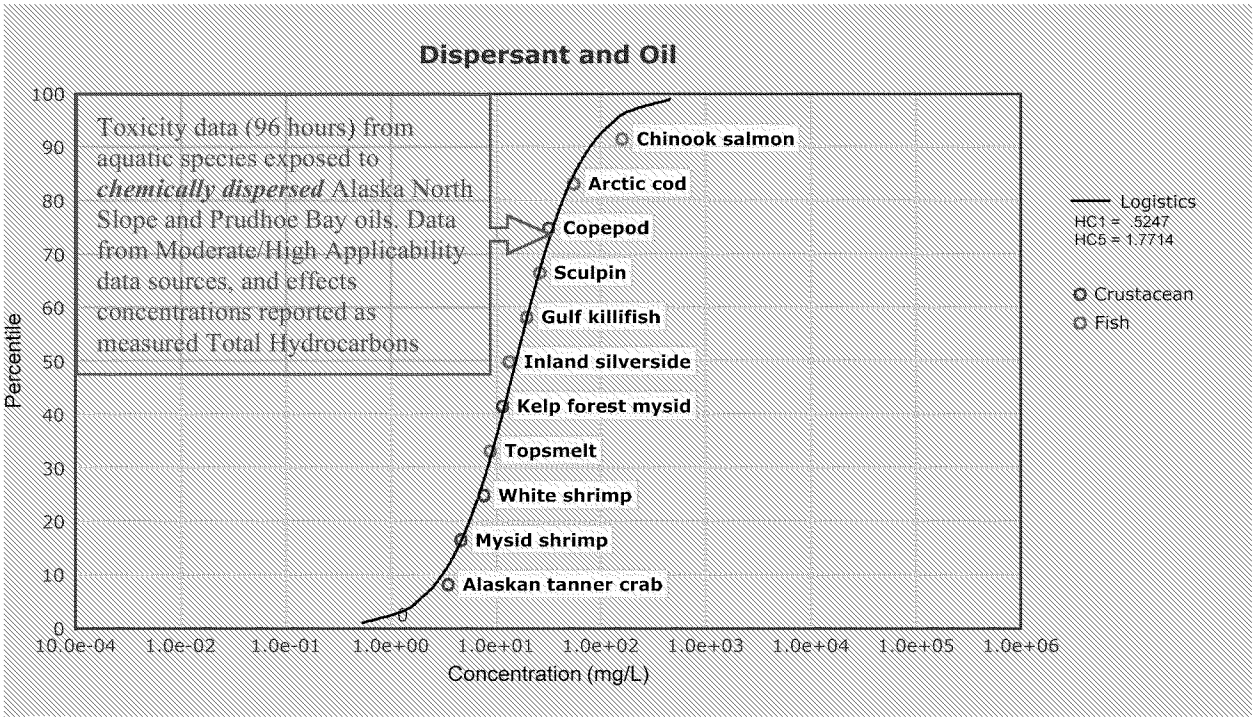


Answer: Yes. Cold water species have similar sensitivities to medium oil chemically dispersed with Corexit9500 as temperate species (top plot), as well as one of the U.S. standard test species (topsmelt) (bottom plot). Therefore, both temperate and U.S. standard test species may be suitable surrogate for cold water species in toxicity testing of oil and dispersants.

ED_001324_00007355-00064

Does Corexit 9500 increase the toxicity of Alaskan oils?





Answer: No. Based on the best available toxicity data available to date, there is no evidence that Corexit9500 increases the toxicity of Alaskan oils. As shown above, curves from physically and chemically dispersed oil are similar and both have comparable hazard concentrations (HCs).

ED_001324_00007355-00065

To: steve.lehmann@noaa.gov[steve.lehmann@noaa.gov]; ed.levine@NOAA.gov[ed.levine@NOAA.gov]; Conmy, Robyn[Conmy.Robyn@epa.gov]; scott.lundgren@noaa.gov[scott.lundgren@noaa.gov]; Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Hansen, Kurt A CIV
Sent: Fri 7/15/2016 6:32:34 PM
Subject: Two Interesting Papers from AMOP
Countermeasures AMOP 2016.pdf
Canada Dilbit Training AMOP 2016.pdf

I may be sending more out as I relook over the proceedings.

Kurt A. Hansen, P.E.
U.S. Coast Guard Acquisition Directorate
Research & Development Center
(860) 271-2865

Development of Health and Safety Procedures and Training Materials for Dilbit/Synbit Crude Oil Spills for Environment Canada's Responders

P.G. Lambert, M. Goldthorp, B. Fieldhouse, N. Jones, S. Laforest, L. Atwater and C.E. Brown
Emergencies Science and Technology Section
Science and Technology Branch
Environment and Climate Change Canada
Ottawa, Ontario, Canada
Patrick.Lambert@canada.ca

Abstract

In 2015, Emergencies Science and Technology Section (ESTS), Environment and Climate Change Canada (ECCC) reported on a literature search study of the health and safety issues for its oil spill response personnel. The study reviewed the chemical properties and composition of two diluted bitumen (dilbit) crude oils Access Western Blend and Cold Lake Bitumen, their fate and behavior during a spill and potential exposure pathways for on-site responders. In summary it was noted that the characteristics relevant to health and safety of unconventional crude oils can differ from those typical of conventional crude oils. The difference was primarily a result of the small molecular weight, volatile compounds in the condensate portion of dilbit. Evaporation of the dilbit could result in the rapid transfer of 12 to 16% by weight of the mass to air within the initial 6 hours of a spill. Consequently, there is a potential inhalation and contact threat to initial responders under certain significant spill scenarios. Recommendations for air monitoring instrumentation, chemical protective clothing, medical monitoring and decontamination protocols were put forth.

ESTS followed the aforementioned study with a subsequent oil spill health and safety project to (1) undertake a critical task inventory and hazard assessment analysis of a dilbit and synthetic bitumen (synbit, www.crudemonitor.ca) spill response by Environment and Climate Change Canada personnel as well as develop safe work procedures; and (2) to develop training materials suitable to site safety planning, including protective equipment and other tools for on-site response by Environment and Climate Change Canada personnel. The end result is to expand Environment Canada's current health and safety toolbox for personnel who may respond on site to spills of conventional and unconventional crude oil

1 Objective

The purpose of this paper is to present information on a project undertaken by ESTS to develop new health and safety procedures and training material specific to a dilbit and/or synbit unconventional oil spill. The tools developed may be transferable to the larger oil spill response community.

2 Introduction

ECCC and other Federal departments began a multi-year Research and Development (R&D) program in 2013 to examine specific topics related to a potential spill of dilbit crude oil on marine systems typical of those found in Northwest British Columbia. In the subsequent phase of the Enhanced Marine Safety Strategy (formerly the World Class Tanker Safety System (WCTSS) Initiative) four additional priority areas of Southern British Columbia, the St. Lawrence River, Port Hawkesbury and the Strait of Canso as well as the Bay of Fundy were included. An example

Lambert, P.G., M. Goldthorp, B. Fieldhouse, N.C. Jones, S. Laforest, L. Atwater, and C.E. Brown, Development of Health and Safety Procedures and Training Materials for Dilbit/Synbit Crude Oil Spills for Environment Canada's Responders, Proceedings of the Thirty-ninth AMOP Technical Seminar, Environment and Climate Change Canada, Ottawa, ON, pp. 554-571, 2016.

of ESTS's R&D priorities is the study of the impact of oil spills on shorelines as well as oil spill detection and monitoring R&D projects. ESTS has undertaken a study that reviews health and safety concerns for oil spill response workers focusing on ECCC personnel who are required to conduct their work in close proximity to spills of unconventional diluted bitumen crude oil spills.

3 A Historical Perspective on ESTS's Health and Safety Program

ESTS's oil and hazardous materials environmental emergencies R&D work originated with the Arctic and Maine Oil Spill Program (AMOP) and Chemical Hazards Emergency Countermeasure (CHEC) program in 1977 and 1980 respectively. A unique feature of ESTS is its operational role to provide reach back and when required, on-site scientific support to ECCC's Environmental Emergency Program as well as the oil spill response community. Health and safety of ESTS's on-site personnel has always been a priority and is supported by R&D projects. Environment and Climate Change Canada staff are trained and equipped to safely undertake on-site operations and have done so for decades. Health and safety projects carried out by ESTS generally focus on personnel safety at a spill site and include the development of technical information tools like spill manuals and training. Too more clearly demonstrate the context and scope of ESTS's health and safety projects carried out over the years, a few examples are listed below:

- Environment Canada's EnviroTIPS series included a protective measures section for the use of personnel working in the vicinity of chemical spills (EnviroTIPS, 1985);
- Several reports detail discussions of personal protective equipment for use on site at spills as cited in *Handbook of Hazardous Spills Technology* (Fingas, 2002);
- Health and safety concerns from volatile compounds evolved while restoring a chemically contaminated structure (Lambert et al., 2007);
- An overview of ESTS's experience with its respirator fit testing program (Fieldhouse, 2009); and,
- A study to evaluate current on-line resources for site safety planning (Goldthorp et al., 2012).

4 Project Rationale and Overview

A core principle of Environment Canada's Enhanced Marine Safety Strategy and related R&D was to enhance "Operational Science to Inform Marine Oil Spill Response". ESTS was to conduct environmental research on marine oil spill preparedness and response and through ECCC's National Environmental Emergencies Centre (NEEC), to provide science-based expert advice and tools for oil spill responders.

Health and safety programs evolve over time. ESTS is currently reviewing its health and safety procedures and training requirements for on-site activities. Recently, a scoping study was concluded to address a knowledge gap related to the occupational health and safety issues of a dilbit and synbit oil spill response (Murphy and Almosnino, 2015). Further, ESTS is a participant in the Worker Safety and Health Subcommittee (WSHS) which is a subcommittee within the Response Committee co-chair by U.S. EPA and OSHA. The U.S. EPA National Response Team (NRT) led a multi-agency group that included Environment and Climate Change Canada and Transport Canada to develop and deliver an internet-based, openly accessible training course on "Emerging Risks Responder Awareness Training Bakken Crude Oil" (www.nrt.org). The U.S. Federal Emergency Management Agency (FEMA) invited ESTS to participate in a number of oil spill exercises they hosted throughout 2015. The exercises partnered with local city and Native

(U.S. term for Indigenous) government agencies to build awareness of issues including health and safety for responding to potential crude-by-rail incidents.

In late 2015, ESTS contracted the services of a private company (Resource Environmental Associates (REA) Limited, Markham, Ontario) to undertake a project to develop the health and safety procedures and a training materials "tool box" for ECCC personnel who may respond on site to a terrestrial or marine dilbit or synbit oil spill. For the purposes of this paper, the project has been divided into four tasks as described in the subsequent paragraphs.

i. To prepare a critical task inventory and associated task hazard assessment document in accordance with requirements of Part 19 of the Canada Occupational Health and Safety Regulations (CCOHS, 2009);
ii. Using the information obtained from the task hazard analysis in task (i.), task (ii) was to prepare a health and safety procedures report intended to guide protective actions at sites. Included was a template or job aid to be used to specify actions and equipment for specific deployments;
iii. The preparation of an one hour short awareness training course. The awareness course is an overview and is intended to provide basic information about (a) the differences between conventional and unconventional crude oils, (b) the volatile organic compound (VOC) composition of dilbit and synbit (versus conventional crude oils), and the implications of VOC composition for health and safety hazards associated with spills, (c) the dynamics of VOC composition following the occurrence of a spill on land and/or a marine setting, and under different seasonal and weather conditions, as well as the implications of these variables for changes in the hazard profile at a spill site in the hours, days and weeks after the occurrence; and
iv. The forth task was to prepare an introduction level training course for ECCC personnel. The course deals with health and safety aspects of responding to dilbit or synbit spills. It was designed as a stand-alone course or can be used as an additional module enhancing ESTS's existing suite of oil and chemical training courses. The course content is intended to address the results from task (i.) and (ii.). It will be taught in a conventional instructor-led classroom format over the course of up to one day (8 hours) with practical exercises. The course goal is to provide a more comprehensive understanding of dilbit and synbit spill scenario hazards, the origins of these unconventional crude oils and appropriate occupational health and safety protective actions. The final instructional package for the one day training course includes the following:
    - A curriculum;
    - A list of learning objectives;
    - A brief training plan document describing how the learning objectives are expected to be achieved through delivery of the course;
    - A set of instruction slides and guidance annotations;
    - Exercise materials; and,
    - Quizzes or similar to evaluate achievement of learning objectives.

5 Environment Canada's Hazard Assessment and Safe Work Procedures

An assessment of potential hazards was carried out by a contractor specializing in workplace health and safety, in consultation with ESTS personnel. Hazards considered in the assessment were those likely to be encountered by ESTS and other ECCC personnel travelling to, or on site at a dilbit or synbit crude oil spill. Incidents involving a rail, pipeline or marine spills

were included in the hazard assessment. A critical task inventory of thirty-one deployment tasks associated with ECCC deploying on-site to a dilbit or synbit incident was established. For example within the seven travel tasks listed, they range from vehicle travel by maintained roads to helicopter travel. There are twenty-one on-site tasks ranging from climbing up and down ladders, to walking along docks, to working near spilled chemicals, and to working in remote locations. Potential hazards for each task were listed and reviewed with consideration given to the role of ECCC staff at a spill. Control measures are steps that can be taken to minimize or eliminate the hazard at the source. Reasonably expected control measures were categorized into three groups titled personal protective equipment, safety devices and supplies as well as, personal emergency equipment. The Hazard Assessment Summary Matrix for ECCC personnel is presented in Appendix 1 for reference purposes.

A few observations are discussed based on a review of the completed Hazard Assessment Summary Matrix. When developing the critical task inventory and hazard assessment for a dilbit or synbit crude oil incident, we did not note a significant difference in the process used to compile the critical tasks as compared to the existing critical tasks for a conventional crude oil incident. This implies that the critical task inventory and hazard assessment process is flexible and can be adapted to new or evolving work related jobs. Rail, pipeline and marine spill scenarios resulted in only a few changes to the critical task inventory. In other words, the majority of critical tasks necessary to enable ECCC personnel to carry out their job at a rail or pipeline or marine incident are similar. However there are some exceptions. For example, a critical task of working near live rail lines has a high probability at a rail incident and much lower probability at a pipeline or marine incident. The critical task inventory and hazard assessment process was an opportunity for ESTS to re-assess the risk (probability and impact) of potential hazards at a dilbit and synbit incident. For instance, chemical exposure and fire/explosion are two hazards associated with working near spilled or burning fuel or chemicals. These exist at conventional and unconventional crude oil spills. During the re-assessment process for dilbit and synbit, the probability of chemical exposure and fire/explosion in localized areas is greater than most conventional crude oil spills.

Safe Work Procedures for a rail, pipeline and marine dilbit or synbit spill were developed to address the identified critical tasks and potential hazards. The titles of the prepared Safe Work Procedures are provided for the information of the reader.

- **TRAVEL TASKS**
  - ATV travel - off road
  - Helicopter travel to site - departure from land base
  - Jump-off exit from helicopter onto land
  - Small fixed wing aircraft travel to site
  - Snowmobile travel - off road
  - Travel by small boat or ship
  - Vehicle travel to site - maintained roads
  - Vehicle travel to site - non-maintained roads or off road
  - Walk-off exit from helicopter onto land

- **ON-SITE TASKS**
  - Climbing up / down ladders / stairs on ship
  - Climb onto portions of pipeline structures
  - Climb onto rail cars

- Entering hold of ship
- Examining site of personal injury
- Interviewing personnel
- Standing close to radar emitters on ship
- Walk near edge of body of water
- Walk on frozen surface of body of water
- Walk through wilderness areas
- Walking dockside / alongside on dock
- Walking on ship deck
- Work in small team alone in remote area
- Work near burning chemicals / fuels
- Work near large haulage trucks
- Work near live rail line
- Work near logging / clear cutting equipment
- Work near metal hydraulic shearing
- Work near metal saw cutting
- Work near metal torch cutting / welding
- Work near mobile material handling equipment (cranes, lifts, bulldozers, etc.)
- Working daily for more than 12 hours
- Working near spilled chemicals / fuels
- Working on site in cold weather conditions

Safe Work Procedures listed each potential hazard for that task with the corresponding recommended protective action. An example of one of the Safe Work Procedure developed for ECCC is included for the purpose of demonstrating the content and approach used. The Safe Work Procedure example for a potential chemical exposure by ECCC staff in a typical oil spill response for "working near spilled chemicals or fuel at a rail setting" is provided in Table 1.

In the process to develop the critical task inventory, undertake the hazard assessment and develop the Safe Work Procedures it was necessary to make some assumptions such as, when traveling by commercial aircraft and/or boat that the aircraft and boat were suitably equipped with all required safety devices and would have their own health and safety protocols. Finally, Safe Work Procedures are itemized lists and intended to help with the subsequent development of detailed safety standard operating procedures, to identify hazard specific training, to aid in guidance of necessary medical monitoring of personnel as well as verify fitness to work.

Table 1 Hazard Assessment and Safe Work Procedures.

Potential Hazard	Recommended Protective Measures	
	Type	**Control**
Chemical exposures – ambient atmosphere	Personal Protective Equipment Safety Devices and Supplies	Respiratory protection Gas (VOC, benzene) detector
Chemical exposures - contents	Personal Protective Equipment	Chemical protective gloves Field safety boots Chemical boots or covers Protective eyewear Face shield Chemical impervious coveralls

	Safety Devices and Supplies	Respiratory protection Sanitizing wipes Gas (VOC, benzene) detector
Fire or explosion	Personal Emergency Equipment Personal Protective Equipment Safety Devices and Supplies	Portable fire extinguisher Respiratory protection Chemical protective gloves Field safety boots Nomex clothing Chemical impervious coveralls Gas (VOC, benzene) detector
Item	Additional Information	
Chemical protective gloves	• Use Nitrile gloves if low / no exposure to fire or explosion hazards. A recommendation is to use Nitrile heat resistant gloves if exposed to fire or explosion hazards.	
Gas (Volatile hydrocarbons, benzene) detector	• Must be able to provide instantaneous concentration data for benzene, carbon monoxide, hydrogen sulphide, sulphur dioxide, combustibles, and oxygen. A recommendation is the RAE Systems that is PID equipped with appropriate sensors, or equivalent device.	
Chemical protective clothing or coveralls (see Forsberg, 2014)	• A recommendation is DuPont Tychem ThermoPro or equivalent if exposed to fire or explosion hazards or DuPont Tychem hooded coveralls or equivalent if low / no exposure to fire or explosion hazards.	
Nomex clothing	• Nomex shirts and pants should be worn if Tychem ThermoPro coveralls are worn.	
Respiratory Protection (see ACGIH, 2015 and NIOSH, 2006)	Recommendations only are provided. • For work in atmospheres that are oxygen deficient (<18%), or where work will take place for 15 minutes or longer where ambient carbon monoxide concentrations exceed 400 parts per million, a supplied air respirator must be used. • Use full-face respirator where maximum ambient airborne benzene concentrations exceed 5 parts per million. • Half-face respirator maybe suitable where maximum ambient airborne benzene concentrations do not exceed 5 parts per million (10x the ACGIH (use current 8 hour time-weighted average occupational exposure limit). • Use filter cartridges providing protection against chlorine dioxide, sulfur dioxide, organic vapors, ammonia, hydrogen chloride, methylamine, formaldehyde, chlorine, hydrogen sulfide, hydrogen fluoride, and particulates. Suitable cartridge is multi-acid gas / Organic Vapour / R100 cartridge (oil mist resistant), or equivalent. This cartridge type is also suitable for exposure to fire smoke (but not elevated carbon monoxide), ambient dusts, fumes and gases from metal cutting.	

6 Environment Canada's Training Course

Two training courses were developed to meet the requirements of Environment Canada's Risk Analysis and Hazard Prevention Directive (EC, 2015). They are the awareness level and introduction level training courses respectively. The awareness level course is an abridged version of the more comprehensive introduction course. Basic information is covered in the awareness course on the origin of oil sands bitumen, a comparison between unconventional and conventional oil, the chemical composition of dilbit and synbit and finally, the effects of the oil's chemical composition on spill behaviour, fire and explosion risk and health risks. Awareness training targets audiences with either (1) existing knowledge of the origins of dilbit and synbit, hazard recognition and toxicology as well as preventive safety measures or (2) personnel whose job requires some knowledge of the health and safety issues specific to unconventional crudes and who would have a limited role and exposure on-site at a spill. Meanwhile, the introduction level training course targets Environment and Climate Change Canada personnel who are initial on-site responders to incidents and whose role at an oil spill requires them to potentially work in proximity to the spilled crude oil. Both courses can be taught as stand alone or in conjunction with other training courses offered by ESTS. Neither the awareness nor introduction level course requires any prerequisite training.

A summary of the introduction course is provided. Flexibility was built into the design of the course content where the introduction course is intended to require up to one day (8 hours) of training. The twelve (12) lecture format modules require approximately ½ day of lecture style instruction and is intended as the typical course delivered offsite from the ESTS Training Centre located in Ottawa, ON. The ESTS Training Centre is equipped with many teaching aids and gives the course instructors access to extensive safety training equipment and space for classroom demonstration, tabletop and practical exercises. The introduction course delivered at the Training Centre is intended to be delivered over one full day. In addition to the lecture modules, the training course will include a table top exercise with the objective to complete a site safety plan consistent with the typical role of the participants at an incident. For example, Environment and Climate Change Canada staff from the Environmental Emergencies Office, Enforcement Branch, ESTS scientists and Canadian Wildlife Service (CWS) may respond on-site to any spill. Each group's role on-site, their typical arrival time on site and the potential for either airborne or dermal contact differs. The ability to recognize and assess hazards within the context of one's role at a spill is critical to site safety planning. The site safety plan will follow either the Environment and Climate Change Canada form or Incident Command System form 215A template and address the specific needs of an incident involving dilbit or synbit. As well, a requirement is the full participation by the students in a dilbit/synbit scenario-based practical exercise including the don/doff and use of the respiratory protection and personal protective clothing described in the previous site safety plan. For the benefit of the reader, the twelve (12) lecture modules and learning objectives for the introduction level course the "Protection of Health and Safety in Dilbit/Synbit Spill Field Work" are listed as follows:

1. *Conventional vs. Unconventional Oils* - to develop an understanding of the differences between the terms "conventional oil" and "unconventional oil";
2. *Oil Sands and Bitumen* to be able to distinguish the general composition of oil sand from bitumen based on a list of components;
3. *Chemical Composition of Dilbit and Synbit* - to better understand the meaning of a "diluent" and the reason it is present in unconventional oils;

4. *Effect of Dilbit / Synbit Chemical Composition on Spill Behaviour* - to improve knowledge of the chemical composition of diluents and how the addition of diluent affects the health and flammability risks associated with dilbit and synbit spills;
5. *Effect of Dilbit / Synbit Chemical Composition on Fire and Explosion Risk* - with the objective to better understand the relationship between the presence of diluent and the evolution of light hydrocarbons from spilled unconventional oil and how the ignition of spilled dilbit or synbit alters the air emissions from the spilled material and the associated inhalation exposure risks;
6. *Effect of Dilbit / Synbit Chemical Composition on Health Risk* - to improve the understanding of the manner by which the passage of time, weather conditions, original diluent concentration in the oil solution and environmental temperature affect emissions of light hydrocarbons from spilled unconventional oil and the relationship of this to inhalation exposure risk.
7. *Health-Based Exposure Limits for Air Contaminants* - the objective is to introduce the applicable occupational exposure limit such as "ACGIH" and "AEGL";
8. *Air Contaminant Concentrations at Unconventional Oils Spills* the objective is to present air quality information from recent incidents as well and guidance on how to set up an air quality monitoring safety plan at a spill site;
9. *Health and Safety Protective Measures at Unconventional Oils Spills* - to explain the concept of hazard zones such as the Red (alternate terms are exclusion and hot zones), Green (or contamination reduction or warm zones) and Yellow (or support or cold zones) Zones at a spill site, and what levels of personal protective equipment suites are required for operations in each zone;
10. *Respiratory Protection at Unconventional Oils Spills* - with a goal to improve understanding of air purified respiratory protection, what an "Assigned Protection Factor"(APF) is for a respirator and the APF values for three different types of respirators.
11. *Basics of Self-Contained Breathing Apparatus* – with a goal to improve understanding of self-contained breathing apparatus respiratory protection; and,
12. *ESTS Hazard Assessment and Safety Procedures Documents* – to present an overview of the hazard assessments and safety procedures developed for ESTS as a case study.

7 Health and Safety Concerns at a Dilbit/Synbit Spill

The following paragraphs are key points related to health and safety summarized from the initial study (Lambert et al., 2015; Murphy and Almosnino, 2015) and then incorporated into the introduction training course developed for ECCC by REA Limited (Murphy and Almosnino, 2016).

Oilsands bitumen composition varies by geographical source but is generally more viscous, larger molecular compounds with low volatility. Diluent makes up a significant fraction of dilbit, synbit or dilsynbit and is of primary importance to address health and safety concerns for spill responders. Light naphtha-based oils and natural gas condensates are the most common diluent. The source of a diluent varies. Each diluent may have slightly different chemical composition relative to each other. Much of the information presented here is based on a review of Cold Lake Blend (CLB) and Access Western Blend (AWB) crude oil. These are two high volume unconventional crude oils selected as part of the Federal Government Technical Report (Environment Canada, 2013). Access Western Blend and Cold Lake Bitumen can contain 20% to 30% diluent. Condensates used in dilbit and synthetic crude oil are dominated by predominately

low molecular weight hydrocarbons. These have a high vapour pressure, are very volatile and easily evaporate. Mass lost to air by evaporation can be 12 to 16% by weight with 6 hours and more within the initial 24 hours. The fate and behaviour of dilbit and synbit is unique to each spill incident however it is significantly influenced by several factors such as the percentage (%) of diluent in the mixture, the vapour pressure, temperature of the crude oil, temperature of the surrounding environment, and whether the spill is to land or water. Evaporation of the condensate may result in localized areas where the concentration of hydrocarbons in the air has reached flammable limits and further, the potential to reach the fire point. In the case of an incident involving burning dilbit or synbit crude oil, the chemical composition of the emissions differs from those emitted by evaporation of oil alone. Both scenarios should be reviewed when considering respiratory and personal protective clothing. The chemical composition data of CLB and AWB (Environment Canada, 2013) clearly demonstrates the potential for inhalation exposure with elevated levels of volatile organic compounds (VOCs) in air during the initial response period. Exposure modelling results predict a potential scenario where some individual compounds may even exceed ACGIH workplace safety values (Murphy and Almosnino, 2015).

8 Next Steps

T he final steps planed in ESTS's oil spill health and safety work is to carry out the following:

- The delivery of a least one pilot course to Environment and Climate Change Canada's Environmental Emergencies, Enforcement and Canadian Wildlife Service staff;
- Outreach to other Federal Departments and Agencies including the Canadian Coast Guard and National Energy Boards;
- Technology transfer through participation in joint exercises and workshops with the operational end user such as oil spill response companies
- Steps to revise the training material based on feedback from the aforementioned three bullets as well as ensuring the final documents and training material is compliant with Environment and Climate Change Canada's publishing standards including translation.

The end result is to fulfil Environment Canada's health and safety protocols for its personnel may respond on site to spills of conventional and unconventional crude oil.

9 Conclusions

Over the past two years ESTS undertook a project to study potential health and safety issues that might be encountered by Environment and Climate Change Canada personnel at a dilbit or synbit crude oil spill. The initial work completed in 2015 included a literature review study primarily using data from the chemical composition of two dilbit crude oils Access Western Blend and Cold Lake Bitumen, their fate and behavior during a spill and potential exposure pathways for on-site responders. The study reported that characteristics relevant to health and safety of unconventional crude oils can differ from those typical of conventional crude oils. The small molecular weight, volatile compounds in the condensate portion of dilbit could rapidly evaporate transferring 12 to 16% by weight of the mass to air within the initial 6 hours of a spill. As a consequence, there is a potential inhalation and contact threat to initial responders under certain significant spill scenarios.

In order to address the results and knowledge gaps reported in the study, the subsequent

phase of the health and safety project was to develop the necessary procedures and training material to address the gaps and minimize any risk to ECCC personnel. A critical task inventory and task hazard assessment was carried out. Safe Work Procedures were prepared based on the task hazard assessment and are used to assist with protective measures for on-site response. Finally, a basic awareness level and more detailed introduction level training courses were developed to facilitate knowledge transfer and education of ECCC personnel.

10 Acknowledgements

The authors of this paper would like to graciously acknowledge the efforts of J.H. Murphy and S. Almosnino of Resources Environmental Associates Limited (Markham, Ontario, Canada). Without their assistance with the design and timely delivery of the contracted hazard analysis and training material this paper would not have been possible.

11 References

American Conference of Governmental Industrial Hygienists (ACGIH), TLVs and BEIs for Chemical Substances and Physical Agents and Biological Exposure Indices, ACGIH, Cincinnati, OH, 251 p., 2015.

Canadian Centre for Occupational Health and Safety (CCOHS, 2009), *Job Safety Analysis Made Simple,* Retrieved January, 2015 from http://www.ccohs.ca/.

Environment and Climate Change Canada (EC, 2015), *Occupational Health and Safety, Risk Analysis and Hazard Prevention Directive*, internal report to Environment and Climate Change Canada, 50 p., September 2015.

Environment Canada (EC, 2013), *Properties, Composition and Marine Spill Behaviour, Fate and Transport of two Diluted Bitumen Products from the Canadian Oil Sands*, Federal Government Technical Report, Retrieved January 2014, from *www.ec.gc.ca/.*

Environmental and Technical Information for Problem Spills (EnviroTIPS),*Introduction Manual*, Environment Canada Technical Report Series, Ottawa, ON, 113 p., 1985.

Fieldhouse, B.G., "Fit Testing Respirators: Comparison of Techniques", *Proceedings of the Thirty-second AMOP Technical Seminar on Environmental Contamination and Response*, Environment Canada, Ottawa, ON, pp. 301-313, 2009.

Fingas, M., "Review of Personal Protective Equipment for Spill Situations", in *The Handbook of Hazardous Materials Spills Technology*, Chap. 30, M. Fingas (ed.), McGraw-Hill, New York, NY, pp. 30.3-30.22, 2002.

Forsberg, K., A. Van den Borre, N. Henry III, J. Zeigler, Quick Selection Guide to Chemical Protective Clothing, John Wiley and Sons, Inc., Hoboken, NJ, 260 p., 2014

Goldthorp, M.D., and P.G. Lambert, "Assessing Current On-line Resources as Viable Tools for Site Safety Planning", *Proceedings of the Thirty-fifth AMOP Technical Seminar on Environmental Contamination and Response*, Environment Canada, Ottawa, ON, pp. 126-184, 2012.

Lambert, P.G., M.D. Goldthorp, K. Li, M.F. Fingas, and K. Volchek,"Health and Safety Concerns while Restoring a Chemically Contaminated Structure", (24th TSOCS), *Proceedings of the Thirtieth AMOP Technical Seminar*, Environment Canada, Ottawa, ON, pp. 851-882, 2007.

Lambert, P., M. Goldthorp, B. Fieldhouse, N. Jones, S. Laforest, and C.E. Brown, "Health and Safety Concerns at Dilbit Crude Oil Spills for Environment Canada's Responders", *Proceedings of the Thirty-Eighth AMOP Technical Seminar*, Environment Canada, Ottawa, ON, pp. 664-678, 2015.

Murphy, J.H. and S. Almosnino, *A Scoping Study on Occupational Health and Safety Issues in Dilbit and Synbit Spill Response*, internal contract report to Environment and Climate Change Canadaby Resource Environmental Associates (REA) Limited, Ottawa, ON, 50 p., March 2015.

Murphy, J.H. and S. Almosnino,*Protection of Health and Safety in Dilbit/Synbit Spill Field Work*, internal contract report to Environment and Climate Change Canadaby Resource Environmental Associates (REA) Limited, Ottawa, ON, 147 p., March 2016.

National Institute for Occupational Safety and Health (NIOSH),*NIOSH Pocket Guide to Chemical Hazards*, NIOSH Publications Dissemination, Cincinnati, OH, 424 p., 2006.

Appendix 1 Hazard Assessment Summary Matrix for Environment and Climate Change Canada Personnel.

Deployment Tasks	Dilbit / Synbit Spill Setting			Potential Hazards	Reasonably Expected Controls																														
					Personal Protective Equipment																Safety Devices and Supplies (Note: Assumes Personnel Equipped with Sat Phones)								Personal Emergency Equipment (Note: Assumes Aircraft and Boats Properly Equipped)							
	Rail	Pipeline	Marine		Resp Prot	Cloth Work Gloves	Cold Prot'v Gloves	Chem Prot'v Gloves	Field Safety Boots	Chem Boots / Covers	Nomex Clothing	Prot Helmet	Protv Eyewear	Face Shield	Hearing Protn	High Vis Clothg	Imperv Coveralls	Cold Weather Gear	Survival Suit	Pers Float Dev	Fall Protectn	GPS Locator	Gas Detector	Radiation Detector	Bear Spray	Snow Shoes	Sanitizing Wipes	Protective Shelter / Tent / Trailer	Firearm	Flares	Fire Starter	Flashlight / Beacon	Emerg Horn	Emerg Rations	Port Fire Ext	Emerg Blanket	First Aid Kit
TRAVEL TASKS																																					
Vehicle travel to site - maintained roads	√	√	√	Collision												√														√					√		√
				Breakdown												√														√						√	√
Vehicle travel to site - non-maintained roads or off road	√	√	√	Collision												√						√								√	√	√	√	√	√	√	√
				Breakdown												√						√								√	√	√	√	√	√	√	√
ATV travel - off road	√	√	√	Cold Weather		√			√			√	√	√	√	√		√				√								√	√	√	√	√	√	√	√
				Collision		√			√			√	√	√	√	√						√								√	√	√	√	√	√	√	√
				Rollover		√			√			√	√	√	√	√						√								√	√	√	√	√	√	√	√

Lambert, P.G., M. Goldthorp, B. Fieldhouse, N.C. Jones, S. Laforest, L. Atwater, and C.E. Brown, Development of Health and Safety Procedures and Training Materials for Dilbit/Synbit Crude Oil Spills for Environment Canada's Responders, Proceedings of the Thirty-ninth AMOP Technical Seminar, Environment and Climate Change Canada, Ottawa, ON, pp. 554-571, 2016.

				Breakdown		√									√	√						√								√	√	√	√	√	√	√	√
				Noise											√																						
				Fuel				√					√																						√		
Snowmobile travel - off road	√	√	√	Cold Weather			√		√			√	√	√		√		√				√				√				√	√	√	√	√	√	√	√
				Collision			√		√			√	√	√		√		√				√				√				√	√	√	√	√	√	√	√
				Rollover			√		√			√	√	√		√		√				√				√				√	√	√	√	√	√	√	√
				Breakdown			√									√		√				√				√				√	√	√	√	√	√	√	√
				Noise											√																						
				Fuel				√					√																						√		
Small fixed wing aircraft travel to site	√	√	√	Crash to land or water																																	
Helicopter travel to site - departure from land base	√	√	√	Crash to land																																	
				Ditching in water																																	
Walk-off exit from helicopter onto land	√	√	√	Rotors																																	
				Walking Surfaces																																	
Jump-off exit from helicopter onto land	√	√	√	Snag					√																												
				Landing Surfaces					√																												
Travel by small boat or ship		√	√	Rough conditions					√						√	√		√	√	√																	

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ON-SITE TASKS																																					
Climbing up / down ladders / stairs on ship			√	Slip / Fall					√			√																									
Walking on ship deck			√	Slip / Fall					√			√																									
			√	Hit by Moving Loads								√				√																					
Walking dockside / alongside on dock			√	Slip / Fall					√			√																									
			√	Hit by Moving Loads								√				√																					
			√	Hit by Mobile Material Handling Equipment					√			√				√																					
Entering hold of ship			√	Confined / restricted space					√			√	√			√					√		√														
			√	Slip / Fall					√			√									√																
			√	Chemical exposures				√		√		√	√	√			√						√														
Standing close to radar emitters on ship			√	Microwave exposure																																	
Interviewing personnel	√	√	√	Threat of violence							√							√																			
Examining site of personal	√	√	√	Body fluids exposure				√		√							√										√										

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injury																																						
Working near spilled chemicals / fuels	√	√	√	Chemical exposures - contents	√			√	√	√			√	√			√						√				√											
	√	√	√	Chemical exposures - ambient atmosphere	√																		√															
	√	√	√	Fire / explosion	√			√	√		√						√						√												√		
Work near burning chemicals / fuels	√	√	√	Chemical exposures - ambient atmosphere	√				√	√													√															
				Fire / explosion	√				√		√						√						√												√		
Walk on frozen surface of body of water	√	√	√	Breakthroug h Ice												√			√																		
				Slip / fall					√																													
Walk near edge of body of water	√	√	√	Fall into water												√			√																			
Walk through wilderness areas	√	√	√	Uneven terrain / slopes					√			√														√												
	√	√	√	Hazardous vegetation		√			√																													
	√	√	√	Wildlife					√																√				√									
Work in small team alone in remote area	√	√	√	Wildlife																					√			√	√									
				Getting lost																		√						√		√	√	√	√	√	√	√	√	√
				Medical																								√		√	√	√	√	√	√	√	√	√

Lambert, P.G., M. Goldthorp, B. Fieldhouse, N.C. Jones, S. Laforest, L. Atwater, and C.E. Brown, Development of Health and Safety Procedures and Training Materials for Dilbit/Synbit Crude Oil Spills for Environment Canada's Responders, Proceedings of the Thirty-ninth AMOP Technical Seminar, Environment and Climate Change Canada, Ottawa, ON, pp. 554-571, 2016.

				emergency																																	
Climb onto rail cars	√			Slip / Fall from Height					√			√									√																
				Chemical exposures - contents	√			√		√			√				√						√														
				Chemical exposures - ambient atmosphere	√																		√														
				Ionizing radiation exposure - contents																																	
Climb onto portions of pipeline structures				Slip / Fall from Height					√			√									√																
				Chemical exposures	√			√		√			√				√						√														
				Ionizing radiation exposure - instrumentation																				√													
Work near mobile material handling equipment (cranes, lifts, bulldozers, etc.)	√			Being hit / run over					√			√				√																	√	√				
				Falling objects / crushing					√			√																									
Work near large haulage	√	√		Being hit / run over					√			√				√																	√	√				

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trucks																																						
Work near logging / clear cutting equipment	√	√		Being hit / run over					√			√				√																√	√					
				Falling objects / crushing					√			√																										
				Noise											√																							
Work near metal saw cutting	√	√	√	Flying metal fragments		√			√			√	√	√			√																					
				Metal dusts / fumes	√								√				√																					
				Noise											√																							
				Fire / explosion							√						√																			√		
Work near metal hydraulic shearing	√			Shifting heavy objects / crushing								√				√																						
Work near metal torch cutting / welding	√	√	√	Metal fumes / gases	√								√				√																					
				Noise											√																							
				Ultraviolet radiation									√	√			√																					
				Fire / explosion							√						√																			√		
Work near live rail line	√			Rolling stock / being hit								√				√																						
				Tripping / Falling					√																													
				Noise																																		
Working on	√	√	√	Cold			√		√									√										√			√					√	

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site in cold weather conditions				Weather																																	
Working daily for more than 12 hours	√	√	√	Fatigue																							√										

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To: Loring, Joseph B CAPT[Joseph.B.Loring@uscg.mil]; Weaver, James (USCG)[James.D.Weaver@uscg.mil]; Scott.A.Stoermer@uscg.mil[Scott.A.Stoermer@uscg.mil]; Ottenwaelder, Thomas A CDR[Thomas.A.Ottenwaelder@uscg.mil]; Sligh, Kevin M CIV[Kevin.M.Sligh@uscg.mil]; Carnegie, Tammie R LT[Tammie.R.Carnegie@uscg.mil]; Crecy, Stacey L LCDR[Stacey.L.Crecy@uscg.mil]; Platt, Jeffrey R LCDR[Jeffrey.R.Platt@uscg.mil]; Brooks, Rebecca J LT[Rebecca.J.Brooks@uscg.mil]; Maghini, Monica K CIV[Monica.K.Maghini@uscg.mil]; Hall, Gregory CDR (EDU)[Gregory.Hall@USCGA.EDU]; Fletcher, James E CIV[James.E.Fletcher@uscg.mil]; kurt.a.hansen@uscg.mil[kurt.a.hansen@uscg.mil]; Balsley, Alexander CIV[Alexander.Balsley@uscg.mil]; DiRenzo, Joseph CIV[Joseph.DiRenzo@uscg.mil]; mark.g.vanhaverbeke@uscg.mil[mark.g.vanhaverbeke@uscg.mil]; Catanach, Curtis P CIV[Curtis.P.Catanach@uscg.mil]; Chaves, Wendy[Wendy.G.Chaves@uscg.mil]; Jenkins, Shannon R CIV[Shannon.R.Jenkins@uscg.mil]; dave.westerholm@noaa.gov[dave.westerholm@noaa.gov]; scott.lundgren@noaa.gov[scott.lundgren@noaa.gov]; steve.lehmann@noaa.gov[steve.lehmann@noaa.gov]; john.kucklick@nist.gov[john.kucklick@nist.gov]; jason.boehm@nist.gov[jason.boehm@nist.gov]; Elena.Melchert@hq.doe.gov[Elena.Melchert@hq.doe.gov]; Erica.Folio@Hq.Doe.Gov[Erica.Folio@Hq.Doe.Gov]; kevin.easley@hq.doe.gov[kevin.easley@hq.doe.gov]; david.moore@bsee.gov[david.moore@bsee.gov]; Lori.Medley@bsee.gov[Lori.Medley@bsee.gov]; william.vocke@bsee.gov[william.vocke@bsee.gov]; joseph.levine@bsee.gov[joseph.levine@bsee.gov]; Walter.Johnson@boem.gov[Walter.Johnson@boem.gov]; brian.zelenke@boem.gov[brian.zelenke@boem.gov]; Jeff.Ji@boem.gov[Jeff.Ji@boem.gov]; barry_Forsythe@fws.gov[barry_Forsythe@fws.gov]; holly_herod@fws.gov[holly_herod@fws.gov]; christina_kravitz@fws.gov[christina_kravitz@fws.gov]; michael.carter@dot.gov[michael.carter@dot.gov]; tom.thompson@dot.gov[tom.thompson@dot.gov]; robert.w.smith@dot.gov[robert.w.smith@dot.gov]; james.merritt@dot.gov[james.merritt@dot.gov]; David.Lehman@dot.gov[David.Lehman@dot.gov]; Steven.V.Cary@usace.army.mil[Steven.V.Cary@usace.army.mil]; Andrew.J.Bruzewicz@usace.army.mil[Andrew.J.Bruzewicz@usace.army.mil]; Nathan.J.Lamie@usace.army.mil[Nathan.J.Lamie@usace.army.mil]; Kemp.skudin@navy.mil[Kemp.skudin@navy.mil]; frank.stone@navy.mil[frank.stone@navy.mil]; abe.nachabe@navy.mil[abe.nachabe@navy.mil]; michael.s.dean@navy.mil[michael.s.dean@navy.mil]; daniel.eldredge@navy.mil[daniel.eldredge@navy.mil]; Stephanie A. Brown[stephanie.a.brown@navy.mil]; Conmy, Robyn[Conmy.Robyn@epa.gov]; Principe, Vanessa[Principe.Vanessa@epa.gov]; Wilson, Gregory[Wilson.Gregory@epa.gov]; michael.j.green-1@nasa.gov[michael.j.green-1@nasa.gov]; wayne.yoder@dhs.gov[wayne.yoder@dhs.gov]; jfarrell@arctic.gov[jfarrell@arctic.gov]; Ruth Cooper[Ruth.E.Cooper.93@nd.edu]
From: Brooks, Rebecca J LT
Sent: Thur 7/14/2016 12:53:18 PM
Subject: ICCOPR Minutes and Next Meeting Scheduling
DRAFT Minutes ICCOPR FY16-3nd Quarter Meeting_7_6_16.docx

Good morning ICCOPR,

Please take some time to look through the draft minutes, attached. I request that you let me know if you have any comments or edits by Thursday, August 11th.

Additionally, folks have raised some concerns with the regularly scheduled quarterly meeting in September (which would have been 14 September). I'm including a link to a doodle poll to

determine an alternative. We're looking at either September 7th or 28th. Please let us know which of the dates would work for your schedule using this link: http://doodle.com/poll/gygizqt46h7bnyqt. Thanks for your time and have a great day!

Very respectfully,

LT Becca Brooks

U.S. Coast Guard Headquarters STOP 7516

Office of Marine Environmental Response Policy (CG-MER-3)

2703 Martin Luther King Jr. Ave SE

Washington, DC 20593-7516

Phone: 202-372-2259

To: Wilson, Gregory[Wilson.Gregory@epa.gov]
Cc: Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Malcolm Gore
Sent: Mon 5/2/2016 3:22:39 PM
Subject: FW: Finasol OSR 52 Sample Request

Hello
The below email was sent to Robyn Conmy
I received an out of office and so circulating it to see if someone else can move it through to the AP person responsible.
Thank you'Malcolm

Malcolm Gore
President

CLEAR COAST

+1 832 244 1533
malcolm.gore@clearcoastllc.com
www.clearcoastllc.com

From: malcolm gore <malcolm.gore@clearcoastllc.com>
Date: Monday, May 2, 2016 at 10:18 AM
To: "Conmy, Robyn" <Conmy.Robyn@epa.gov>
Subject: Re: Finasol OSR 52 Sample Request

Hello Robyn
This has been processed our side. We cannot accept credit cards and would ask for a check or direct transfer be made as per the invoice.
Please advise on payment timing
Thank you.
Malcolm

Malcolm Gore
President

CLEAR COAST

+1 832 244 1533
malcolm.gore@clearcoastllc.com
www.clearcoastllc.com

From: "Conmy, Robyn" <Conmy.Robyn@epa.gov>
Date: Thursday, April 28, 2016 at 1:02 PM
To: malcolm gore <malcolm.gore@clearcoastllc.com>
Subject: RE: Finasol OSR 52 Sample Request

Yes we have received the invoice and I have provided our purchase card holder with the information. He will be contacting your office for payment.

Cheers,

Robyn

<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>

Robyn N. Conmy, Ph.D.

Research Ecologist

USEPA/NRMRL/LRPCD

26 West MLK Drive

Cincinnati, Ohio 45268

513-569-7090 (office)

513-431-1970 (EPA mobile)

727-692-5333 (Personal mobile)

conmy.robyn@epa.gov

From: Malcolm Gore [mailto:malcolm.gore@clearcoastllc.com]
Sent: Thursday, April 28, 2016 1:43 PM
To: Conmy, Robyn <Conmy.Robyn@epa.gov>
Subject: Re: Finasol OSR 52 Sample Request

Hi Robyn

I have given the go ahead on this. Please confirm receipt of the invoice sent yesterday.

Malcolm

Malcolm Gore

President

+1 832 244 1533

malcolm.gore@clearcoastllc.com

www.clearcoastllc.com

From: "Conmy, Robyn" <Conmy.Robyn@epa.gov>
Date: Tuesday, April 26, 2016 at 11:05 AM
To: malcolm gore <malcolm.gore@clearcoastllc.com>
Subject: RE: Finasol OSR 52 Sample Request

Thanks for the update!

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conmy.robyn@epa.gov

From: Malcolm Gore [mailto:malcolm.gore@clearcoastllc.com]
Sent: Monday, April 25, 2016 5:45 PM
To: Conmy, Robyn <Conmy.Robyn@epa.gov>
Subject: Re: Finasol OSR 52 Sample Request

Apologies for the delay Robyn

Awaiting some shipping information. Should have this to you in the morning.

Malcolm

Malcolm Gore

President

CLEAR COAST

+1 832 244 1533

malcolm.gore@clearcoastllc.com

www.clearcoastllc.com

From: "Conmy, Robyn" <Conmy.Robyn@epa.gov>
Date: Monday, April 25, 2016 at 10:05 AM
To: malcolm gore <malcolm.gore@clearcoastllc.com>
Cc: Peter Egan <peter.egan@total.com>
Subject: RE: Finasol OSR 52 Sample Request

Hello Malcolm,

Thank you for getting back with me regarding the purchase. Yes, the information below is correct, with a mail stop at room 166. Can you send to me the invoice via email so I can provide to the purchase card holder to make the purchase?

Thank you in advance,

Robyn

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Robyn N. Conmy, Ph.D.

Research Ecologist

USEPA/NRMRL/LRPCD

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Cincinnati, Ohio 45268

513-569-7090 (office)

513-431-1970 (EPA mobile)

727-692-5333 (Personal mobile)

conmy.robyn@epa.gov

From: Malcolm Gore [mailto:malcolm.gore@clearcoastllc.com]
Sent: Monday, April 25, 2016 10:57 AM
To: Conmy, Robyn <Conmy.Robyn@epa.gov>
Cc: Peter Egan <peter.egan@total.com>
Subject: Finasol OSR 52 Sample Request

Hello Robin

I am writing with respect to your email below regarding a sample request of Total Finasol OSR 52.

Clear Coast is the custodian of the product stored here in Houston for Total.

I will arrange the sample as requested.

Please confirm the following:

Contact:

Robyn Conmy 513-569-7090 (office)

Deliver to:

26 West MLK Drive

Cincinnati, Ohio 45268

513-569-7090 (office)

Quantity:

2 US Gallons.

On receipt of confirmation I will get the samples drawn, packaged and dispatched.

Regards

Malcolm

Malcolm Gore

President

CLEAR COAST

+1 832 244 1533

malcolm.gore@clearcoastllc.com

www.clearcoastllc.com

From: Conmy, Robyn
Sent: Monday, April 18, 2016 10:47 AM
To: 'peter.egan@total.com' <peter.egan@total.com>
Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>; Principe, Vanessa <Principe.Vanessa@epa.gov>

Subject: purchase of Finasol OSR52

Mr. Egan,

This follows up our telephone conversation of April 11.

As discussed, EPA is seeking to acquire a number of dispersant products listed on the NCP Subpart J Product Schedule for the purposes of both toxicity and efficacy testing. The product testing is intended to further inform currently proposed regulatory actions under Subpart J of the National Contingency Plan. The products will in addition be used to support our general research in the area of oil spill response.

Your product Finasol OSR52 has been identified as one of interest, as it is commonly stockpiled in the U.S. Not only could the product be encountered when presented with a response situation, but including this dispersant product in toxicity and efficacy testing studies will also allow for comparison and consistency with other existing and ongoing studies by EPA and other federal agencies. EPA's Office of Research and Development (ORD) will be conducting the dispersant studies.

At this time we are seeking 2 U.S. gallons of the product.

We appreciate your time and attention to this request.

Respectfully,

Robyn Conmy

<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>

Robyn N. Conmy, Ph.D.

Research Ecologist

USEPA/NRMRL/LRPCD

26 West MLK Drive

Cincinnati, Ohio 45268

513-569-7090 (office)

513-431-1970 (EPA mobile)

727-692-5333 (Personal mobile)

conmy.robyn@epa.gov

To: Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Vanroden, Victoria
Sent: Fri 4/15/2016 9:29:42 PM
Subject: Re: RESENDING FOR ACTION - RE: "Script" for Dispersants Purchase Call

Hope it all goes well with getting the oil.

Sent from my iPhone

On Apr 13, 2016, at 11:05 AM, Principe, Vanessa <Principe.Vanessa@epa.gov> wrote:

Jim/Lynn:

Per our conversations/feedback.

•□□□□□□□□ OEM was only involved in making the initial contact (because of a "use" waiver issue).

•□□□□□□□□ The email will be sent by ORD/Robyn, since they will be doing the purchase (revised below).

•□□□□□□□□ ORD has purchasing mechanisms in place (through either ORD directly or through their laboratory contract) to obtain supplies/materials/chemicals.

Robyn, please copy Greg, Lynn and I on your message out. Contact info: Mr. Peter Egan, TOTAL (peter.egan@total.com), UNITED STATES: (713) 297-1996.

We're good to go!

Thanks everybody, V

Mr. Egan:

This follows up our telephone conversation of April 11.

As discussed, EPA is seeking to acquire a number of dispersant products listed on the NCP Subpart J Product Schedule for the purposes of both toxicity and efficacy testing. The product testing is intended to further inform currently proposed regulatory actions under Subpart J of the National Contingency Plan. The products will in addition be used to support our general research in the area of oil spill response.

Your product Finasol OSR52 has been identified as one of interest, as it is commonly stockpiled in the U.S. Not only could the product be encountered when presented with a response situation, but including this dispersant product in toxicity and efficacy testing studies will also allow for comparison and consistency with other existing and ongoing studies by EPA and other federal agencies. EPA's Office of Research and Development (ORD) will be conducting the dispersant studies.

At this time we are seeking 2 U.S. gallons of the product.

We appreciate your time and attention to this request.

Respectfully,

From: Bove, James
Sent: Wednesday, April 13, 2016 10:22 AM
To: Beasley, Lynn <Beasley.Lynn@epa.gov>; Principe, Vanessa <Principe.Vanessa@epa.gov>
Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>; Conmy, Robyn <Conmy.Robyn@epa.gov>; Vanroden, Victoria <Vanroden.Victoria@epa.gov>; Perry, Portia <Perry.Portia@epa.gov>

Subject: RE: RESENDING FOR ACTION - RE: "Script" for Dispersants Purchase Call

This is ok from a legal perspective; agree that the contracting officer needs to be looped in. Sounds like Robyn may send this- likely best since ORD is procuring…

From: Beasley, Lynn
Sent: Wednesday, April 13, 2016 10:21 AM
To: Principe, Vanessa <Principe.Vanessa@epa.gov>
Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>; Conmy, Robyn <Conmy.Robyn@epa.gov>; Bove, James <Bove.James@epa.gov>; Beasley, Lynn <Beasley.Lynn@epa.gov>; Vanroden, Victoria <Vanroden.Victoria@epa.gov>; Perry, Portia <Perry.Portia@epa.gov>
Subject: RE: RESENDING FOR ACTION - RE: "Script" for Dispersants Purchase Call

Vanessa – I had minor edits to your email. Is the contracting officer looped in to this?

Jim – are you ok from legal perspective?

Lynn

To: Principe, Vanessa[Principe.Vanessa@epa.gov]
Cc: Wilson, Gregory[Wilson.Gregory@epa.gov]; Conmy, Robyn[Conmy.Robyn@epa.gov]; Bove, James[Bove.James@epa.gov]; Beasley, Lynn[Beasley.Lynn@epa.gov]; Vanroden, Victoria[Vanroden.Victoria@epa.gov]; Perry, Portia[Perry.Portia@epa.gov]
From: Beasley, Lynn
Sent: Wed 4/13/2016 2:20:52 PM
Subject: RE: RESENDING FOR ACTION - RE: "Script" for Dispersants Purchase Call

Vanessa – I had minor edits to your email. Is the contracting officer looped in to this?

Jim – are you ok from legal perspective?

Lynn

++=

Mr Egan:

This follows up our telephone conversation of April 11.

As discussed, EPA is seeking to acquire a number of dispersant products listed on the NCP Subpart J Product Schedule for the purposes of both toxicity and efficacy testing. The product testing is intended to further inform currently proposed regulatory actions under Subpart J of the National Contingency Plan. The products will in addition be used to support our general research in the area of oil spill response.

Your product Finasol OSR52 has been identified as one of interest, as it is commonly stockpiled in the U.S. Not only could ~~will~~ the product ~~could~~ be encountered when presented with a response situation, but including this dispersant product in toxicity and efficacy testing studies will also allow for comparison and consistency with other existing and ongoing studies by EPA and other federal agencies.

EPA's Office of Research and Development (ORD) will be conducting the dispersant studies. At this time we are seeking 2 U.S. gallons of the product. Our contact person for details of the purchase is Dr. Robyn Conmy of ORD. She can be reached at (513) 569-7090.

We appreciate your time and attention to this request. Please feel free to call me as well if you have any questions/concerns.

Respectfully,

Vanessa Principe

Lynn M. Beasley, Deputy Director

Resources Management Division (RMD)

Office of Emergency Management

Mail Code: 5104A

office: (202) 564-1965

cell: (202) 309-4538

From: Principe, Vanessa
Sent: Tuesday, April 12, 2016 4:25 PM
To: Bove, James <Bove.James@epa.gov>; Beasley, Lynn <Beasley.Lynn@epa.gov>
Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>; Conmy, Robyn <Conmy.Robyn@epa.gov>
Subject: RESENDING FOR ACTION - RE: "Script" for Dispersants Purchase Call

Jim/Lynn:

Sorry to bother again. Checking to see if we're ok sending this email. Want to get the ball rolling ASAP. Thank you! V

Jim/Lynn:

DRAFT email to TOTAL contact re. our interest in procuring Finasol OSR52. Checking for any legal/procurement flags.

Of note – Mr. Egan said the waiver was no issue, that they are OK sending a free sample or making it available for purchase to EPA without any waiver.

Comments/edits?

Thanks! V

Mr Egan:

This follows up our telephone conversation of April 11.

As discussed, EPA is seeking to acquire a number of dispersant products listed on the NCP Subpart J Product Schedule for the purposes of both toxicity and efficacy testing. The product testing is intended to further inform currently proposed regulatory actions under Subpart J of the

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We appreciate your time and attention to this request. Please feel free to call me as well if you have any questions/concerns.

Respectfully,

Vanessa Principe

Chemical Engineer

Office Of Emergency Management

Office of Land and Emergency Management

U.S. Environmental Protection Agency

202-564-7913

From: Principe, Vanessa
Sent: Monday, April 11, 2016 11:06 AM
To: Bove, James <bove.james@epa.gov>
Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>; Conmy, Robyn <conmy.robyn@epa.gov>
Subject: "Script" for Dispersants Purchase Call

Jim:

From our discussion last week, below is the "message" for a first conversation with NALCO and TOTAL about purchasing their dispersant products. Of import is the idea that we do not appear to threaten any action if they are not willing to sell without a waiver. Are we ok with the statements below? Just wanted something we all know is appropriate to speak from.

The plan is to make a call from HQ, with ORD also on the line as they would be the ones purchasing. Hoping to get to this today/tomorrow.

Thanks, V

We require 2 gallons.

We are not in a position to sign any waivers that would limit our use of the product.

[If a waiver is insisted upon] We will need to go back and discuss next steps internally.

To: Principe, Vanessa[Principe.Vanessa@epa.gov]; Beasley, Lynn[Beasley.Lynn@epa.gov]
Cc: Wilson, Gregory[Wilson.Gregory@epa.gov]; Conmy, Robyn[Conmy.Robyn@epa.gov]
From: Bove, James
Sent: Tue 4/12/2016 8:32:57 PM
Subject: RE: RESENDING FOR ACTION - RE: "Script" for Dispersants Purchase Call

Yep that works-

From: Principe, Vanessa
Sent: Tuesday, April 12, 2016 4:32 PM
To: Bove, James <Bove.James@epa.gov>; Beasley, Lynn <Beasley.Lynn@epa.gov>
Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>; Conmy, Robyn <Conmy.Robyn@epa.gov>
Subject: RE: RESENDING FOR ACTION - RE: "Script" for Dispersants Purchase Call

Or we can just have Robyn send it, since the purchaser is ORD. We can just be cc'd.

From: Bove, James
Sent: Tuesday, April 12, 2016 4:28 PM
To: Principe, Vanessa <Principe.Vanessa@epa.gov>; Beasley, Lynn <Beasley.Lynn@epa.gov>
Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>; Conmy, Robyn <Conmy.Robyn@epa.gov>
Subject: RE: RESENDING FOR ACTION - RE: "Script" for Dispersants Purchase Call

OK by me, but I take it Robyn will contact them to purchase (as opposed to them contacting Robyn)? Seems we are setting this up below expecting them to contact Robyn…

From: Principe, Vanessa
Sent: Tuesday, April 12, 2016 4:25 PM
To: Bove, James <Bove.James@epa.gov>; Beasley, Lynn <Beasley.Lynn@epa.gov>
Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>; Conmy, Robyn <Conmy.Robyn@epa.gov>
Subject: RESENDING FOR ACTION - RE: "Script" for Dispersants Purchase Call

Jim/Lynn:

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Of note – Mr. Egan said the waiver was no issue, that they are OK sending a free sample or making it available for purchase to EPA without any waiver.

Comments/edits?

Thanks! V

Mr Egan:

This follows up our telephone conversation of April 11.

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Vanessa Principe

Chemical Engineer

Office Of Emergency Management

Office of Land and Emergency Management

U.S. Environmental Protection Agency

202-564-7913

From: Principe, Vanessa
Sent: Monday, April 11, 2016 11:06 AM
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Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>; Conmy, Robyn <conmy.robyn@epa.gov>
Subject: "Script" for Dispersants Purchase Call

Jim:

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Thanks, V

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[If a waiver is insisted upon] We will need to go back and discuss next steps internally.

To: Principe, Vanessa[Principe.Vanessa@epa.gov]; Beasley, Lynn[Beasley.Lynn@epa.gov]
Cc: Wilson, Gregory[Wilson.Gregory@epa.gov]; Conmy, Robyn[Conmy.Robyn@epa.gov]
From: Bove, James
Sent: Tue 4/12/2016 8:28:25 PM
Subject: RE: RESENDING FOR ACTION - RE: "Script" for Dispersants Purchase Call

OK by me, but I take it Robyn will contact them to purchase (as opposed to them contacting Robyn)? Seems we are setting this up below expecting them to contact Robyn…

From: Principe, Vanessa
Sent: Tuesday, April 12, 2016 4:25 PM
To: Bove, James <Bove.James@epa.gov>; Beasley, Lynn <Beasley.Lynn@epa.gov>
Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>; Conmy, Robyn <Conmy.Robyn@epa.gov>
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Jim/Lynn:

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Jim/Lynn:

DRAFT email to TOTAL contact re. our interest in procuring Finasol OSR52. Checking for any legal/procurement flags.

Of note – Mr. Egan said the waiver was no issue, that they are OK sending a free sample or making it available for purchase to EPA without any waiver.

Comments/edits?

Thanks! V

Mr Egan:

This follows up our telephone conversation of April 11.

As discussed, EPA is seeking to acquire a number of dispersant products listed on the NCP Subpart J Product Schedule for the purposes of both toxicity and efficacy testing. The product testing is intended to further inform currently proposed regulatory actions under Subpart J of the National Contingency Plan. The products will in addition be used to support our general research in the area of oil spill response.

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We appreciate your time and attention to this request. Please feel free to call me as well if you have any questions/concerns.

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Vanessa Principe

Chemical Engineer

Office Of Emergency Management

Office of Land and Emergency Management

U.S. Environmental Protection Agency

202-564-7913

From: Principe, Vanessa
Sent: Monday, April 11, 2016 11:06 AM
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Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>; Conmy, Robyn <conmy.robyn@epa.gov>
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The plan is to make a call from HQ, with ORD also on the line as they would be the ones purchasing. Hoping to get to this today/tomorrow.

Thanks, V

We require 2 gallons.

We are not in a position to sign any waivers that would limit our use of the product.

[If a waiver is insisted upon] We will need to go back and discuss next steps internally.

To: Wilson, Gregory[Wilson.Gregory@epa.gov]; Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Conmy, Robyn
Sent: Tue 4/12/2016 12:58:30 PM
Subject: FW: purchase fo finasol and corexit

Mike Fulton (NOAA) says that Debbie Theriot was also their contact at NOAA. They were unable to purchase from them without signing the waiver that no toxicity testing would occur.

Want to try calling again? Or send an email to her instead of calling?

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Robyn N. Conmy, Ph.D.

Research Ecologist

USEPA/NRMRL/LRPCD

26 West MLK Drive

Cincinnati, Ohio 45268

513-569-7090 (office)

513-431-1970 (EPA mobile)

727-692-5333 (Personal mobile)

conmy.robyn@epa.gov

From: Mike Fulton - NOAA Federal [mailto:mike.fulton@noaa.gov]
Sent: Tuesday, April 12, 2016 8:41 AM
To: Conmy, Robyn <Conmy.Robyn@epa.gov>
Subject: Re: purchase fo finasol and corexit

Hi Robyn,

See below contact info for NALCO. You may have more success if you can sign a waiver that you won't use for toxicity testing. Good luck.

Mike

Debby.Theriot@nalco.com

281 263 7709

On Tue, Apr 12, 2016 at 7:58 AM, Conmy, Robyn <Conmy.Robyn@epa.gov> wrote:

Thanks Mike. I spoke to a contact at Total yesterday and we are getting some Finasol. Nalco hasn't responded to a voicemail as of yet, so your contact at Nalco could be a huge help.

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Robyn N. Conmy, Ph.D.

Research Ecologist

USEPA/NRMRL/LRPCD

26 West MLK Drive

Cincinnati, Ohio 45268

513-569-7090 (office)

513-431-1970 (EPA mobile)

727-692-5333 (Personal mobile)

conmy.robyn@epa.gov

From: Mike Fulton - NOAA Federal [mailto:mike.fulton@noaa.gov]
Sent: Monday, April 11, 2016 5:00 PM
To: Conmy, Robyn <Conmy.Robyn@epa.gov>
Subject: Re: purchase fo finasol and corexit

Hi Robyn, Ultimately, We weren't able to get Corexit from Nalco, but I'll get you the contact info for both manufacturers.

On Monday, April 11, 2016, Conmy, Robyn <Conmy.Robyn@epa.gov> wrote:

> Hi Mike,
>
> Awhile back we had discussed NOAA's possible procurement of Corexit and Finasol for your toxicity work. Would you mind sharing the POC for Nalco and Total that were contacted in your hunt to procure the dispersants?
>
> Thanks,
>
> Robyn
>
> <>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>
>
> Robyn N. Conmy, Ph.D.
>
> Research Ecologist
>
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>
> conmy.robyn@epa.gov

--

Dr. Michael H. Fulton-Estuaries and Land Use Branch Chief

Center for Coastal Environmental Health and

Biomolecular Research (CCEHBR)

USDOC/NOAA/NOS/NCCOS

219 Fort Johnson Road

Charleston, SC 29412-9110

voice: (843) 762-8576 fax: (843) 762-8700

e-mail: mike.fulton@noaa.gov

--

Dr. Michael H. Fulton-Estuaries and Land Use Branch Chief

Center for Coastal Environmental Health and

Biomolecular Research (CCEHBR)

USDOC/NOAA/NOS/NCCOS

219 Fort Johnson Road

Charleston, SC 29412-9110

voice: (843) 762-8576 fax: (843) 762-8700

e-mail: mike.fulton@noaa.gov

To: Principe, Vanessa[Principe.Vanessa@epa.gov]; Beasley, Lynn[Beasley.Lynn@epa.gov]
Cc: Wilson, Gregory[Wilson.Gregory@epa.gov]; Conmy, Robyn[Conmy.Robyn@epa.gov]
From: Bove, James
Sent: Mon 4/11/2016 7:17:40 PM
Subject: RE: "Script" for Dispersants Purchase Call

Don't think we can accept anything for free; do you want me to double check?… But good to know they are happy to sell to us without a waiver-

From: Principe, Vanessa
Sent: Monday, April 11, 2016 3:16 PM
To: Bove, James <Bove.James@epa.gov>; Beasley, Lynn <Beasley.Lynn@epa.gov>
Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>; Conmy, Robyn <Conmy.Robyn@epa.gov>
Subject: RE: "Script" for Dispersants Purchase Call

Jim/Lynn:

DRAFT email to TOTAL contact re. our interest in procuring Finasol OSR52. Checking for any legal/procurement flags.

Of note – Mr. Egan said the waiver was no issue, that they are OK sending a free sample or making it available for purchase to EPA without any waiver.

Comments/edits?

Thanks! V

Mr Egan:

This follows up our telephone conversation of April 11.

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We appreciate your time and attention to this request. Please feel free to call me as well if you have any questions/concerns.

Respectfully,

Vanessa Principe

Chemical Engineer

Office Of Emergency Management

Office of Land and Emergency Management

U.S. Environmental Protection Agency

202-564-7913

From: Principe, Vanessa
Sent: Monday, April 11, 2016 11:06 AM
To: Bove, James <bove.james@epa.gov>
Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>; Conmy, Robyn <conmy.robyn@epa.gov>
Subject: "Script" for Dispersants Purchase Call

Jim:

From our discussion last week, below is the "message" for a first conversation with NALCO and TOTAL about purchasing their dispersant products. Of import is the idea that we do not appear to threaten any action if they are not willing to sell without a waiver. Are we ok with the statements below? Just wanted something we all know is appropriate to speak from.

The plan is to make a call from HQ, with ORD also on the line as they would be the ones purchasing. Hoping to get to this today/tomorrow.

Thanks, V

We require 2 gallons.

We are not in a position to sign any waivers that would limit our use of the product.

[If a waiver is insisted upon] We will need to go back and discuss next steps internally.

To: Wilson, Gregory[Wilson.Gregory@epa.gov]; Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Conmy, Robyn
Sent: Mon 4/11/2016 2:37:18 PM
Subject: Total and Nalco contacts

For the purchase of Finasol, DFO started by contacting Peter Egan with Total (peter.egan@total.com) who them in touch with the distributor for the East Coast, which was Clear Coast, llc. Contact there is Malcolm Gore (malcolm.gore@clearcoastllc.com).

For Nalco, all we have on file is the one from the NCPPRS

Nalco Environmental Solutions LLC
7705 Highway 90-A
Sugar Land, TX 77478
Product Management:
Office: (281) 263-7709
Mobile: (832) 851-5164
E-mail: debby.theriot@nalco.com
(Ms. Debby Theriot)

<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>

Robyn N. Conmy, Ph.D.

Research Ecologist

USEPA/NRMRL/LRPCD

26 West MLK Drive

Cincinnati, Ohio 45268

513-569-7090 (office)

513-431-1970 (EPA mobile)

727-692-5333 (Personal mobile)

conmy.robyn@epa.gov

To: Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Wilson, Gregory
Sent: Mon 4/11/2016 1:31:15 PM
Subject: FW: Another possible helpful document
Overview of dispersant tests in Europe.pdf

From: Ed Levine - NOAA Federal [mailto:ed.levine@noaa.gov]
Sent: Monday, April 11, 2016 7:43 AM
To: _NOS ORR HAZMAT SSC <nos.orr.hazmat.ssc@noaa.gov>; alan.mearns@noaa.gov; Gary Shigenaka - NOAA Federal <gary.shigenaka@noaa.gov>; msmiles@lsu.edu
Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>
Subject: Another possible helpful document

This paper is based on a 2008 working document developed for an EMSA workshop by national experts from the United Kingdom, Norway and France, an external consultant (Alun Lewis) and EMSA. The paper has been later revised and updated in its current version during 2014-2015 by the members of the Technical Correspondence Group on Dispersants (TCG Dispersants), in accordance with its mandate under the framework of the Consultative Technical Group for Marine Pollution Preparedness and Response (CTG MPPR).

(the French model is pretty simple - page 47)

European Maritime Safety Agency

Overview of national dispersant testing and approval policies in the EU

Information Paper developed by the Technical Correspondence Group on Dispersants, under the Consultative Technical Group for Marine Pollution Preparedness and Response (CTG MPPR)

Date: March 2016

EMSA

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List of Abbreviations

CTG MPPR	Consultative Technical Group for Marine Pollution Preparedness and Response
ExDET	Exxon Dispersant Effectiveness Test
FET	Field Effectiveness Test
HOCNF	Harmonised Offshore Chemical Notification Format
IFP	Institut Français du Pétrole
MNS	Mackay, Nadeau and Steelman
NEBA	Net Environmental Benefit Analysis
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
TCG Dispersants	Technical Correspondence Group on Dispersants
WSL	Warren Spring Laboratory

Cover photo source: CEFAS, UK

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Acknowledgements

This paper is based on a 2008 working document developed for an EMSA workshop[1] by national experts from the United Kingdom, Norway and France, an external consultant (Alun Lewis) and EMSA. The paper has been later revised and updated in its current version during 2014-2015 by the members of the Technical Correspondence Group on Dispersants (TCG Dispersants), in accordance with its mandate under the framework of the Consultative Technical Group for Marine Pollution Preparedness and Response (CTG MPPR). EMSA has compiled this paper, based on the help and valuable input from the TCG Dispersants contributors mentioned below.

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France: Francois Merlin (Cedre); Julien Guyomarch (Cedre);
Norway: Per Daling (SINTEF); Kirsti Natvig (Norwegian Environment Agency);
United Kingdom: Alun Lewis[2] (Consultant); Kevin Colcomb (MCA); Mark Kirby (Cefas); Bernard Christie (MMO);

And to the Annexes contributors and paper reviewers:

Belgium: Ronny Schallier (MUMM);
Greece: Eftichia Dima (Directorate of Energy Industrial and Chemical Products); Efthimia Cotou (Hellenic Centre for Marine Research); Marine Environment Protection Directorate, Hellenic Coastguard;
Italy: Divisione III[a], Ministry of Environment;
Germany: Dierk-Steffen Wahrendorf (Federal Institute of Hydrology); Birgit Böhme (CCME);
Portugal: Joana Sofia Jeronimo (DGAM); João Carvalho (DGAM);
Spain: Laura De La Torre (SASEMAR); Goretti de la Fuente (General Directorate of the Merchant Marine);
The Netherlands: Bert van Munster (Rijkswaterstaat);

This document was compiled by EMSA:

Walter Nordhausen, Lito Xirotyri, Hilde Dolva.

[1] EMSA workshop: "Towards a harmonised approach in dispersant usage in the EU" (Lisbon, 19 -20 May 2008)
[2] Alun Lewis contributed to the 2008 working document, on which this paper is based.

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0. Summary

This paper "*Overview of national dispersant testing and approval policies in the European Union*" has been developed by EMSA under the framework of the Technical Correspondence Group on Dispersants (TCG Dispersants). This Group of experts was tasked by the Consultative Technical Group for Marine Pollution Preparedness and Response (CTG MPPR) to describe existing testing procedures for approval of dispersant products in Europe and to explore if further harmonisation of such tests can be achieved, in an effort to avoid further diversification in Europe (*Chapter 1*). The paper is intended for information purposes and provides for the first time detailed combined and up-to-date information on test procedures for dispersants in place in the EU/EFTA States, focusing primarily on the long-established tests of France, Norway and the United Kingdom. Overall, only six EU/EFTA countries have such tests in place; in addition to the above three, this includes also Greece, Spain and Italy.

The paper provides general background information on the use of dispersants as an oil spill response option (*Chapter 2*) and looks into the national policies regarding dispersant use in Europe (*Chapter 3*). Facts on dispersant products currently approved and in stockpiles in Europe are also provided, highlighting that there are currently approximately 75 different dispersants approved for use in the EU/EFTA countries, but only 34 are stocked in Europe. The distinction between dispersants testing for product approval versus authorisation for dispersants use during an actual incident is also emphasised, as different requirements and procedures are in place for these two distinct authorisation phases (*Chapter 4*). Dispersant product approvals and dispersant use authorisations are nationally regulated by the individual countries.

There are currently different approaches in dispersant product approval procedures across Europe. Annex 1 includes a summary table with information on how the different tests are currently performed in the six countries in Europe. While it is known that laboratory tests, in general, do not represent conditions in the open sea, dispersant product approval procedures typically include tests for the:

Effectiveness of the dispersant (test usually performed first, with low or high mixing energy);

Dispersant's toxicity or the toxicity of the treated oil (dispersed oil);

Other additional tests, which usually include biodegradation, bioaccumulation, and similar toxicological tests.

The main objective of such testing, common to all countries, is to select a dispersant product which is efficient and low in toxicity (either on its own – product's inherent toxicity, or when the oil is treated with the product - dispersed oil's toxicity, which is the case for the UK toxicity tests). The paper (*Chapter 5*) describes in detail the background and current approaches to the tests performed in each of the three countries (France, Norway and the UK), explaining the key principles behind each national approach. The paper also includes comments and observations from using these tests throughout the years (*Chapter 7*). All three countries established their dispersant approval procedures over 20 years ago, following extensive research and these procedures are regularly reviewed and submitted to national consultations. The way each of the effectiveness, toxicity and biodegradability tests are performed in each country and the key principles behind the different test methods are described in order to better understand the main similarities and differences, which are also explicitly identified and listed in the paper (*Chapter 6*). This is particularly important for those countries that do not have their own established tests in place and rely on, or accept, the existing tests performed in these (six) countries, or may be considering developing new tests or revising their own procedures. Further diversification of such tests should be avoided in Europe.

EMSA has encouraged the national experts contributing to this paper to explore the possibility to identify commonly accepted principles that would assist the further harmonisation of test procedures in the EU/EFTA countries. The conclusion from the Groups' work is that further harmonisation is desirable, but is not possible for the time being (*Chapter 8*). The reasons for this are complex and are related to difficulties to agree on any guidelines or accept minimum standards that deviate from the long established and nationally accepted procedures. Fundamental differences in testing procedures (especially with regard to the toxicity testing), associated costs and difficulties of changing existing procedures at this stage are additional factors of concern. EMSA encourages further work on harmonisation of dispersant test procedures in Europe, even if it cannot be achieved for the time being. At least, where possible, further deviations from the existing test protocols should be avoided.

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The paper concludes with remarks deriving from the TCG Group's work in updating and completing this paper (*Chapter 9*). These include:

> The approaches towards dispersant effectiveness testing are fairly similar across Europe. The most common methods used for performing effectiveness tests are the IFP, MNS and WSL tests. The energy used in the effectiveness tests is of importance; the low energy test (such as the IFP) is more representative of normal field conditions than the high energy test (such as the WSL), and may be more relevant with regard to the efficiency in the field. On the other hand, the high energy tests are easier to perform in the laboratory. The test oils used differ, but they usually have a viscosity from 500 cP to 8000 cP. The Dispersant to Oil ratio (DOR) is mostly between 1:10 and 1:30, and most countries have specific thresholds for approval of dispersant products. Norway is the only country that performs effectiveness tests on weathered oil.
>
> Toxicity testing is performed on the dispersant alone in five of the six mentioned countries with test procedures in place. Only the UK tests the dispersant toxicity on a mixture of chemically dispersed oil in comparison to mechanically dispersed oil. The impact of dispersed oil in the environment is assessed also differently in the various countries; the UK includes this assessment in the toxicity testing, other countries assess the toxicity in the environment separately from the product approval toxicity tests (e.g. Norway uses advanced software models based on bio–assay studies). Different test organisms (planktonic algae, limpets, brown or white shrimps etc.) are used in the toxicity testing, but there seems to be an aim to select commonly used test organisms that are easily available and preferably described in the OSPAR Convention.
>
> Biodegradability tests are performed in four of the six countries, usually to verify that the dispersant does not inhibit the biodegradation of the oil. Some experts believe that this test is important as a dispersant with low toxicity and high biodegradability would be preferable to a dispersant with low toxicity and low biodegradability. It should also be noted that intermediate degradation products may be more toxic than the original dispersant substance, as some studies have suggested.
>
> Decision trees/matrixes for the usage of dispersants and environmental impact studies are very important in supporting decision making during and following the actual dispersant application in an oil spill incident. Examples of existing 'Decision Trees' for the use of dispersants are provided in Annex 3.
>
> The test results are usually not public information, with only the products having passed the tests being published on national approval lists. The countries not having test procedures in place often use and/or accept the products in the approval lists of other countries. Since the tests are performed differently, it is important to understand these differences and the key principles behind each procedure. The transparency of how tests are performed is of special concern for the countries not having test procedures in place.

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1. Introduction

1.1 The European Maritime Safety Agency (EMSA) supports with technical and scientific advice the Member States of the European Union (EU) and the European Commission in the field of maritime safety, prevention, preparedness and response to pollution by ships, as well as response to marine pollution from oil and gas installations. These objectives are addressed through specific tasks, including operational activities in the field of pollution preparedness, detection and response. The Agency implements operational tasks through its annual Work Programmes and "Action Plans" which have been adopted by the EMSA Administrative Board. These address, *inter alia*, the use of oil spill dispersants.

1.2 The document entitled "*Overview of national dispersant testing and approval policies in the EU*" was initially developed in 2008 by representatives from France, Norway, the UK and EMSA and an independent consultant, in preparation for the EMSA dispersants workshop entitled "*Towards a harmonised approach in dispersant usage in the EU*" which was held in Lisbon in May 2008. The mentioned document has since been updated and renamed by EMSA. The completion of this document has been identified as a task of the work of the Technical Correspondence Group on Dispersants (TCG Dispersants), established in 2012 by the Consultative Technical Group for Marine Pollution Preparedness and Response (CTG MPPR). (The CTG MPPR provides a forum for EU Member States to meet, share best practice and expertise and define priority actions in the field of marine pollution preparedness and response).

1.3 The TCG Dispersants, comprised of scientists and experts from national administrations in the field of dispersants, has been tasked with reviewing the existing scientific and operational aspects of dispersant testing procedures in Europe, in view of identifying similarities/differences and exploring options towards a more harmonised approach (in the sense of convergence) or mutual acceptance of such dispersant testing procedures in Europe.

1.4 There are currently many brands and formulations of dispersants on the market, approved for use in the EU/EFTA countries (approximately 75). The existing stockpiles in Europe consist of dispersants tested and approved for use in different ways. The Group's work should facilitate reducing further diversification of testing procedures in the EU. This revised paper describes in detail and discusses the different testing procedures and the possibilities and hindrances for further harmonisation of such tests across Europe, focusing in particular on Norway, France and the United Kingdom, countries with long-established test procedures in place.

1.5 The review of these procedures reveals similarities and differences in the various tests performed. In this paper the key principles and main philosophy behind each national approach are identified. The requirements of all the tests are described and commented by the Group members, and the experiences gained from using the different test methods are included. It is the Group's intention, that this information will enable the other countries to better understand the current tests in place and accordingly to facilitate the national decision making of how to proceed regarding developing or revising their own dispersant testing procedures.

2. General background on dispersants usage

2.1 Once oil is spilled to the sea there will be inevitable impacts to the environment within the geographical area of the spill no matter how much effort is put into spill response. The primary goal of any oil spill response is to minimise the impact and remove the spilled oil as fast as possible, thus minimising the impact to the organisms inhabiting the marine environment and prevent oil on the shorelines. This response goal provides a mechanism for discussion of the environmental trade-offs associated with any response option.

2.2 While the goal of mechanical recovery using oil recovery vessels, booms, and skimmers is to remove oil from the sea surface, a task that can be potentially hindered by rough seas, the purpose of oil spill dispersants is to transfer the oil from the sea surface to the water column in the form of very small droplets. The use of dispersants greatly enhances the rate and extent of the natural dispersion process. Natural dispersion is the conversion of a surface oil slick into oil droplets and is caused by breaking waves. The crests of breaking waves passing through an oil slick convert the oil into droplets of a wide range of sizes. Most of these are large enough to be buoyant and rapidly resurface. A small proportion of these oil droplets will be small enough to be retained in the water column.

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The application of dispersants to spilled oil greatly increases the proportion of small oil droplets which will not resurface.

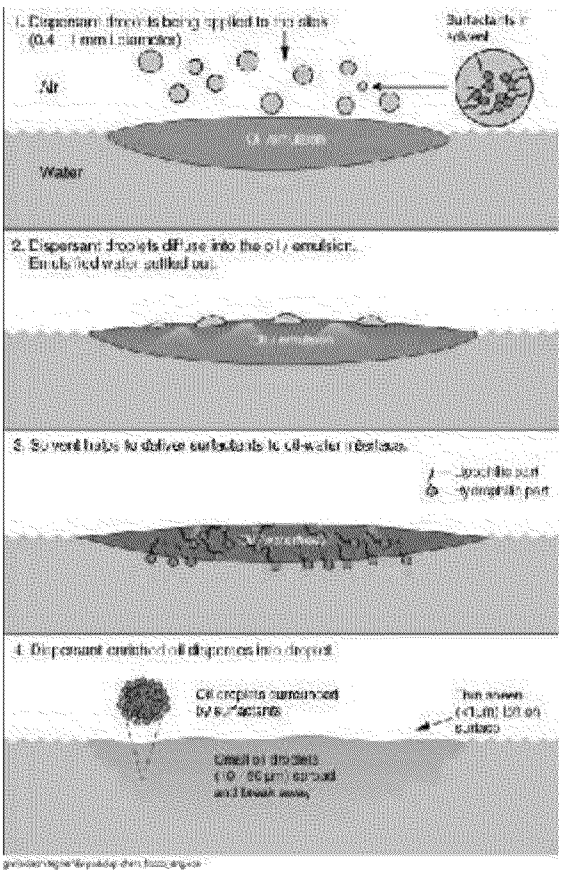


Figure 1: How dispersants work (Source: SINTEF)

2.3 These small droplets are subject to turbulence and remain in the upper meters of the water column. Rough seas that impair mechanical recovery can actually benefit dispersants' effectiveness (as long as the rough sea conditions do not impair the effectiveness of the dispersant application). The initial dispersion distributes the oil over a larger volume thus reducing its concentration. Wind driven mixing and currents further dilute the dispersed oil fairly rapidly. In addition, the formation of these very small dispersed oil droplets increases the surface area of the oil tremendously, thus favouring enhanced aerobic microbial degradation. The oil is essentially "eaten" by the micro-organisms as a carbon source.

2.4 When used in an appropriate and timely manner, dispersants can remove a significant amount of oil from the water surface. This reduces the risk of oiling marine birds and shorelines, but exposes pelagic organisms present to a higher concentration of oil in the dispersed oil plume. While the concentration of the dispersed oil rapidly decreases, one should also consider the type of organisms exposed and the duration of their exposure (dose). Also the recovery potential of the potentially affected species should be taken into account. The organisms in the water column that are primarily affected are plankton and fish eggs/larvae that cannot escape such a plume. Marine mammals and fish on the other hand are able to detect dispersed oil and have been observed to actively avoid such plumes thus reducing their exposure and risk.

2.5 The decision whether to use dispersants or not should always be based on a Net Environmental Benefit Analysis (NEBA)[3]. While discussions on dispersants' use are important and should involve all stakeholders, fundamental decisions need to be made well in advance of a spill and the results should become part of the national or regional (area specific) contingency plans. Prompt decisions are important because the window of opportunity for dispersants' use is generally short due to weathering processes of the oil. The ultimate decision to apply dispersants in an oil spill must always be based on the specific conditions including the current environmental

[3] NEBA is the term usually used. NEEBA (Net Environmental and Economic Benefit Analysis) and NEDRA (Net Environmental Damage and Response Assessment) are also used and specify further the content of the analyses.

(weather, sea-state, presence of endangered species, etc.) situation, possible economic constraints (human activities) and operational realities of the particular incident.

3. National policies regarding dispersant usage and testing in the EU countries

3.1 Within the EU, the decision to use dispersants during oil spill response operations lies entirely with the affected coastal Member State(s) and a number of countries may consider the option of using dispersants in an oil spill with certain reservations. Dispersant usage has been a topic of renewed interest for the European national administrations in recent years, in particular following the *Deepwater Horizon* incident in 2010 in the Gulf of Mexico.

3.2 EMSA publishes since 2005 an "*Inventory of national policies regarding the use of oil spill dispersants in the EU Member States*" (EMSA Dispersants Inventory), which is updated in regular intervals. The latest inventory was published in November 2014 and includes data provided and/or validated by the relevant national administrations in Europe. The aim of this inventory is to regularly collect and disseminate relevant information to the EU Member States, the European Commission and the interested public regarding dispersant usage policies and dispersant application operational capabilities across the EU. The EMSA Dispersants Inventory has been used as background information for this paper and also serves as a building block in determining appropriate EMSA "added value" activities in this field. It contains information for each EU coastal Member State, as well as for Norway and Iceland, with respect to:

- Policies regarding dispersant use as an oil spill response option;
- Dispersant testing and product approval procedures in place;
- Stockpiles, means and equipment available for dispersant application (including GIS based maps).

3.3 Of the twenty five coastal EU /EFTA Member States (MS) in the 2014 EMSA Dispersants Inventory, twenty three countries would consider dispersant usage in their pollution response strategy, alongside the mechanical recovery of oil or only under very specific conditions, as shown in Figure 2 below. Two countries (Bulgaria and Slovenia) would not use dispersants in an oil spill situation at all. Dispersant testing and approval procedures have been developed in six countries (France, Greece, Italy, Norway, Spain and the United Kingdom). Of the remaining nineteen EU/EFTA countries that don't have their own testing and approval procedures, at least seven of these would allow the use of dispersants approved in a neighbouring country or within the Bonn Agreement region.

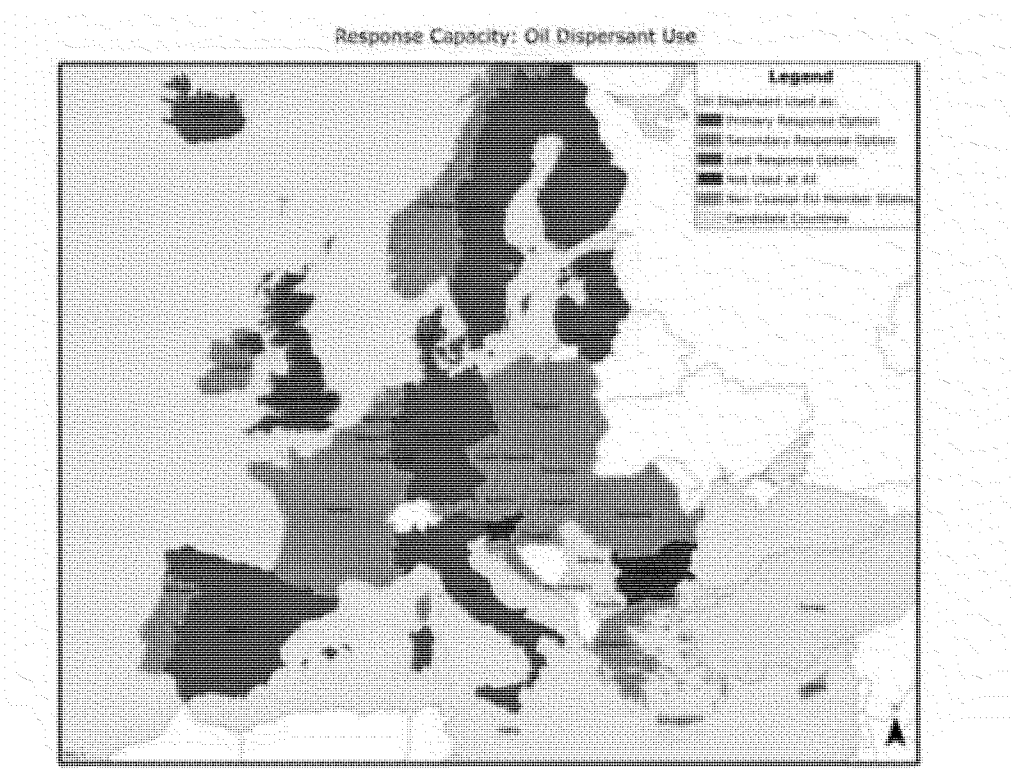


Figure 2: Dispersant usage policies in Europe (Source: EMSA Dispersants Inventory published in 2014).

3.4 In all countries that allow the use of oil spill dispersants, a specific authorisation from the responsible national administration(s) is required prior to the actual use/application of dispersants at sea. The procedures for authorising the use of dispersants for a specific incident (approval to use) vary among the EU countries and they are also clearly different from those procedures approving a dispersant product at national level, meaning which products are approved for use when a decision to disperse has been made (dispersant product approval *versus* dispersant use authorisation; see also Chapter 4).

3.5 In 2013, the national stockpiles of dispersants in EU/EFTA countries, based on information from the EMSA Dispersants Inventory published in 2014, were approximately 3900 tonnes[4]. The private Oil Spill Response Ltd (OSRL) has a dispersant stockpile of 2500 m^3 in Europe and EMSA has in 2014/15 bought 400 m^3 of dispersants; accordingly, the total dispersants stockpile in Europe in 2015 is approximately 6800 m^3 (the information about the OSRL and EMSA stockpiles is not included in the 2014 EMSA Dispersants Inventory).

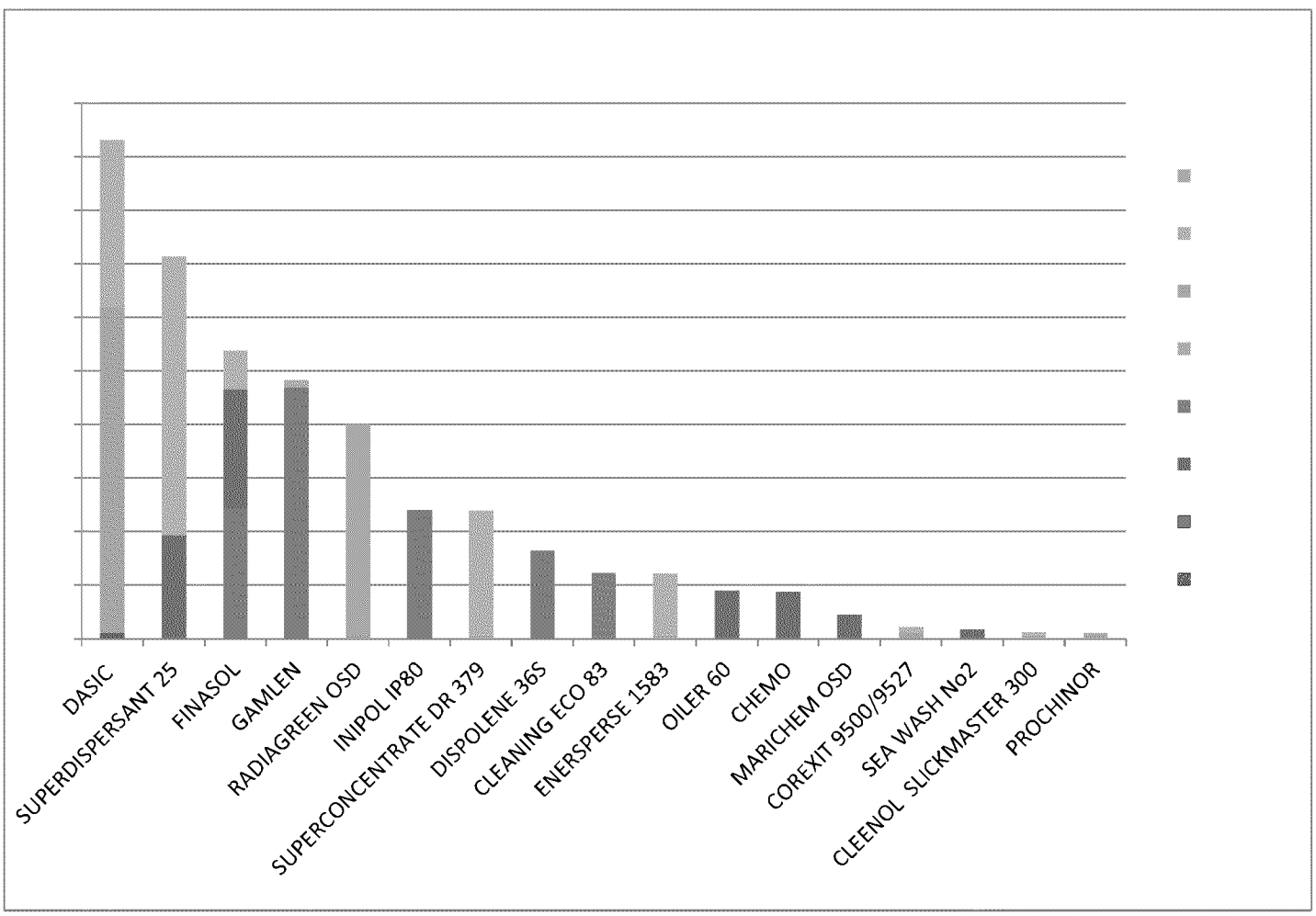


Figure 3: Quantities (tonnes) of dispersants in the EU/EFTA Member States. Dispersants are grouped (e.g. different types of Finasol are in one group) and quantities < 10 t are not included in the graph. The EMSA stockpile is included in the graph, whereas the OSRL stockpiles in Europe are not. (Source for the EU/EFTA stockpile: EMSA Dispersants Inventory, 2014).

3.6 Based on 2014 data in the EMSA Dispersants Inventory, there are approximately 75 brands of dispersants approved for use in the EU/EFTA countries. However, only 34 different dispersant brands are currently in stockpiles in Europe. Figure 4 lists the 19 brands of dispersants of over 20 tonnes currently in stock in Europe (stockpiles of less than 20 tonnes are excluded).

[4] Not all stockpiles from the private sector in the EU countries are included in this number.

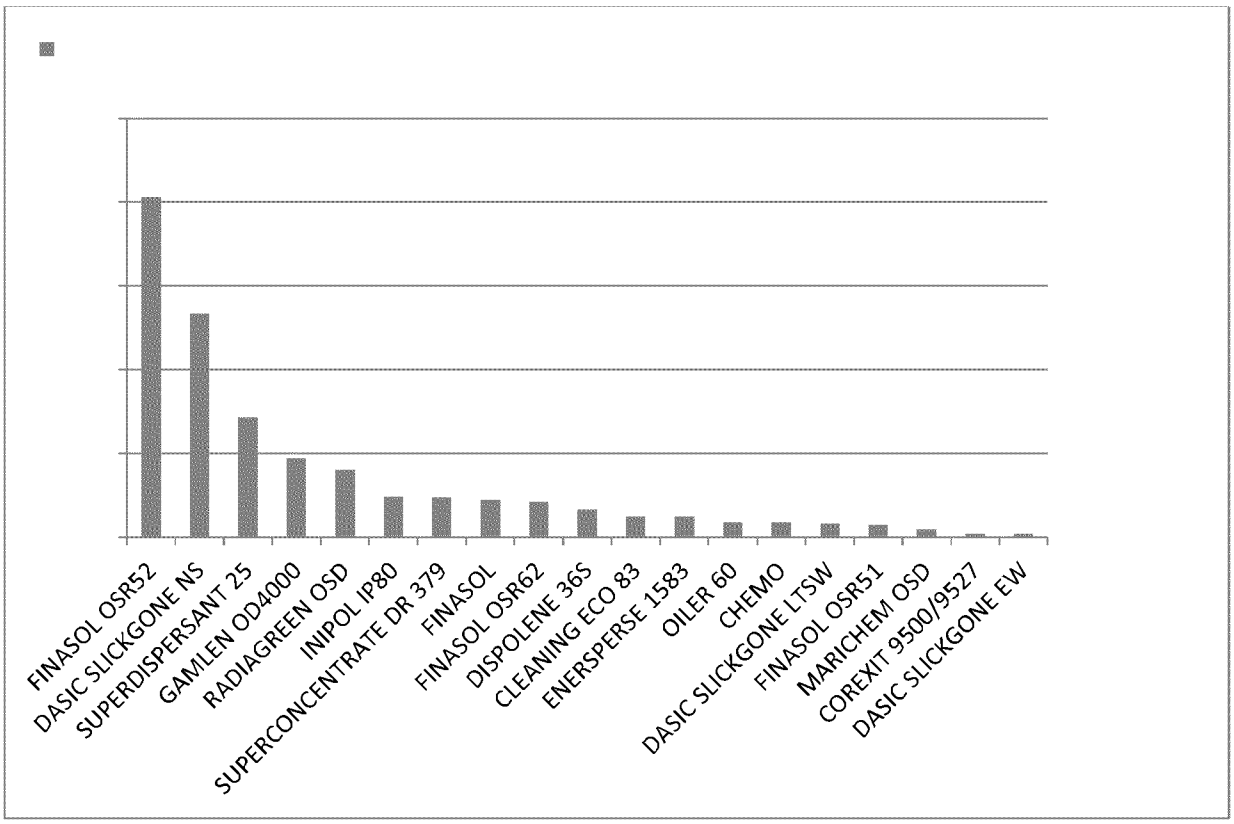


Figure 4: This figure shows the total stockpiles of dispersants in EU/EFTA countries in 2015, including product name and volume (approx. 6800 tonnes in total). The figure includes the national stockpiles, the OSRL stockpile in Europe (2500 tonnes) and the EMSA stockpile (400 tonnes).

4. Dispersants testing for product approval versus dispersants use authorisation

4.1 The licensing of specific dispersants as a response option for marine oil spills typically requires prior approval by the responsible national authority (-ties). Approval procedures typically include tests for the effectiveness of the dispersants and their toxicity, prior to approval for use in oil spill response operations. The effectiveness test is usually performed first, before the toxicity test. Other additional tests may include biodegradation, bioaccumulation, and similar toxicological tests, and in some cases other criteria (e.g. physical criteria such as maximum viscosity).

4.2 These approval tests are conducted *to grant the principal license to introduce the substance into territorial waters of the authorising state*. Laboratory tests, in general, do not represent conditions in the ocean. An accurate simulation of the mixing processes of the sea is not possible on a small scale and there is obviously a very wide range of mixing "energy" levels possible at sea from flat calm to extremely rough seas. Therefore the effectiveness measured in the approval tests cannot directly be related to the effectiveness of the product used in a real application case. Laboratory tests methods (and particularly effectiveness measurements) are originally designed to rank dispersants products in terms of performance. In this respect, tests are meant to demonstrate:

- A minimum level of dispersant performance, and
- A specified maximum permitted level of toxicity of the dispersant (dispersant and dispersed oil in the UK tests).

Approved dispersants are typically published in national lists of licensed products for spill response applications; however, not all countries have such lists (e.g. Norway does not publish a national list of approved dispersants). The test results are often confidential information and only the brand names of dispersants that pass the tests are available for the public.

4.3 These laboratory tests must not be confused with *the authorisation to apply dispersants during the response in an actual oil spill.* This case-by-case decision-making must be linked to the:

- Individual spill situation (e.g. amount and type of oil, release/spill conditions and location, weathering degree of the oil, time frame etc.);
- Environmental conditions (e.g. weather, temperature, sea-state, water depth, distance from shore, salinity etc.);
- Natural resources (e.g. environmentally sensitive areas, presence of aquaculture facilities, presence of endangered species at the prevailing time of the year, etc.);
- Response capability (availability of dispersant and dispersant application equipment, mobilisation time, remote sensing etc.).

4.4 It is very important that the actual effectiveness of the dispersant application in a given spill is monitored and environmental impact assessments are considered during and after the dispersant application is conducted. For more information on the potential impacts to seabirds versus plankton see also French McKay et al. (2006)[5] and the article from the Institute of Marin Research in Norway and SINTEF about dispersants effects on fish eggs and larvae, Vikebø et al. (2015)[6].

4.5 The approval scheme is for products to be allowed to be used, but before they are given permission for use in a particular response scenario, or in relatively shallow water, the request should once again be scientifically reviewed before permission for use is given. The criteria for response options for relevant spill scenarios must be reflected in well-prepared contingency plans in order to make a rapid – but critical assessment and decision-making during the specific spill situation. A number of countries have developed relevant decision support tools and procedures.

4.6 Annex 3 includes examples of "Decision Trees" for use of dispersants, documents which are facilitating decision making regarding the dispersant use during the response to an actual spill.

5. Current dispersants testing procedures in the EU

While six European countries currently have test procedures in place, this paper focusses on describing the test methods in place for the three countries with long established testing and approval procedures, namely France, Norway and the United Kingdom. In addition to these three countries, Spain, Italy and Greece also have tests in place, but their procedures are newer and partly under establishment. A table summarising and comparing the various testing methods of all the six countries is attached as **Annex 1**.

5.1 France

5.1.1 Background

5.1.1.1 France uses three main laboratory tests (for the effectiveness, toxicity and biodegradability of the dispersant itself) to select the most effective and least toxic marine dispersants. In order for a dispersant to be approved, it has to pass all three tests; if a product fails in one of these tests, the procedure is interrupted. Testing of a new product begins with the effectiveness test. The results of this test determine whether or not the other tests will be carried out.

[5] Modelling Potential Impacts of Effective Dispersant Use on Aquatic Biota, Deborah French McCay, Walter Nordhausen, James Payne, Proceedings of the 29 th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Emergencies Science Division, Environment Canada, Ottawa, ON, Canada, pp. 855-878, 2006.

[6] Dispersants Have Limited Effects on Exposure Rates of Oil Spills on Fish Eggs and Larvae in Shelf Seas, Frode B. Vikebø, Petter Rønningen, Sonnich Meier, Bjørn Einar Grøsvik, Vidar S. Lien. Environmental Science & Technology 2015, 49, pp. 6061 – 6069.

5.1.1.2 The French approach is based on the following principles:

- Select a product which is efficient (the effectiveness testing is performed first).
- Avoid products which would be too toxic by themselves (the dispersant toxicity testing is conducted second).
- The biodegradability test is conducted third, as a "vestige" of the past.

5.1.1.3 This procedure was set up in 1978 and revised in 1988. Since 2000, test results are valid for 5 years and accordingly, once approval is granted for a product, it is valid for five years. The Centre of Documentation, Research and Experimentation on Accidental Water Pollution (Cedre) is in charge of the dispersant approval process and publishes a list of approved dispersant products, which have passed the various tests (Annex 1 contains a link to this list). While it is not required by law in France to use the approved dispersants listed by Cedre (this list is seen more as a 'recommendation'), it is very unlikely that a non-approved product is used in France.

5.1.1.4 The various test methods used are described in official standards (normes francaises), such as the NFT 90 345 (effectiveness test), NFT 90 349 (toxicity test) and NFT 90 346 (biodegradability test). Today these tests are conducted by Cedre (effectiveness and toxicity tests) and the national institute for industrial safety and environmental protection (INERIS) (biodegradability test).

5.1.1.5 Physical properties are not assessment criteria; however dispersants would have to meet other specific requirements, according to the user (e.g. the Navy requires flash point > 51°C, freezing point < -10°C). The operational stockpiles are subjected to periodic quality controls, first, 5 years after purchase then every two years. These controls cover physical parameters and effectiveness testing (IFP test), and are performed by Cedre.

5.1.1.6 So far the French approach has been not to publish the actual test results. The results are not published in order to not confuse the user / purchaser of dispersant, so as to differentiate between products whose effectiveness would be close (closer than the confidence interval of the measurement).There are many other factors (especially the conditions of application) which can change the results in the field, much more than a small difference of effectiveness in the lab test. Therefore, only the list of approved products is published in France, without the detailed tests results.

5.1.2 Effectiveness test (French standard NF.T.90-345)

5.1.2.1 France uses the Institut Français du Pétrole (IFP) dilution test method, Standard NFT90-345. This test assesses the dispersant effectiveness in relatively "low energy" conditions and with a continuous seawater dilution to 'mimic' the open sea conditions. The test is conducted in a test tank with continuous clean seawater inflow at the surface, which causes gradual dilution of the content. For the effectiveness test method, the principle is to decrease the mixing energy in order to select the best products i.e. those which remain efficient even at low energy level. The method aims at simulating real environmental conditions: contact -the dispersant is added onto the oil- and infinite dilution -this is achieved by the stream of water flowing through the test tank-. The testing method was developed in the 80's according to field tests carried out in Marseilles/Fos[7]. The objective was to develop a test which provides a ranking of the dispersants similar to the ranking issued from the field tests.

5.1.2.2 The reference oil is a mixture of topped crude oil (BAL 110 – a "topped Arabian Light crude oil) and heavy fuel oil, the proportion of the two components in the mixture is adjusted in order to reach the appropriate viscosity of 1000-mPa.s (or cP) (defined in standard NFT 90 345). It should be noted here that the French Navy requests an additional effectiveness test in its call for tenders to purchase new dispersants: an effectiveness test with the same test method (NFT 90 345) but using a reference oil which is more viscous (can be up to 8000 cP). This additional test aims at selecting the very best products among the approved dispersants for the French needs, considering that the spilled oils to be treated in French waters will generally be quite viscous, either due to their weathering at sea or to the fact that the major pollution threat is coming from bunkers. This additional test is performed by Cedre.

5.1.2.3 The threshold value of 60% in the French effectiveness test has been chosen arbitrarily (looking to the results of a panel of commercial products) in order to select the best dispersants. The test oil is in the confined ring and the dispersant (neat concentrated / type 3[8]) is applied on the top, drop by drop. Energy is applied to the test oil on the surface, by a submerged beater-ring (vertical oscillation), and dispersed oil is collected from the bottom of

[7] Article: A field test and assessment of oil dispersant efficiency - J. P. Desmarquest, J. Croquette, F. Merlin, C. Bocard, C. Gatellier - International Oil Spill Conference Proceedings. 02/1983; 1983(1):574-574.
[8] The different types ("categories") of dispersants are described in Chapter 5.3.2.

the tank. The dispersant effectiveness is measured by the amount of oil that is dispersed and collected from the bottom outflow during the test duration (1 hour); the effectiveness is expressed between 0 and 100%, where 100% corresponds to the maximum theoretical quantity that could have been removed in case of a totally soluble compound. The effectiveness reflects the proportion of the oil actually dispersed in the test. This effectiveness is expressed in % compared to what would have been collected if the total oil would have been dispersed. Dispersants pass the test if dispersion is greater than 60%.

Figure 5: French effectiveness test (Source: Cedre)

5.1.2.4 While it is a relatively complex / difficult test to run, this method is good for running studies and obtaining comparative results according to different parameters on the same tests series (relative results). Some of its advantages include that it requires low energy, thus 'pushing' the product to the limits of its capability and it gives a good indication of the dilution process. In the context of the approval procedure, this test is a bit tricky as it involves a long calibration process to get perfect repeatability (absolute results).

5.1.2.5 France is currently exploring options to modify and adapt this test with a new system that allows variable energy levels to be introduced in the test tank (e.g. keep same set-up with less energy). A new standard will be developed after the completion of the validation tests; however, this new energy adjusted IFP test is not foreseen to be completed in the near future.

5.1.3 Toxicity test (French standard NF.T.90-349)

5.1.3.1 The aim for the toxicity test is to avoid products which would be too toxic. The French test method assesses the intrinsic acute toxicity of the dispersant alone in a relatively simple LC_{50} test (lethal acute toxicity), by using white shrimps (*Paleomonetes varians*) and testing equipment similar to the one used in the UK. The choice of this test species is done for practical and historical reasons and it could be changed in the future if needed. At that time the shrimp was used by the UK (grey shrimp) and France (grey or white shrimp) for the toxicity testing. France stopped using grey shrimp (wild species), because white shrimp could be easily supplied from a fish farm – aquaculture.

5.1.3.2 In accordance with this test, the shrimps are exposed for 6 hours (tidal duration) followed by 24 hours recovery time in clean waters, to see the mortality rate. The dispersant toxicity must be at least ten times lower than the toxicity of a reference toxicant (a cationic surfactant Noramium DA50) tested in the same conditions and on the same batch of shrimp as the dispersant. This procedure, which compares the results of the dispersant test with those of the reference toxicant (Noramium), intends to avoid any seasonal variation of sensibility of the test organisms[9]. The Noramium DA50 has similar surface active agents as dispersants and is known to be slightly toxic,

[9] This approach is based on the thesis: Bardot, C. *Evaluation de la toxicité d'un traitement par dispersion d'une pollution pétrolière laboratoire de Crangon crangon dans des conditions contrôlées (= Toxicity evaluation of a dilution process of oil pollution by chemical dispersants* Thèse de 3e cycle. Discipline : Océanol. biol. Paris : Université de Paris 6, 1985,115 p.

therefore the approved dispersant must be less toxic than this reference toxicant. The threshold value has been chosen empirically: toxicity of the dispersant must not be higher than 10 times the one of the reference toxicant. The method (standard: NFT 90 349) is comparative (comparison of the toxicity levels of the dispersant and of the reference toxicant). This approach has been adopted in order to get results independent of the batch of shrimps and also independent of the season of the year (e.g. the moult).

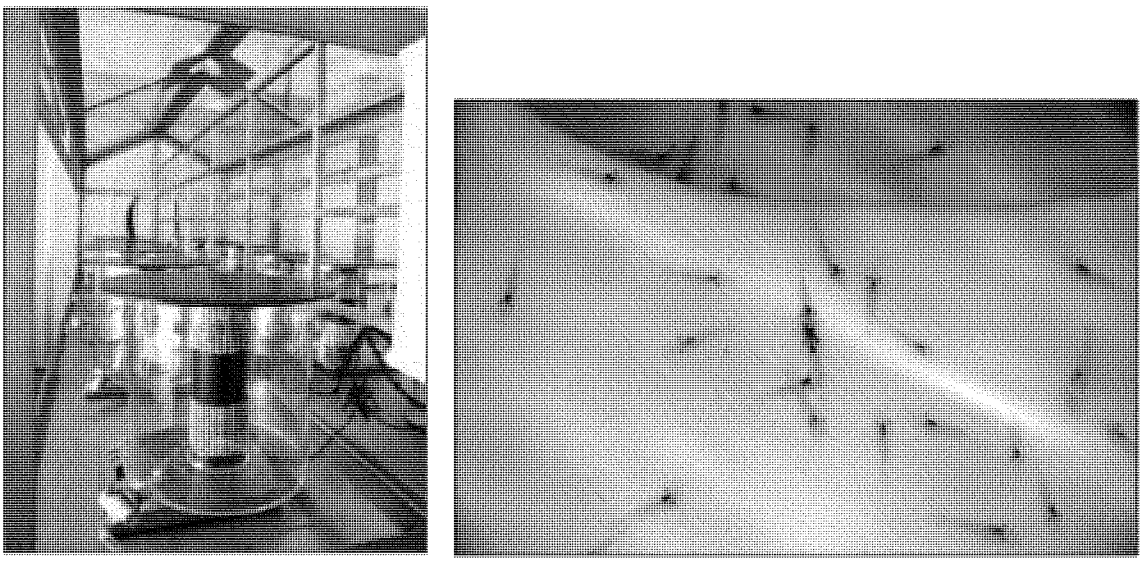


Figure 6: French toxicity test tank (Source: Cedre)

5.1.3.3 While France does not test the toxicity of the dispersed oil in the product approval phase, this is considered when reviewing the use/application of dispersants for a particular spill; it is generally considered that the better/finer an oil is dispersed, the more toxic it will be and accordingly the most efficient product may be rejected if the toxicity of the dispersed oil is tested in the product approval phase. The toxicity of dispersed oil is considered during the decision making process to use a dispersant in a particular spill.

5.1.4 Biodegradability test (French standard NF.T.90-346)

5.1.4.1 The biodegradability test (standard NFT 90346) is still in force in France, but could be dropped in the future as it is not considered to add much useful information. The French test assesses the dispersant's biodegradability in 28 days by measuring how much carbon dioxide (CO_2) has been produced. The dispersant is considered as a whole (surfactant and solvent) and its biodegradability should be at least 50% of the non-evaporable fraction (fraction which is not stripped during the test by the bubbling of CO_2 in the flasks). So far, there is no clear relationship of the dispersant's biodegradability to its toxicity. (This testing method is derivate from the STURM[10] protocol applied for determining the ultimate aerobic biodegradability of organic chemicals by monitoring CO_2 production in sealed vessels containing the test compound). In the concept of a harmonisation, France could consider to give up this test.

[10] Sturm, RN. 1973. Biodegradability of nonionic surfactants: screening test for rate of ultimate biodegradation. *J. Amer. Oil Chem. Soc.* 50:159-167.

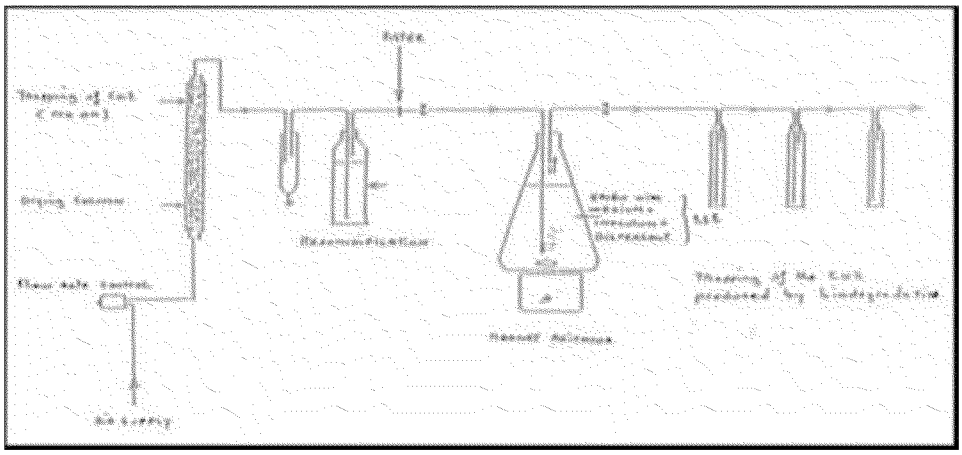


Figure 7: French biodegradability test (Source: Cedre)

5.2 Norway

5.2.1 Background

5.2.1.1 The first Norwegian regulations relating to the composition and use of dispersants in oil spill response were established by the Ministry of Environment in 1980. The regulations were very restrictive, stipulating that the *"Dispersants may be employed only when use of mechanical recovery has shown to be ineffective"*. The dispersant oil spill response in Norway became a non-operative contingency for many years, and there was a lack of maintenance and functionality testing of the equipment. One of the main criticisms of these old regulations was the lack of relevance of the test regimes used. For example, the test conditions for the effectiveness testing (using WSL-test, similar to the still existing UK test) used only a medium fuel oil (MFO, 2000 cP at 10°C), which was not considered as representative for those oil types and spill situations where dispersants were most likely to be used, i.e. in connection to smaller offshore spill incidents where different crude oils are produced and transported. The test oil was also not representative for the type of bunker fuel oils used by ship traffic along the Norwegian coast which often would be IFO 180 and IFO 380. Furthermore, the acute toxicity test was considered not to be representative for "Norwegian spill situations", as the test-organism used was a fresh-water alga (*Clamydomonas reinharti*).

5.2.1.2 During the late 1980s and the 1990s, extensive research and testing was performed (funded both by the authorities and in cooperation with the industry). This consisted of laboratory testing, basins experiments and experimental field trials in order to generate better scientific documentation as a basis for coming up with new regulations with testing protocols both for acute toxicity and effectiveness. One important goal and philosophy for these up-coming new regulations was to use the NEBA approach. Therefore, the regulations should cover relevant documentation needed for robust contingency planning, for taking rapid decisions concerning use/non-use of dispersants and also for generating scientific documentation with operational value for the dispersant response action and strategy (e.g. dosage needed for the specific oil, weathering properties and "time-window" for effectiveness use under different sea conditions etc.).

5.2.1.3 With regard to <u>effectiveness testing</u>, several studies were carried out in the 1990s for the Norwegian authorities and in cooperation with the oil industry (e.g. Daling et al, 1991, Brandvik et al. 1993, Lewis et al 1994,). Different laboratory effectiveness tests methods were evaluated including the MNS (Mackay, Nadeau and Steelman), IFP (Institut Français du Pétrole), ExDET (The Exxon Dispersant Effectiveness Test), FET (Field Effectiveness Test), WSL (Warren Spring Laboratory) and the Swirling Flask Test. E.g. a study for the Authorities – SFT: (Knudsen and Daling, 1994:*"Selection of test-criteria for approval of dispersants effectiveness in Norway")* included testing of 13 dispersant products that at that time were on the "Norwegian approval list". They were tested under a variety of test conditions, i.e.: different oils (including weathered emulsions), different dosages, salinities and temperatures. Generally, there are several factors that affect the dispersant effectiveness testing. These include the test's energy level (high-low); mixing time; applying the dispersant pre-mixed with oil or undiluted directly on the oil slick; the oil to water ratio; the test's reproducibility and how simple and rapid a test is. These factors were considered in these studies.

5.2.1.4 Conclusions and experiences drawn from all these studies concerning the various test methods included:

- IFP-test (+ strength / - weakness):
  - + Low energy test, representing non-breaking waves
  - + Low oil-to-water ratio and included the water dilution concepts (more close to field situation)
  - + Sampling taken under dynamic conditions (continues sampling during the agitation period)
  - + Correlated to field (IFP, 1985)
  - + Is a Sensitive / selective test (i.e. give a large span in dispersant ranking / screening)
  - - Reproducibility / Calibration may be time consuming when doing pass/fail testing
  - o Trained operators are important

- MNS-test (+ strength / - weakness):
  - + Energy generated by wind (realistic to field / no mechanical)
  - + Medium / high energy (representing breaking wave conditions)
  - + Correlated to field –energy (Mackay 1980)
  - + Reproducible (i.e. suitable for pass / fail testing)
  - - Less sensitive / selective test than IFP-test (i.e. give a large span in dispersant ranking / screening)
  - - Reproducibility / Calibration may be time consuming when doing pass/fail testing
  - o Trained operators are important

- WSL-test (+ strength / - weakness):
  - + Rapid / simple test
  - + Reproducible (i.e. suitable for pass / fail testing)
  - - Less realistic to field conditions:
    - o too high mixing energy (can disperse "everything" if long enough mixing time)
    - o need for settling time / static sampling (i.e. test result reflecting the density of the test oil)
    - o very high oil-to-water ratio (20,000 ppm oil in water coalescence /adsorption to a surface
  - - Less Sensitive /selective (i.e. give less span /differences between the dispersants in screening)

5.2.1.5 Most of the other test methods (e.g. ExDET, Swirling /Baffled flasks) that were evaluated require to pre-mix the dispersant into the oil prior to the testing, and thereby they don't allow to use w/o-emulsified oils as test-oils, which is considered as an important factor for getting a realistic understanding and documentation of the effectiveness of the dispersant for the specific oil to be tested under realistic simulated conditions.

5.2.1.6 Acute toxicity testing: The aim (philosophy) of the acute toxicity testing of the dispersants is to prevent that new products come on the market that have a significant higher acute toxicity than other "well-known" dispersants that have undergone toxicity / bio-assay studies in the laboratory or in the field. The dispersants shall be tested alone, not in combination with dispersed oil. The reason for this is that a test on dispersed oil would actually, in many cases, be a test on the combined mixture of dispersant and dispersed oil. Since it is very difficult to define the content of this mixture, the results may not be sufficiently representative. It is important, however, to emphasize that in addition to these standardized eco-toxicity tests for fulfilling the requirements of the dispersant products that are given in the Norwegian dispersant regulations, extensive bio-assay studies have been carried out over the past decades.

5.2.1.7 In these R&D programs, realistic exposure systems for studying the biological effects (chronic and acute) have been designed for both dispersant enhanced and natural dispersed oils droplets and dissolved oil components (WAF) using different sensitive test organisms (e.g. fish eggs/-larvae) and oil types that are representative for Norwegian waters. Data from these research programs have been used together with advanced 3D-spreading model tools to predict the potential environmental risk connected to the use of dispersant versus non-use in relevant spill–situations. Such model analyses of different spill scenarios have been an important basis for the NEBA assessment used in the scenario-based contingency plans.

5.2.1.8 Norway does not publish any official / public list of approved dispersant products. Although, the dispersants used must fulfil the requirements in the Norwegian regulation for the use of dispersants, requirements are specified according to a specific toxicity threshold and performance of effectiveness testing. For the use of a dispersant in Norway, an application must be sent to the relevant authorities. The stockpiles of dispersants are retested generally every 5 years. For dispersants in tanks on response vessels, testing is performed more frequently. See Annex 1 for further information about retesting of dispersants in Norway.

5.2.2 Current test procedures in Norway

5.2.2.1 All these R&D studies in the 1980s and 1990s formed the basis for the new dispersant regulations that came into force in Norway in 2002. According to these regulations, all tests shall be carried out at laboratories that are either accredited in accordance with EN-ISO-17025 or certified according to EN-ISO-9001 or can document that they have internal quality systems for documentation, traceability and comparative testing corresponding to good laboratory practice (GLP) or specific ISO standards.

5.2.2.2 The Norwegian regulations are founded on the principle of "internal control". This means that the enterprise (company / entity) responsible for the oil spill response has the responsibility for producing the pre-planned documentations in the emergency plans. In principle, the owner of this documentation is the enterprise. However, the Authorities have access to all the documentation. In practise, most of this documentation (e.g. the effectiveness testing of dispersant on the specific oils) is made open for the public through e.g. the oil weathering and dispersibility testing reports produced by the enterprise or other research studies.

5.2.2.3 According to the 2002 new regulations for dispersants usage, the tests described below are used for dispersants. A minor revision of the dispersant regulations was carried out during 2009, linked to the inclusion of shoreline cleaners and bio-remediation products into the same regulations, meaning that the "working mechanisms" of the various agents have to be documented. The Norwegian testing approach is based on long-running experience and is very detailed, since the industry is very much involved in testing dispersants for the specific oils they produce, process or store. Consequently, financial resources and more information on dispersant testing for a variety of different oils is available (compared to the testing on one/two reference test oils used in UK and FR, done to address accidental oil spills).

5.2.2.4 As Norway does not approve dispersant products as such, there exists no official / public list of approved dispersant products; dispersants are always tested per type oil or range of oils for a specific location/area. Information on the test results is available for the authorities and can be available for others upon request. So far, the toxicity test has been performed only for a limited number of dispersants, due to limited brands of dispersants in the present stockpiles in Norway (mainly Dasic NS is in the NOFO[11] stockpile). The present test-procedures produce data that are valuable for the contingency planning and for the NEBA assessment of relevant oil spill scenarios for the specific oils. The dispersant has to document its performance on various test conditions (e.g. dosages) and particularly on various weathered and emulsified "stages" of the different oil types, in order to know more about the performance under realistic scenarios. To this effect, Norway is the only country that tests the dispersibility of oils on varying weathering levels. Such documentation will also have an operational value such as: how to treat the oil slick in an optimal way (i.e. dosage needed, need for double / multi-treatment of the slick etc.). The Norwegian regulations / requirements are focusing on this issue.

5.2.2.5 The dispersant testing results are therefore used as input to operative oil spill models; this is done both to verify the extensive oil spill modelling work done nationally and to define the window of opportunity for using dispersants under different environmental and weather conditions for the oils produced in oil fields and oils transported in Norway.

5.2.2.6 The use of dispersants is regulated, through permits from the Norwegian Environment Agency; any dispersant used at sea, must have performed/passed the tests of effectiveness and toxicity. Norway regulates the testing and approval of the dispersant product and sets requirements for dispersant use in view of the dispersants' operational use. No dispersants are considered for use if they do not fulfil the requirements in the Norwegian regulations. In principle oil spill dispersants can only be used if they are part of an approved emergency response system of an entity required to have such emergency response systems in place (e.g. entities producing or processing oil); if this is not the case, dispersant use may only take place with a permit from the Norwegian Coastal

[11] NOFO: Norwegian Clean Seas Association for Operating Companies

ED_001324_00007385-00019

Administration (NCA). The NCA is also currently considering building up oil spill dispersant capacity for bunker fuels (HFO).

5.2.3 Effectiveness test

5.2.3.1 The procedures for testing the effectiveness of dispersants vary in Norway, depending on whether a company/entity is producing or processing oil or not.

5.2.3.2 For companies/entities that produce, process or store specified types of oil and that plan to use dispersants as part of their emergency response procedures, the effectiveness tests shall be conducted using the specific oil or for those types of oil most likely to be treated with dispersants. As different oils are used, there is no specific effectiveness threshold for approval. The aim of the testing is to compare products (relative ranking) and select the most effective dispersants, the dosage ratios required, and for estimating the "time window" for use of dispersants for the relevant oils, taking into account the oil weathering taking place at sea. The latter is in particular important for the validation of the extensive oil at sea modelling in Norway.

5.2.3.3 In the first step of screening the dispersant effectiveness on oils produced, processed or handled in Norway, the IFP dilution test is used. This is the same "low energy" dispersibility test used in France, where energy is applied to the oil on the surface, by a submerged beater-ring, and dispersed oil is collected from the bottom of the tank. The dispersants selected for the screening are tested on an artificial weathered fraction of the specific oil in question (e.g. 200°C+ /50% water-in-oil[12]- emulsion). A minimum of two parallel tests shall be conducted for each product, at a dispersant-to-oil ratio of 1:25.

5.2.3.4 The next step of the effectiveness testing includes a dosage-test, where the best dispersants (1-3 best products) from the screening testing of the specific oil (200°C+ /50% water-in-oil- emulsion) are tested at varying dispersant to oil dosage ratio (e.g. from DOR 1:10 to 1:200). This is done both with the IFP and the MNS tests. Such a dosage test is very useful operationally, both in estimating the amount of dispersant needed for this specific oil, and also if additional mixing energy will be required during the dispersant application operation.

5.2.3.5 In the last step of the effectiveness testing, the entities have to test the oil's dispersibility at varying weathering degrees for the relevant oil in order to predict the "time window" for effective use of dispersants under various turbulence conditions. For this, the IFP test is used in combination with the MNS test, representing two turbulence conditions. In the MNS test, an air-flow above the surface generates an acute mixing and circular wave corresponding to "medium energy" breaking wave conditions. Samples of the dispersed oil are taken and quantified. This combined use of the IFP and MNS tests is assumed to represent the type of turbulence you may have in the field both without and with breaking waves conditions. This testing of the oils' dispersibility at varying weathering degrees gives information about the upper viscosity limits for the oils and the window of opportunity for use of dispersants. This testing approach has been correlated to field tests which involved release of oils. This type of information is also needed and required for contingency planning in Norway.

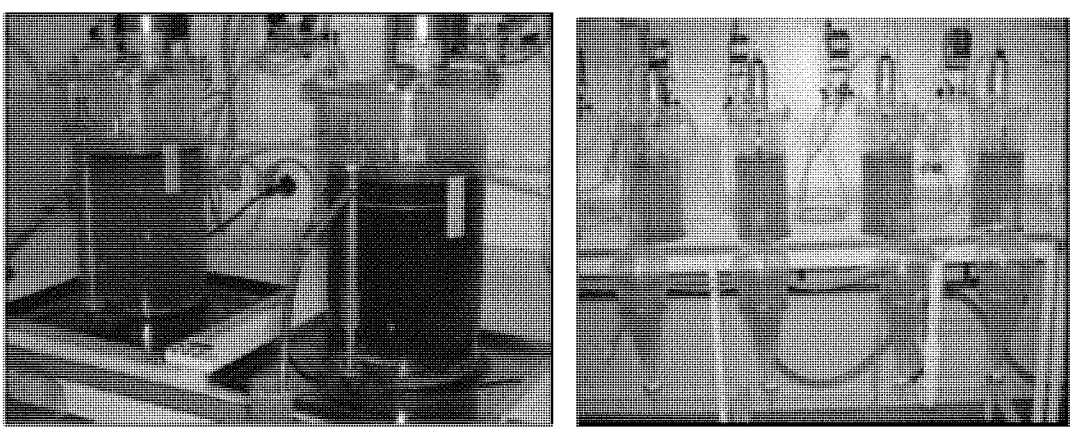


Figure 8: Dispersant effectiveness testing - IFP apparatus at SINTEF laboratories (Source: SINTEF)

[12] A 200°C+ /50% water-in-oil emulsion is an oil restudies that has evaporated off all components with boiling point below 200°C and has incorporated 50% seawater. This corresponds roughly to oil that has been weathered from typically 0.5 -1 day on the sea surface.

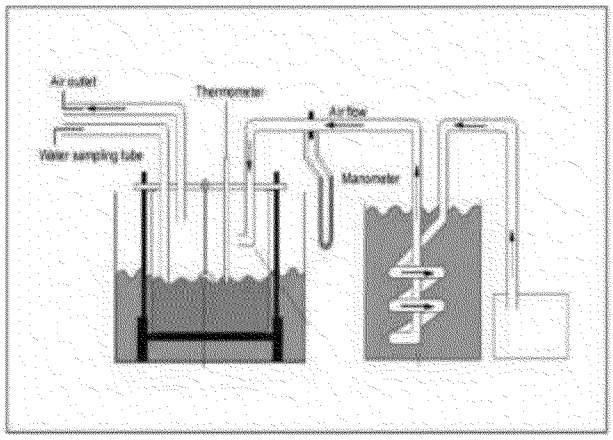
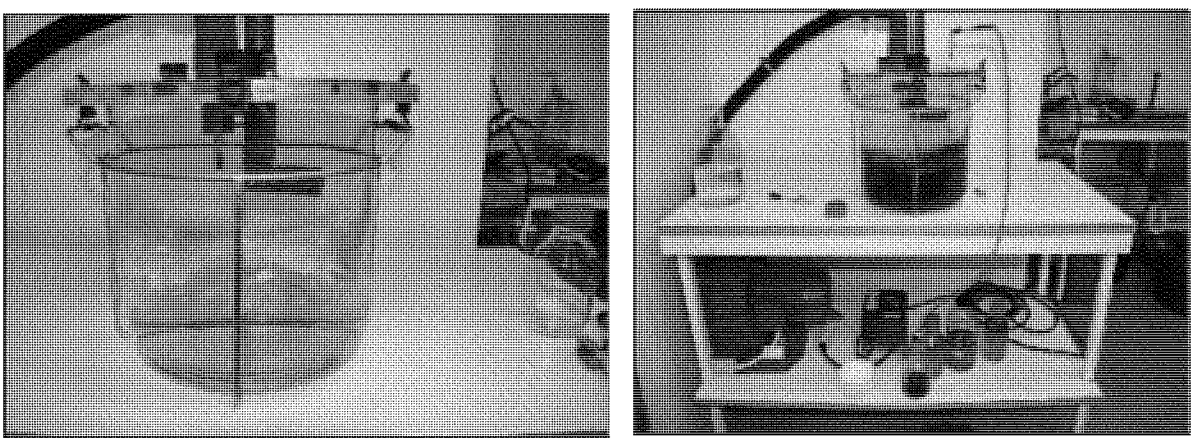


Figure 9: Dispersant effectiveness testing - MNS apparatus – Schematics (Source: SINTEF)



Showing wave actions before applying the oil

Dispersed oil after dispersant application

Figure 10: Dispersant effectiveness testing using the MNS-apparatus at SINTEF (Source: SINTEF)

5.2.3.6 Entities that do not produce or process oil, which are required to have an emergency response system but cannot link this to one or more specific types of oils, must be able to draw up emergency response plans including dispersants as a response option if they have carried out a *standard test procedure* for dispersant effectiveness. This addresses accidental oil spills where the spilled oil is unknown. In these cases, the WSL test is used in Norway, which is a relatively "high energy test" using rotating flasks that cause the dispersant-treated oil and water to thoroughly mix. The test aims to assess the proportion of the total volume of treated oil that is dispersed into the water column. This test is also used in the UK. In Norway, four different standard reference test oils are used for this tests, on varying weathering levels and two different salinities, as listed below. The first two tests (in table below) shall be run for all the products, while the third test is only needed if there are plans to use the dispersant product at low salinity.

5.2.3.7 The required conditions for the WSL test procedure to be conducted are shown below. It should be mentioned however, that the WSL test has not been performed in Norway since the new regulations came into force in 2002. A further specification of the test oils used for the WSL test might be updated in the future.

WSL Test		
	Test oil	**Conditions (temp. & salinity)**
1	Sture Blend 200°C/50% synthetically weathered emulsion	10°C, 3,5% salinity / DOR 1:25
2	Medium Fuel Oil (2000cP at 10°C)	10°C, 3,5% salinity / DOR 1:25
3	Sture Blend 200°C/50% synthetically weathered emulsion	10°C, 0,5% salinity / DOR 1:25
4	IFO 180 (viscosity around 10.000 cP at 10°C)	10°C, 3,5% salinity / DOR 1:25

Table1: Effectiveness testing – WSL test conditions

5.2.4 Toxicity test

5.2.4.1 The Norwegian test method, like the French one, determines the acute toxicity of the dispersant alone, by testing it on planktonic algae (*Skeletonema costatum)*, in accordance with the procedure described in ISO 10253. This is one of the standardised internationally accepted eco-toxicity tests used by the "OSPAR" Convention. This is a test measuring the acute toxicity as the concentration (mg/l) inhibiting the growth of the algae by 50%. The dispersant is not approved if it has a median effective concentration EC_{50} < 10mg/l. The test criteria requirement of EC50 > 10 mg / L is a general criteria for the water column HOCNF (Harmonised Offshore Chemical Notification Format) tests organisms, However, the toxicity measurement does not include "single component" tests, but only determines the acute toxicity of the "whole" dispersant". This is a pass/fail test.

5.2.4.2 It should be noted that the shoreline cleaning agents used in Norway must be tested for acute toxicity; testing is on the same algae (*Skeletonema costatum)* and shoreline cleaning agents are not approved if they have a median effective concentration EC_{50} < 100mg/l. In a more recent study (Hansen et al , 2014[13]), the *S. costatum* test results were extensively validated and correlated to other HOCNF tests, showing a good correlation and similar sensitivity to other water column organisms (e.g. *Acartia tonsa*). However, they did not provide a good correlation to the sediment organism (*Corophium volutator*). This last test is therefore today only included in the regulations/guidelines for testing shoreline cleaning agents.

5.3 United Kingdom

5.3.1 Background

5.3.1.1 The UK philosophy with regard to dispersant use is based firstly on the unlikelihood of getting oil recovery vessels to site in time, thereby aerial application of dispersants is deemed primary response and that mechanism is therefore in place as clear policy. The protocols for the regulation of dispersant use were not developed simply theoretically – but rather through the extensive and thorough laboratory and at-sea real-scale trials. Those trials delivered significant evidence to the process to ensure that decisions on development of UK dispersant effectiveness and toxicity testing were technically, scientifically and realistically sound. One important aspect of the trials, which fed into the process, was the fate of oil at-sea trials where oil concentrations were measured beneath trial oil slicks – both treated and untreated. The trials recorded the relative effectiveness of natural dispersion and dispersant induced dispersion thereby providing a real measure of the effectiveness of specific dispersant products.

5.3.1.2 Understanding the fate of chemically and naturally dispersed oil (and the differences) is fundamental in the development of dispersant use philosophy. In the UK the basis of dispersant regulation is to achieve a best outcome, not to make matters worse. The overall UK philosophy for toxicity therefore is to ensure that the oil +

[13] Bjørn Henrik Hansen, Dag Altin, Kristin Bonaunet & Ida Beathe Øverjordet (2014). Acute Toxicity of Eight Oil Spill Response Chemicals to Temperate, Boreal, and Arctic Species, Journal of Toxicology and Environmental Health, PartA: Current Issues, 77:9 -11, 495-505, DOI: 10.1080/15287394.2014.886544

dispersant is not significantly more damaging than the oil alone. For effectiveness – the UK process is very simple – any dispersant presented for testing must attain a minimum of 60 percent. Simply – no point in introducing something which does not work to the degree which senior UK Government maritime scientists and policy makers each deem reasonable.

5.3.1.3 The UK approval scheme for dispersants differs from those of other national protocols. The main difference regards the toxicity tests that include the effect of dispersed oil in addition to the dispersant alone. The UK addresses the dispersant approval testing procedures from an operational perspective (e.g. testing the toxicity of the dispersed oil, as dispersants will always be used in combination with oil), whereas the other countries do not consider these elements in the 'product approval' phase, but rather during the 'dispersant usage approval' phase. This difference of necessary requirements for the *'product approval'* phase, and for the *'dispersant usage approval'* phase should be highlighted. It seems that even though all countries share similar concerns, they deal with these at different phases (either during the product approval or during the approval to use dispersants in a particular spill).

5.3.1.4 The UK testing scheme is designed to provide the appropriate balance between efficiency and environmental acceptability. The UK recognises that a more efficient dispersant product may be more toxic, and in accordance with the UK key principle and its testing approach, this is not an issue; a less effective product will be used, which is less toxic. The selection of dispersants for use should be a 'trade-off' between these - this is a principle inherent within the UK approach. In addition, the UK testing and approval scheme is designed to be able to provide assessments of *all* products used to treat oil spills. The combined "Sea" and "Rocky Shore" toxicity test approach is also used to assess sorbents, surface cleaners, bioremediation agents and a range of miscellaneous products. The "Rocky Shore" test is very pertinent to the testing and approval of several of these product categories.

5.3.1.5 For the UK, dispersant application is considered a primary oil spill response option and therefore substantial financial and human resources have been invested in defining the national testing scheme, with extensive and regular stakeholder consultations, in order to establish a generally acceptable framework. There is a clear link in the UK's testing philosophy with how the dispersant product will actually be used in operations. The latest review of the UK approval scheme for 'oil spill treating products' was held in 2011 and showed that there is a strong support of the current UK testing and approval approach, which aims to represent the risk of the actual use of a product and assess the potential of a product to increase the oil's toxicity. A number of recommendations were also made, including the need to develop a modification of the Sea Test to allow for the assessment of products for the treatment of Heavy Fuel Oils (HFOs).

5.3.1.6 The UK protocol respects the competition element for the dispersant manufacturers. The UK declares publicly whether any product has passed or failed the tests, i.e. the actual results are not public information.

5.3.2 Effectiveness test (LR 448 WSL)

5.3.2.1 The UK is using the Warren Spring Laboratory (WSL) test to determine dispersants effectiveness. Two reference tests oils are used; medium fuel oils with viscosities of 500cP and 2000cP at 10°C (the test temperature). The WSL test is a relatively "high energy test" using rotating flasks that cause the dispersant-treated oil and water to thoroughly mix. The effectiveness test aims to assess the *proportion of the total volume* of treated oil that is dispersed into the water column. While two reference oils are used, comparing the effectiveness results between the two, the core oil for the pass or fail decision is the heavier fuel oil with 2000cP. Similarly to France, and differently from Norway, the UK effectiveness test does not cover varying weathering degrees of the oil.

5.3.2.2 The Maritime and Coastguard Agency (MCA) research project: "*Determination of the limiting oil viscosity for chemical dispersion at sea*" (MCA project MSA 10/9/180), was commissioned to explore what the key factors might be in limiting the effectiveness of dispersants on heavier oils. The report concludes that some oil spill dispersants will be an effective response to oils with viscosity of 2,000 cP, but will not be effective on oils with a viscosity of 7,000 cP or more, in waves associated with wind speeds of 7 to 14 knots. The precise limiting viscosity between 2,000 and 7,000 cP is not known. The limiting viscosity will increase with wind speed; it is possible that oil with a viscosity of 7,000 cP will disperse at 20 or more knots wind speed. However, it was not possible to test this at sea. Additionally, further research was funded by the UK Department for Environment, Food and Rural Affairs (Defra) (Project ME1309, 2010) which investigated the adaptation of the existing Sea Test for the assessment of products for use in the treatment of heavy fuel oils (HFOs) or heavy crude oils. The new test was successfully

developed but, as yet, the separate assessment of products for use on heavier oils has not been implemented as part of the UK statutory scheme.

5.3.2.3 The minimum effectiveness requirements, according to the UK regulation, for a product to be considered effective and to pass the test depend on the type/categories of dispersant being tested:

- UK Type 1 (hydrocarbon solvent-based dispersant applied undiluted) and Type 2 dispersants (concentrate diluted 1:10 with seawater before application) must achieve an effectiveness of 30%. Type 1 and 2 dispersants are on the UK list of approved dispersants, but will most likely not be used in response operations.
- UK Type 3 (high effectiveness concentrate applied undiluted) must achieve an effectiveness of 60%. During response operations, in principle Type 3 dispersants are used. The threshold of 60% means that 60% of the oil must be dispersed in the water column for the product to pass. This differs from the 60% threshold in the French method, according to which the effectiveness is expressed between 0 and 100%, where 100% corresponds to the maximum theoretical quantity that could have been removed in case of a totally soluble compound. Dispersants pass the effectiveness test in France if dispersion is greater than 60%). Often the dispersants used in the UK are Type 2/3, so the same test method is used, but with different threshold values, as mentioned above. (See Annex 1 for more details on the UK effectiveness test protocol).

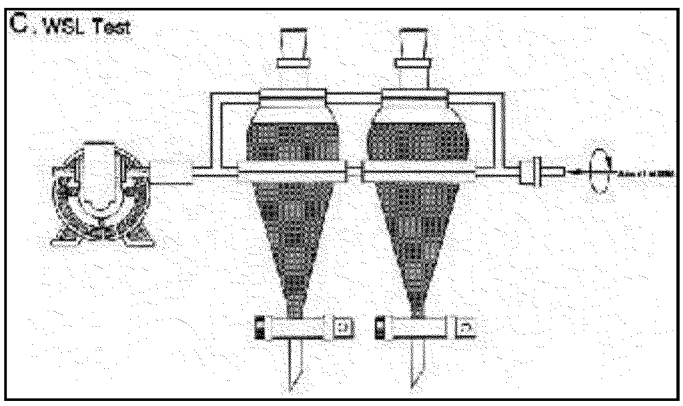


Figure 11: UK effectiveness test: WSL test (Source: CEFAS)

5.3.3 Toxicity tests (Sea Test and Rocky Shore Test)

5.3.3.1 The toxicity tests conducted in the UK for dispersant licensing are different in approach to other toxicity tests conducted in Europe and the United States. The Sea Test compares the toxicity of treated oil (i.e. treated with dispersant or other product) against that of oil alone (no product added, oil that is mechanically dispersed)– it does not 'estimate' the toxicity of the dispersant alone. It is generally accepted that the (dispersed) oil is by far more toxic than the dispersants. The UK does not consider the inherent toxicity of the dispersant alone because, if used correctly, animals should only be exposed to it in the environment in combination with oil; so it is important to see how the application of a product changes the oil's toxicity. The UK policy aims to approve sufficiently effective products that have less potential to make the situation worse than it already is as a result of the oil spill. Taking account of dispersed oil effects in tests could result in the most efficacious products failing due to their potential to increase the bioavailability of oil to test organisms. The UK testing policy accepts this as a legitimate reason for test failure of certain products, especially as several products demonstrate adequate effectiveness for operational purposes and ability to fulfil the requirements for the UK toxicity tests. (If the UK were to test the toxicity of the dispersant alone, it would use the OSPAR Guidelines for Completing the Harmonised Offshore Chemical Notification Format - HOCNF).

5.3.3.2 The two toxicity tests conducted in the UK for a product to be on the list of approved dispersants are the 'Sea test' and the 'Rocky Shore test', described below. The toxicity tests are conducted by Cefas (the Centre for Environment, Fisheries and Aquaculture Science). The test oil used in both toxicity tests is the Kuwait crude (a medium crude oil relatively high in BTEX[14]). (See Annex 1 for more information on the UK toxicity testing protocols).

[14] BTEX: Benzene, Toluene, Ethylbenzene, Xylene

5.3.3.3 The Sea test is compulsory and involves the exposure of brown shrimp (*Crangon crangon*) to oil treated with dispersant (at a DOR (Dispersant to Oil Ratio) of 1:10) and mechanically dispersed by two shielded propellers rotating at 800rpm. This test compares the relative toxicity of an oil-dispersant mix to that of oil alone. The shrimp are exposed to dispersed oil at 1000ppm concentration in the water for 100 minutes followed by a 24 hour recovery period in clean flowing seawater. Five replicates each of a 'treated' exposure (oil + product) and a control or 'non-treated' (oil only) are conducted simultaneously. The test assessment is based on a statistical comparison of shrimp mortality between the two exposure types.

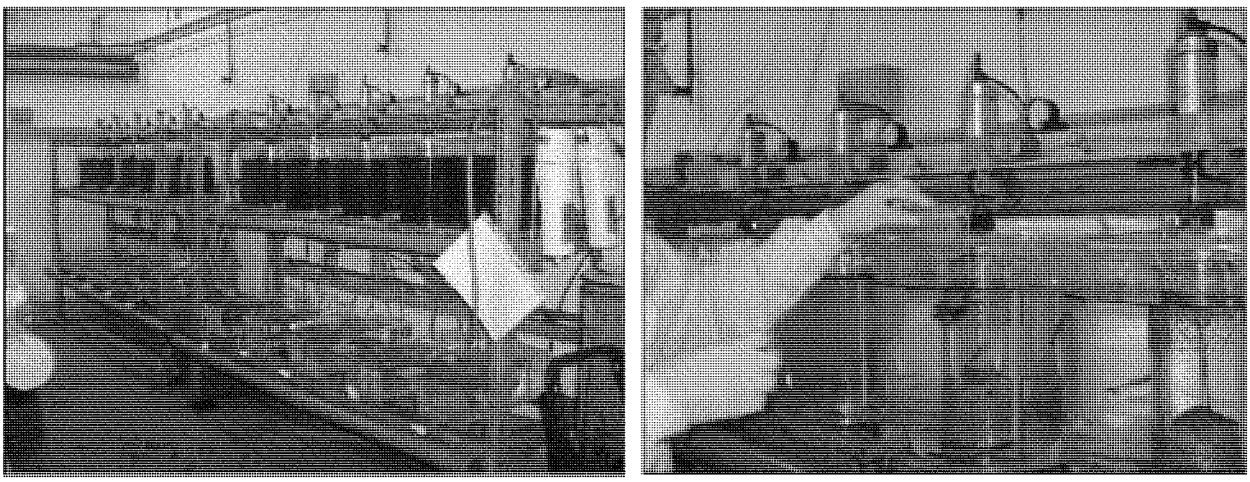


Figure 12: UK toxicity test: Sea Test (Source: CEFAS)

5.3.3.4 The Rocky Shore test involves the exposure of a representative rocky shore test organism, the common limpet (*Patella vulgata*), to either oil or the test product (i.e. dispersant alone – or oil and product for some product categories, e.g. sorbents) on Perspex plates. Limpets are left exposed on the plates, in a moist controlled environment, for 6 hours before being rinsed with clean seawater and the plates suspended in recovery tanks of clean flowing seawater. The limpets are monitored for mortality and loss of adhesion to the plate for a further 72 hours (including a daily period of 6 hours air exposure to represent tidal conditions). This test is no longer compulsory for products approved for "offshore" use only; the 'offshore' product designation is designed to identify those products which appear on the UK approved list but would not be considered for use on, or in the vicinity of, sensitive rocky shoreline environments. As with the Sea Test, five replicates of each treatment are conducted and the test assessment is based on a statistical comparison of limpet 'mortality' between the exposure types.

5.3.3.5 When the Rocky Shore test was developed dispersants formulations were being produced for use on shorelines as well as at sea. Dispersants have been used in the UK on shorelines and therefore the requirement to assess use impacts on this important ecological area is still considered important – especially by conservation organisations. The use of the Rocky Shore test also provides the basis for the approval of products that may be used near to rocky shorelines as well as on them. It should be noted that the Rocky Shore test is not just for 'shoreline cleaning products'. It is for the additional assessment of any product (ind. dispersants, sorbents, bioremediation agents and shoreline cleaners (referred to as surface cleaners)) that may be used to treat/clean oil on, or in the vicinity of, rocky shorelines.

6. Similarities and differences in existing dispersant testing procedures

6.1 There are similarities and significant differences in the test methods for dispersants effectiveness and toxicity required for government approval in the countries described in this paper. It is worth repeating that all countries share the same concerns and objectives when approving dispersants, they just approach these in different ways and with different tests requirements and procedures. This chapter focus on the similarities and differences in the various tests performed in the three countries with long experiences with dispersants (France, the UK and Norway).

6.2 Main similarities

- France and Norway test the toxicity of the dispersant alone and use an LC50 (lethal concentration)/EC50 (effect concentration) as an indicator of the toxicity. However, France and Norway use different test organisms and test method procedures.
- France and the UK are both conducting their toxicity tests with similar crustaceans; the white shrimp (*Paleamonetes varians*) in the case of France and the brown shrimp (*Crangon crangon*) in the UK.
- There is a common philosophy among the countries regarding dispersants effectiveness testing (specification of a minimum level of performance).
- France and Norway are using the same "low energy" dispersants effectiveness test (IFP test), as described. The "energy level" produced in the different effectiveness test methods cannot be directly related to particular sea conditions or wind speeds and is only relative.
- France and the UK have a specific threshold to determine dispersants effectiveness, although the test oils used and the interpretation of E > 60% are different. In France it is E > 60% whereas the UK LR448 protocol is based on a pass threshold level for UK Type 2 and 3 dispersants; E > 30% for UK Type 2, and E>60% for UK Type 3 with the 2000 cP at 10°C medium fuel oil. It should be noted here that the official policies of France and Norway only recognise modern, concentrate dispersants (UK Type 3) and do not recognise the classification of a UK Type 2, water-dilutable concentrate dispersant. Also it is important to point out that the efficiency percentage measured with the different methods of the countries cannot be compared directly to each other.
- All three countries (France, Norway and UK) perform the effectiveness test first. Toxicity tests are not performed if effectiveness tests are not acceptable (the products have to pass the effectiveness test, in order to proceed to the toxicity test).
- All three countries (France, Norway and UK) perform recheck of dispersants in their stockpiles. The tests differ a bit, but the focus is on testing the effectiveness after 3 -10 years in stock. The IFP test is used in France and Norway, and the WSL test is used in the UK. How and how often this rechecking is performed depends on the storage conditions. See Annex 1, column "Re-test/check of dispersants", for further information.

6.3 Main differences

- The fundamental difference in the test methods used for approval is with regard to the toxicity testing of dispersed oil versus toxicity testing of dispersant alone; the UK requires toxicity testing of the dispersed oil for approval. It should be emphasised that all the countries are equally concerned about the toxicity of the dispersed oil, but they deal with this at different phases. France and Norway determine the toxicity of the dispersant alone for approval, but also consider the toxicity of dispersed oil for the following reasons:

  - France considers the toxicity of the dispersed oil for dispersants usage and application in French waters. When setting up the pre-defined geographical limits, where dispersants usage is allowed with no prior official authorisation required, then the dispersed oil toxicity is taken into consideration; no specific toxicity test is carried out at that stage.
  - In Norway, extensive bio-assay studies on the toxicity of both dissolved oil components (WAF - Water Accommodated Fraction) and dispersed oil for different oil types are ongoing as part of the documentation needed for preparing contingency plans for the use/non-use of dispersants in coastal waters. The bio-assay studies are important input to advanced 3-D spreading and exposure models used as tool for NEBA assessment of relevant oil spill scenarios, as part of the contingency planning. Extensive research has been undertaken and is still taking place on oil droplets, toxicity of the oil (which is found to be far more toxic than the dispersants) and the toxicity to fish eggs, embryonic and larvae development for cod, haddock and herring and toxicity to Calanus (marine copepod). This research is based on as much as possible realistic levels of concentration of dispersant after a treatment and uses sensitive and relevant test organisms for Norway. Results are compared, with and without application of dispersants. These bio-assay studies are not directly linked to approval procedures for dispersants, but are needed for contingency plans which aim to prepare for the best possible counter polluting measures in Norway.

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- Norway conducts toxicity tests, included in the OSPAR Convention, that are based on the impacts of the dispersants on planktonic algae (Skeletonema costatum test, ISO 10253).
- Only France conducts a dispersants biodegradability test as part of its approval procedure, but is currently considering the possibility of abandoning this test. The UK has conducted specific research in the past to ascertain the general biodegradability of modern dispersants. The result was that they were found to be generally readily biodegradable and therefore the need for a routine assessment as part of the scheme was not considered necessary.
- Norway regulates the dispersant use and not the approval of the dispersant products as such; therefore it does not have a list of approved products, like the UK and France have and maintain.
- Norway is the only country that tests dispersant product effectiveness on oil in varying weathering levels and reflects upon two different salinities in their national regulation.
- Norway has two different dispersant effectiveness testing procedures: one applicable for entities that produce or process oil (dedicated to the oils that are produced/processed) and a different one for entities that do not produce or process oil. Whereas the UK and France address dispersant product approval tests from the point of view of maritime traffic / accidental spills (where the oil types are not known in advance).
- The type of test oils differs for the effectiveness tests. France uses light crude mixed with heavy crude (1000 cP). In France, the Navy requires an additional effectiveness test which uses heavier test oil (8000cP). UK uses two medium fuel oils (500 and 2000 cP). Norway uses specific oils, depending on the enterprise/entity in question and has defined test oils if the oils are unknown/not specific producing oils. Norway has requirements in the regulation that specify the need to test the specific crudes oils.
- The UK is the only country having dispersant Type 1 on their approval list, even if in practice it is not used in response operations in the UK. Type 1 dispersant is not on the approval list in France and not used in Norway.
- In France, the test procedures and approved list of dispersants are not regulated by law requirements. This indicates that products not on the list can be applied/used and that the test procedures can be changed without legal implications. In Norway and the UK the approval procedures are part of regulations and required by law.
- Toxicity testing is also performed for spill response products to be used in environmentally sensitive areas. In the UK, the Rocky Shore Test is used to test dispersants, sorbents, bioremediation agents and shoreline cleaners which may be used on or in the vicinity of rocky shores. In Norway the planktonic algae (*Skeletonema costatum*) is also used for testing shoreline cleaning products. How the countries link the toxicity testing of shoreline cleaning products and dispersants differs, but there is an aim to perform the same tests (use the same organisms) if possible and appropriate.

7. Key principles behind the different test methods

7.1 The dispersant testing methods and requirements in France, Norway and the UK are listed in detail in the table in **Annex 1**. This Overview Paper, which aims to provide as much as possible complete and transparent information on this topic, includes information, as provided by the representatives to the TCG Dispersants of France, Norway and the United Kingdom, on:

- The key principles behind each national procedure (Table 2)
- The requirements of each test (Table 3)
- Comments and observations based on the experiences gained from the use of these tests (Tables 4 & 5).

7.2 It is the intention of the TCG Dispersants, that this paper will enable the other countries to better understand the current tests and with this information to 'choose' how to proceed regarding developing or revising their own dispersant testing procedures. For example, if they rely on one of these approval regimes for accepting products to be used in their own country (as many do), to know what that really entails, and if they develop their own new test procedures, to learn from the experiences gained already and avoid duplication of efforts and resources. This may prevent further diversification of test methods in Europe.

7.3 The key principles behind each of the selected national dispersant product approval tests are as follows:

Key Principles behind national test procedures in France, Norway and the UK		
FR	**Effectiveness test**	- Low energy test in order to identify more accurately the effectiveness of dispersant. - Dilution test: effectiveness related to well dispersed oil and not only oil transferred to the water column.
	Toxicity test	- Toxicity of dispersed oil is mostly due to the oil itself & to the effectiveness of the dispersant. - Dispersants are assessed alone to check that they do not have a significant intrinsic toxicity.
	Biodegradability test	- To check that the dispersant does not inhibit the biodegradation of the oil.
NO	**Effectiveness test**	- To compare products and select the most effective dispersants (ranking of products instead of "pass/fail"). - To identify the dosage ratios required. - To test the oil's dispersibility at varying weathering degrees for the relevant oil tested in order to predict the "time window" for effective use/application of dispersants. - Three different test methods are used for different effectiveness testing purposes (IFP, MNS and WSL). The principles and the pros / cons for these three test methods are summarized in Chapter 5.2.1.4.
	Toxicity test	- The standardised OSPAR acute toxicity test (ISO 10253) is a simple, but robust EC_{50} test. - The aim is to prevent that new products come on the market that have a significant higher acute toxicity than other "well-known" dispersants that have undergone toxicity / bio-assay studies in the laboratory or in the field. - The dispersants are therefore tested alone (not in combination with oil).
UK	**Effectiveness test**	- Aerial application of dispersants is deemed potential response to oil spills and there is a clear policy in place. - Any dispersant (UK Type 3, which is usually used in response operations) presented for testing must attain a minimum of 60 percent effectiveness. - To ensure products introduced work to a reasonable degree.
	Toxicity tests	**Sea Test**: - To assess products for their potential to increase environmental impacts when added to oil. - To assess products specifically for 'at sea' applications. - To ensure products are on the approved list that have an appropriate balance between effectiveness and the potential to increase toxic effects of a spill.
		Rocky Shore Test: - To assess products for their potential to adversely affect a representative Rocky shoreline species. - To compare product alone vs oil alone in recognition of the greater potential for product only exposure to occur during shoreline use. - Takes account of other important, 'non-toxic' adverse effects, such as adhesion loss.
		Overall: To relate the testing and approval process to actual operational use (dispersants will always be used in combination with oil)

Table 2: Key principles behind national dispersant test methods in France, Norway and the UK

7.4 Due in part to these key principles, different test methods are chosen to be used with different threshold values, test oils and test species for the effectiveness and the toxicity tests performed in these countries.

7.5 With regard to the **effectiveness tests**, the three most common tests performed in Europe today are the:

- IFP – Institute Francais du Petrole
- MNS – Mackay, Nadeau and Steelman
- WSL- Warren Spring Laboratory

7.6 The energy level differs in the tests, from high to low. The high energy tests are often used for pass/fail tests. The low energy tests might also be used for pass/fail tests, but the lower energy tests induce a better ranking of the products. Effectiveness test results can be a way to select the most efficient products. The results can give useful information regarding the use of dispersants if the specific oil type of the spill is known and tested. However, it is important to be aware of the fact that test results only describe what is happening in the laboratory.

7.7 The table below contains a brief summary of the various effectiveness tests performed in France, Norway and the UK (Annex 1 gives a more detailed description of each test method.)

Country	Effectiveness Tests	Energy level	Test oil type(s)	Dispersant to Oil Ratio (DOR)	Threshold(s)
France	IFP test	IFP: Low	Arabian light crude mixed with heavy crude, 1000 cP. More viscous oil, 8000 cP, is used when performing tests for the French Navy (additional test).	1:20 (5%)	60% (where 100% is based on theoretical quantity of a totally soluble compound)
Norway	(i) Entities processing or producing oils: IFP & MNS tests (ii) Others (unknown oil): WSL test	IFP: Low MNS: Medium/High WSL: High	It varies: the oil that is produced / processed by that entity is used as test oil. Test on weathered oil (~ 0,5 –1 day at sea). Defined test oils for WSL test: Weathered Sture Blend, medium Fuel oil (2000cP at 10°C) and IFO 180 (ca 10 000 cP at 10°C).	IFP: 1:25 IFP & MNS: 1:10 – 1:200 (for testing optimal dosage needed) WSL: 1:25	No specific threshold is provided in the Norwegian regulation for any of the effectiveness tests. (Due to the different test oils used each time) Results are used for ranking dispersants.
United Kingdom	WSL	WSL: High	Medium fuel oils: 500cP and 2000cP	1: 20 – 1:30	Dispersants Type 1 and 2: 30% (diluted 1:10 w/ seawater) Dispersants Type 3: 60% (60% must be dispersed in the water column)

Table 3: Summary of the effectiveness tests used in France, Norway and the UK for dispersant product approval (Annex 1 provides more details on each test method)

7.8 The table below includes some **observations and comments** on each effectiveness test, as provided by the representatives to the TCG Dispersants of France, Norway and the United Kingdom, based on their countries' long experience with using these tests.

Test	Comments & Observations
IFP	- A very satisfactory low energy test (representing field conditions with "non-breaking" waves). - Very suitable when doing dispersant ranking; It is a sensitive/selective test (i.e. gives a large span in dispersant ranking / screening). - A calibration procedure (not requested by the norm) has to be implemented by each laboratory. - Calibration may be time consuming when doing pass/fail testing. - Representative of normal field conditions (low oil-to-water ratio and includes the water dilution concepts). - Particular care has to be taken regarding the choice of the reference oil and dispersant. - Sampling taken under dynamic conditions (continues sampling during the agitation period).
MNS	- Medium/high energy. - Interesting for R&D studies on crude oils. - Complementary to the IFP when testing the dispersibility of an oil (MNS representing more "breaking waves" field conditions). Important when defining the upper viscosity for dispersibility of an oil. - The high energy tends to level out the effectiveness between various dispersants when testing on low viscosity oils, but very suitable for testing on more viscous oils. - Samples can be taken under both dynamic (during mixing) and static conditions (after settling). - Representative of field conditions (energy generated by wind - no mechanical energy input). - Suitable for pass/fail testing. - Less sensitive than IFP test.
WSL	- Simple test useful for screening dispersants on non-emulsified oils (can lead to poor efficiencies on emulsions, even at low viscosity). - High mixing energy (can disperse "everything" if long enough mixing time). - Very high oil-to-water ratio (20,000 ppm oil in water coalescence /adsorption to the wall). - Requires settling time / static sampling (i.e. test result will reflect the density of the test oil; Can therefore lead to low effectiveness for lighter oils with low density and viscosities. - Rapid and simple test. - Suitable for pass/fail testing. - Limited span/differences between the dispersants. - Less representative of field conditions.

Table 4: Comments and observations from using the effectiveness tests (based on input from the TCG Dispersants members)

7.9 With regard to the **toxicity tests** performed in Europe today, the fundamental difference is whether the test is performed on the dispersant itself or on an oil/dispersant mixture. Is the toxicity testing of a dispersed oil (dispersant, oil, and water mixed with high mixing energy) the best way to select effective dispersants for national approval? It is clearly recognised that in any field application of dispersants to oil slicks, there are many variables and organisms can be potentially exposed to higher concentrations of dispersed oil than would be the case if dispersants were not used. It is also generally accepted that the dispersed oil has the potential to exert more toxic effects than the dispersant alone or the non-dispersed oil; the dispersed oil is potentially more bioavailable to marine organisms (such as plankton) and thus can have a bigger effect on marine organisms than oil on the sea surface. In this respect, as a 'general principle' the dispersant that is the most effective would produce more, or more finely (smaller oil droplets), dispersed oil and therefore has the potential to exert more toxic effects to exposed organisms.

7.10 The exact relationship between effectiveness and toxicity is not simple, and it may be needed to have an expert evaluation of the connection between efficiency and toxicity test results. The approval procedure aims to

select the most efficient and least toxic products. Generally, the more efficient a dispersant product is, the more and finer dispersed oil droplets are formed. This results in a greater potential for increased bioavailability of the dispersed oil to exposed organisms with a subsequent increase in the risk of detrimental effects. Therefore, taking account of dispersed oil effects in tests could result in the most efficacious products failing, due to their potential to increase the bioavailability of oil to test organisms. Except for the UK, all the other countries in Europe with dispersant test procedures in place (France, Norway, Spain, Greece and Italy), test the toxicity of the dispersants alone in the approval process.

7.11 The toxicity data to marine organisms is also used in other chemical registration schemes (e.g. offshore chemicals notification scheme). However, the purpose of this is to rank potential hazard to facilitate product categorisation and is not used as a pass/fail criteria. It is recognised that the actual ability of a chemical to elicit impacts in the marine environment is a result of many factors including, volumes used, the dilution/dispersion potential at the release point and the sensitivity of the receiving environment and inherent toxicity only informs about hazard and not its environmental risk. Furthermore, in the case of appropriate use of dispersants, marine organisms will not be exposed to dispersant alone and the inherent toxicity of a product/dispersant will only partly be relevant to the toxicity of the product/oil combination. For operational use the toxicity of both the dispersant and the oil must be considered. The UK point of view is that the approval process should also consider the oil/dispersant mixture, which the UK considers as a more correct use of toxicity data since the oil and dispersants always work together. The UK states further that the dispersants are designed for a specific use, therefore the approval scheme should take into account the operational use and environmental risk (as opposed to hazard).

7.12 However, the toxicity of the dispersed oil is for some countries (e.g. France and Norway) taken into account not in the approval scheme but when dealing with the conditions for the use of dispersant, the contingency planning, which indicates where and to which extent the dispersants can be used according to the local environmental sensitivity and water exchange. If used correctly, dispersants will not be introduced into the environment in large amounts on their own, but only in combination with the much larger amounts of spilled oil. Taking into account that it is the dispersed oil, then the oil itself and lastly the dispersant that is of greatest toxicological concern during an incident when dispersants are used - as long as modern, concentrate dispersants (UK Type 3) are used. The 1st generation dispersants (1967 Torrey Canyon incident) contained aromatic solvents and were highly toxic; in fact they caused more harm than they contributed to the restoration process. In addition realistic scenario based model simulations should be performed to support the NEBA assessment. The "correct use" (spray onto the thickest oil, good water exchange, not too shallow, use remote sensing observations, etc.) of dispersants is very important for avoiding negative impacts on the natural resources.

7.13 The toxicity test criteria and organisms used should be harmonized with OSPAR as far as possible; this is looked upon as an advantage by members of the TCG Dispersants. Using test organisms mentioned in the OSPAR (The Convention for the Protection of the Marine Environment of the North-East Atlantic) promote the test of representative organisms for Europe and test protocols exist. Internationally standardized methods (e.g. ISO) for toxicity testing can also be applied. Research has been performed to compare aquatic toxicity testing for spilled oil, dispersant and dispersed oil. The US EPA has compared toxicity of Louisiana Sweet Crude (LSC), Corexit 9500A and dispersed oil (LSC + Corexit 9500); a DOR of 1:10 was used. The US test methodology was used (toxicity tests required by the EPA Test Method 821-R-02-012 (USEPA, 2002)) and the results showed that the dispersant alone was far less toxic to the fish species and shrimps than the crude itself. Test organisms used in this research were Mysid shrimp and Silverside fish[15]. Due to the fact that dispersants are less toxic than the dispersant/oil mixture several countries prefer to test toxicity on the dispersant alone. They consider it more appropriate to assess the dispersant alone, as the most efficient dispersants will present quite toxic values when oil/dispersant are tested together. As mentioned before, the toxicity and environmental impacts of using dispersant must be considered, but this process is in many countries separated from the approval process.

7.14 The table below contains a summary of the toxicity tests used today in France, Norway and the UK and some **observations and comments** on each test, as provided by the respective representatives to the TCG Dispersants group, based on their countries' long experience with using these tests. Annex 1 gives a more detailed description of each test.

[15] US EPA (2010). Comparative Toxicity of Louisiana Sweet Crude Oil (LSC) and Chemically Dispersed LSC to Two Gulf of Mexico Aquatic Test Species. August 2010 and the updated report of September 2010. Environmental Protection Agency, Office of Research and Development. A summary can also be found in: Dispersants: subsea application - Good practice guidelines for incident management and emergency response personnel. IPIECA IOGP Report 533, 2015 (see page 25).

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Country	Test	Test Organisms	Oil Type	Comments & Observations
France	French standard NF.T. 90-349	White shrimps (*Paleomonetes varians*)	N/A (Test only on dispersants)	- Advantage: toxicity measured relatively to a reference toxicant. - Shrimps not always available. - Low mortality in the field of dispersant solubility.
Norway	ISO/DIS 10253 Test on dispersant included in OSPAR Convention	Planktonic algae (*Skeletonema costatum*)	N/A (Test only on dispersants)	- A simple test. - Skeletonema costatum is available and representative for Europe. - Shown good correlation to other OSPAR / PARCOM tests.
United Kingdom	a) Sea Test (compares relative toxicity of an oil-dispersant mix to oil alone) b) Rocky Shore Test (compares toxicity of dispersants alone or oil and product). This test is not compulsory for offshore products.	a) Brown shrimp (*Crangon crangon*) b) Limpet (*Patella vulgata*)	Kuwait crude (medium crude)	- Brown shrimp are robust test animals, readily available and representative of exposed species for much of Europe. - The Sea Test is a comparative test (between dispersed oil and oil alone) and therefore takes account of seasonal variations in shrimp sensitivity. - Assesses the effect of dispersant/oil combinations as a standard dispersal. - Is based on assessing operational use but is not regarded as a 'simulation' due to fixed exposure times and concentrations. - General test system can be adapted to take account of different oils, species and exposure conditions. - Designed to assess potential impacts on and near to Rocky Shore zones which are considered to be ecologically important and particularly sensitive to the use of oil spill treatment products. - Allows some assessment of oil/dispersant effects under shoreline specific conditions (e.g. tidal cycle and intermittent air/water exposure). Also assess other important endpoints such as adhesion loss. - Limpets can be more difficult to source and should ideally be removed from chalk shorelines to avoid damage to the test organisms.

Table 5: Summary of toxicity tests and comments and observations on their use (based on input from the TCG Dispersants members)

8. Could there be a harmonised approach of dispersants testing in Europe?

8.1 This question has been brought up in the past at regional (e.g. Bonn Agreement) and EU levels (CTG MPPR, EMSA dispersants workshops) and it was addressed again by the TCG Dispersants Group at its 2014 and 2015 meetings, in accordance with the Group's mandate, as mentioned in Chapter 1. As dispersant use is considered a potential oil spill response option in most European sea regions and taking into account the extensive scientific work undertaken and operational experience that already exists in France, the UK and Norway in this field, further diversification of dispersant test procedures should be avoided in Europe. Several EU countries, especially the ones not having test procedures in place, wish to see a more harmonised approach- in the sense of convergence - of testing procedures in Europe. France, Greece, Italy, Norway, Spain and the United Kingdom are currently the countries in the EU with established procedures for dispersant testing for governmental approval.

8.2 All the countries with established test procedures share the same aim and objectives, even though as already described above the various tests have significant differences. It is important to clearly understand these similarities and differences when referring to these countries' dispersants test methods, especially when several countries in the EU would accept dispersants approved for use in the UK , France or Norway, although they may have been approved with very different testing methods. For example, some dispersants are approved for use both in the UK and in France, which means they have been tested at least twice with different test methods and have passed approval in both cases[16] even though the testing regimes are different. This procedure could be simplified if a more harmonised approach was used.

8.3 It should also be noted that a number of EU Member States have approved dispersants for use, without having national test procedures in place; the approval is based on the product being approved for use in other European countries. This is the case for example of Croatia, Cyprus, Malta, Ireland, Belgium and the Netherlands. Examples of products include the *Dasic NS, Finasol, Radiagreen OSD* and *Superdispersants 25*, which are approved for use in several countries, based on other countries' tests. It should also not be inferred that the absence of approval status in one or other of these countries for an individual dispersant is an indication that it would not be approved. There are commercial reasons why a dispersants manufacturer might choose not to submit a dispersant for approval in some countries.

8.4 Some of the **advantages** resulting from a more harmonised approach in dispersants testing methods across the EU are the following:

- Encourage the common aim of an efficient dispersant with a low toxicity.
- Provide guidance to countries either developing new policies regarding the testing, approval and use of dispersants as an oil spill response option or changing their existing policies on dispersants approval and usage.
- Enable an increased comparability of the results of the testing procedures, a more precise assessment of dispersants (effectiveness and ecotoxicology) and facilitate the acceptance of test results of dispersants approved for use elsewhere based on a common/harmonised testing protocol.
- Simplify the use of existing dispersants stockpiles among countries, in particular in waters of neighbouring states (Regional Agreements), and elsewhere as well; the situation during the Deepwater Horizon spill, where foreign stockpiles of dispersants could not be activated because the products were not approved according to the US national testing protocol, clearly demonstrated to what operational difficulties the lack of mutual acceptance of products may lead, also in Europe.
- Achieve a more predictable situation in regard to regional contingency planning regarding the response to oil spills.
- Allow financial savings for governments and/or manufacturers by avoiding the duplication of tests and by enlarging the possible market for dispersants (European area instead of individual countries).

[16] According to the 2014 EMSA *Inventory of national policies regarding the use of oil spill dispersants in the EU Member States* , six dispersants are currently approved for use both in France and in the UK (this list is not exhaustive and is based on information provided by the respective administrations). These are: *Dasic Slickgone NS; Finasol OSR 51; Finasol OSR 52; OD 4000; Superdispersant 25; and Radiagreen OSD.*

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8.5 As demonstrated by the discussions within the TCG Dispersants Group, harmonising certain parts and procedures of the laboratory tests currently conducted in Europe for the approval of dispersant products for potential application on oil spills was also expected to meet some **challenges**. These include:

- While most countries share the same concerns when it comes to approving a dispersant product for use in territorial waters, they deal with it in very different ways. They all want a relatively effective product, which is as less toxic as possible, either on its own, or when applied on oil. However, it should be considered that to achieve this goal, different tests, test methods, reference test oils, test species, energy levels, threshold values (if any) and pass/fail requirements are used across Europe.
- The dispersant toxicity tests currently conducted in France, Norway and the UK have a fundamental difference in their approach, i.e. testing dispersant toxicity vs. testing the dispersed oil toxicity.
- For the countries which have oil exploitation (or offshore oil fields), such as Norway, the type of oil which may cause pollution is known and the dispersant product approval testing is targeted on these individual and known oils, whereas for those countries without oil exploitation activities, the risk of pollution has more focus on maritime traffic and in this case the oil type remains unknown. These countries have to refer to reference oils (a sort of "average" oil) for their dispersant testing procedures. If the oil types are unknown, not crude oils like mentioned above, then test oils should be specified. To define representative oil type(s) for the EU/EFTA would be challenging.
- Test species used in one country may not be relevant for another country nor for a pan European test protocol.
- Any change in existing national regulations may require the consultation by a large number of bodies at national level.
- Countries have different environmental conditions (e.g. salinity and water temperatures), and their dispersant testing protocols and regimes have been established after considerable research and testing, and in some cases after exhaustive consultation across government bodies, in order to meet these specific conditions.
- Test results are usually not public information. In France and the UK lists are published which inform if products pass the tests, without giving more specific information.

8.6 In addressing its task, the TCG Dispersants Group met twice, in 2014 and 2015. The first meeting included the whole TCG Group dealing with this task (13 experts from 8 countries), whereas the second meeting only included experts from France, Norway and the UK. Both meetings aimed to:

- Investigate the possibility for further harmonisation of dispersant tests in Europe, and
- Explore options for developing a guidance document on minimum standards for dispersant test methods, in particular for those countries which do not have dispersant test procedures in place.

8.7 The conclusions from these two meetings of the TCG Dispersants Group were that:

- Further diversification of test methods for dispersant approval in Europe should be avoided;
- Under the framework of the TCG Dispersants Group, harmonisation of existing tests it not achievable at this time, due to the fundamental differences in the current approaches to the dispersants' tests;
- It is also not possible to define minimum standards for the test procedures for dispersant approval in the EU/EFTA area, due primarily to the fundamental differences in the current approaches to the dispersants' tests. Furthermore, there was no agreement to change or adapt existing procedures in place or to identify commonly acceptable minimum test standards for use by other countries. The platform or basis to develop a guidance document at EU level on this issue under the framework of the TCG Dispersants Group currently does not exist.

9. Concluding remarks

9.1 The TCG Dispersants group, as established in 2012 under the CTG MPPR framework, was tasked to address issues linked to the use of oil spill dispersants in Europe. One of its tasks was to explore options towards a more harmonised approach of performing test procedures for dispersant product approval in Europe. As per the Group's Terms of Reference, this task was to be implemented by:

- Updating this Overview Paper describing the current tests in place in Europe, and
- Exploring with the European dispersant experts in this group if and how further diversification of test procedures could be avoided. To this effect it was discussed among the TCG group to develop a guidance document, which based on the experience of the UK, France and Norway with such tests, would identify commonly acceptable minimum test standards for use by other countries, which do not have such tests in place.

9.2 The outcome of the discussions among the TCG group is that further harmonisation is not achievable for the time being, even if the countries agree that further diversification of such tests should be avoided.While there is no requirement for the existing and long-established tests in France, Norway and the UK to change, it seems difficult to agree on any guidelines or recommendations on minimum standards for such tests, since each country has developed these over many years and only accepts its own test requirements.

9.3 Consequently, this Overview Paper has been updated by the Group **for information purposes**, to achieve a good understanding of the test procedures currently in place, their requirements and key principles behind each of them. In particular, it is important to understand how each test differs and the rationale why each procedure is selected by these three countries. Furthermore, some observations and comments on each test procedure, as provided by the TCG members are also included in this Paper.

9.4 This information is relevant, since several of the other EU countries are not performing their own testing, but use existing test results, often performed in neighbouring countries and accept the use of products approved in other EU countries. For these countries which are developing new test procedures or consider revising existing test procedures it is important to have this information, which has been provided by the Group as complete and as transparent as possible. It is the Group's intention, that this information will enable the other countries to better understand the current tests in place and accordingly to facilitate the national decision making of how to proceed regarding developing or revising their own dispersant testing procedures.

9.5 The paper presents how the dispersant effectiveness and toxicity testing is performed in the EU/EEA countries; in total 6 of the countries have tests in place. The procedures are described quite thoroughly for the three countries having most experience with such tests (France, Norway and the UK), while an overview of the tests in Italy, Greece and Spain is also annexed (Annex 1). While the described test procedures are performed differently, a lot of similarities also exist. EMSA encourages the prior review of the existing tests in the EU/EEA countries presented in the Paper when (and if) new test procedures are to be introduced by a country, in order to gain from the experience and expertise in place and make efficient use of valuable human and financial resources.

9.6 While the tests performed in the laboratories do not represent realistic conditions at the field, most countries share the same concerns when testing dispersants and the laboratory testing with the same or similar conditions enables the comparison and ranking of dispersants. However, the development of new and improved test methods should continue and should be based on the experience gained from existing methods.

9.7 From the work of the TCG Dispersants Group in implementing this task, the following **concluding remarks** can be made with regard to dispersant product approval testing in Europe:

- **Dispersant effectiveness testing:** The approaches towards dispersant effectiveness testing are more similar across Europe. There is general agreement that it should be carried out on relevant oil(s) and the viscosity of the test oil(s) should be carefully considered. Test oils from 500 to 8000 cP are usually used, and Norway is the only country which performs effectiveness tests also on weathered oils. The energy used in the effectiveness tests is of importance; the low energy test (such as the IFP) is more representative of normal field conditions than the high energy test (such as the WSL) and may be more relevant with regard to the efficiency in the field.

On the other hand, the high energy tests are easier to perform in the laboratory. The different brands of dispersants have a different efficiency on weathered oil, which should also be considered at some point

- **Dispersant toxicity testing:** The toxicity tests are performed differently and with different test organisms. Countries often aim to select a commonly used test organism that is easily available and preferably described in the OSPAR Convention. The fundamental difference in the toxicity tests performed in Europe today is that the UK tests the toxicity of the oil/dispersant mixture, with the rationale that dispersant and oil is always used together in operations. France Norway, Spain, Italy and Greece test the toxicity of the dispersant alone, which makes it easier to assess the toxicity of the dispersants used and to separate between the different brands of dispersant. The toxicity tests performed in the laboratory will not necessarily simulate the exposure a marine organism would experience if the dispersants were used in an incident at sea, since in the laboratory the concentration is relatively high and the duration of exposure long. While it is clear to all stakeholders that the impacts of dispersed oil on the environment must be addressed, it is often argued that this discussion should be separated from the initial product approval process. Some countries prefer to assess the environmental impacts of using dispersants under more realistic field conditions. Generally, it is accepted that the toxicity of dispersed oil is much higher than the toxicity of approved dispersants. The use of 3D modelling that predicts oil drift and toxicity (based on bio-assay studies and realistic exposure of dispersant) is useful for the decision of the most appropriate counter pollution measures. Such information is not directly linked to approval procedures, but is useful / needed for contingency planning and to assess the environmental impacts of using dispersants. This difference in toxicity testing will probably remain in the future as the mentioned countries have strong national support of the existing tests in place.
- **Dispersant biodegradability testing**: France, Spain, Greece and Italy are currently performing biodegradability tests to the dispersant products linked to the approval process. The dispersant is considered as a whole (surfactant and solvent) and the test is done to check that the dispersant does not inhibit the biodegradation of the oil. As mentioned in Chapter 5.1.4, France is considering abandoning this test. However, some experts believe that this test is important as a dispersant with low toxicity and high biodegradability would be preferable to a dispersant with low toxicity and low biodegradability. It should also be noted that intermediate degraded products could be more toxic than then original dispersant substance. Norway and the UK do not perform biodegradability tests in the product approval phase.
- **Test results**: The actual test results are not public information, due to often small differences in test results and in order to avoid confusion for the users. Most countries present only a list of dispersants passing the tests. The test results refer to results in laboratories and do not reflect all the variables at a real oil spill. It is clearly not possible to test for the potential effects of exposure to dispersed oil for all the different oil types that might be spilled, for all relevant organisms and all conceivable weather and current situations, so this approach can only provide approximate guidance.
- **Subsea dispersant testing**: So far, no country in Europe has introduced specific procedures for approval of dispersants used for subsea application/SubSea Dispersant Injection (SSDI). A lot ofresearch is going on in this field, and additional criteria might be introduced in the future. Marine life in deep water will be more exposed when subsea dispersants are used. The environmental impact studies and monitoring after the use of subsea dispersants will for sure be of special concern.

9.8 EMSA encourages further work on harmonisation of dispersant test procedures in Europe, even if it cannot be achieved for the time being. At least, large deviations from the existing test protocols should be avoided.

9.9 The aim remains that the test procedures will be further discussed and involve cooperation among European countries. Transparent test procedures are important in this matter, as an oil spill might easily involve several countries. The approval processes and the use of the dispersants are linked, even if the processes often are treated separately. EMSA has annexed to this Paper some examples of “decision trees” for operational use of dispersants, which provide useful information.

9.10 This Paper is intended for information purposes and will be published on EMSA’s website in 2016.

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Effectiveness test

Country	Type of test & test protocol	Objective(s)	Test Oil used	Dispersant type & DOR	Test duration	Number of tests	Threshold(s)
France	Low energy test, Institut Français du Pétrole (**IFP**) with continuous seawater inflow / dilution, with a submerged beater-ring (vertical oscillation) [French standard NF.T.90-345	Objective: selecting efficient dispersants for the emergency stockpiles. The test method selects dispersants which keep efficient at low energy. The testing equipment is a flow through test (continuous dilution). designed to mimic the open ocean. *Note: however the effectiveness measured in laboratory for standard conditions does not reflect necessarily the operational effectiveness of the product in real use	One reference oil: Arabian light crude, mixed with heavy fuel oil, 1000cP viscosity. The French Navy requires an additional effectiveness test, a more viscous oil, 8000 cP, is used.	Dispersant (neat concentrated / type 3) applied on the top, DOR = 5% (1:20)	1 hour	2 tests if results keep in the confidence interval [+-3], possibly 3 tests.	Amount of dispersed oil collected at bottom & quality of dispersion tested should be 60% of what would have been collected in the same conditions with a pure soluble compound (instead of oil and dispersant mixture).
Norway	**(a)** For entities producing / processing oil: Low energy test (**IFP**) with continuous seawater inflow / dilution, with a submerged beater-ring (vertical oscillation); the IFP test is used in combination with the high energy **MNS** test, to test the oil's dispersibility at varying weathering degrees for the relevant oil in order to predict the "time window" for effective use of dispersants under various turbulence conditions. In this test the air-flow above the surface generates an acute mixing and circular wave corresponding to "medium energy" breaking wave conditions. Samples of the dispersed oil are taken and the product effectiveness is checked. **(b)**For entities that do not produce or process oil, the Warren Spring Laboratory (**WSL**) test is used , which is a relatively "high energy test" using rotating flasks that cause the dispersant-treated oil and water to thoroughly mix. The test aims to assess the proportion of the total volume of treated oil that is dispersed into the water column.	Compare products and select the most effective dispersants, the dosage ratios required and the "time window" for use of dispersants for the relevant oils	**(a)** For entities producing/processing oil: Different test oils are used, depending on each entity. However, the specific test oil in question is a synthetically weathered emulsion (e.g. 200ºC+/50% water). **(b)**For entities that do not produce or process oil, four different reference test oils are used in the WSL tests, on varying weathering levels and two different salinities: 1. Sture Blend 200ºC/50% synthetically weathered emulsion 10ºC, 3,5% salinity. 2. Medium Fuel Oil (2000cP at 10ºC) 10ºC, 3,5% salinity. 3. Sture Blend 200ºC/50% synthetically weathered emulsion 10ºC, 0,5% salinity 4. IFO 180 10ºC, 3,5% salinity. Tests 1 and 2 above shall be run for all the products, while the third test is only needed if there are plans to use the dispersant product in low salinity.	DOR: 1:25	IFP: 1 hour mixing / dilution time MNS: 5 min mixing time WSL: 2 min. mixing time, 1 min settling time	2 parallel tests for each product. A third parallel is carried out if large deviation in the two first parallel. Leave out then the "outlayer".	No specific threshold exists, as different oils are tested.
United Kingdom	Warren Spring Laboratory (**WSL**) test is used , which is a relatively "high energy test" using rotating flasks that cause the dispersant-treated oil and water to thoroughly mix [LR 448 WSL].	To assess the proportion of the total volume of treated oil that is dispersed into the water column. (While two reference oils are used, comparing the effectiveness results between the two, the core oil for the pass or fail decision is the heavier fuel oil with 2000cP).	Two reference tests oils are used: medium fuel oils with viscosities of 500cP and 2000cP at 10ºC (the test temperature).	DOR = between 1:20 and 1:30	All reagents in fridge for 24 hrs prior to test. Rotating flask test 5-6 mins. Then chloro extraction x 2 which could take	Effectiveness index is determined by the average of 3 determinations.	Depends on the type of dispersant being tested: - Type 1 (hydrocarbon solvent-based dispersant applied undiluted) and Type 2 (concentrates diluted 1:10 with seawater before application) must achieve an effectiveness of 30%. - Type 3 (high effectiveness concentrates applied undiluted) must achieve an effectiveness of

Effectiveness test							
Country	Type of test & test protocol	Objective(s)	Test Oil used	Dispersant type & DOR	Test duration	Number of tests	Threshold(s)
					20 mins. In all less than one hour for each of 3 tests.		60%. The threshold of 60% means that 60% of the oil must be dispersed in the water column for the product to pass.
Spain	Evaluation of potential effectiveness of a dispersant. Test based on the 'Swirling Flask Dispersant Effectiveness Test' (EPA, 2003), but using manual agitation and establishing different agitation and settling times (Spanish Standard UNE 77101:2014	The test evaluates the effectiveness of the dispersant products available in the market. The aim of the test is to measure the effectiveness facilitating the best mixture of the oil and the dispersant by providing an energetic manual shaking. The new regulations for dispersants are currently being developed by the Maritime Authority and will include the Spanish Standard effectiveness test in the dispersant approval process. The selected demands little calibration compare to other effectiveness tests.	Reference crude oil (density at 15ºC>0,84 g/ml and viscosity at 15ºC>14cP) Two test oils: South Louisiana and Proudhoe Bay The low viscosity of test oils enables an easy mixing of oil and dispersants.	DOR = 1:11	2 minutes of manual shaking and 10 minutes of settling.	4 tests are used to calculate the average capacity of the crude oil to be dispersed, both naturally and chemically.	The potential effectiveness of a dispersant must be over 50%. The potential effectiveness is calculated as the difference between the capacity of a crude oil to be dispersed in seawater when dispersed chemically and when dispersed naturally by manual shacking.
Greece	Type of test: WSL test LR 448 (OP) Annex II of Ministerial Decision No 5219/F.11.4.2000 (Government Gazette 455/B/4.4.2000). Test protocol: The oil spill dispersant is mixed with reference fuel oil and synthetic sea water in a conical flask. Circumvolution of the flask for 120 sec to prepare a representative mixture of reference fuel oil-sea water-dispersant. The quantity of reference fuel oil in a sample of this mixture is determined by spectrophotometry.	Selecting of efficient dispersants with low toxicity.	Two reference fuel oils are used: 1st: dynamic viscosity at 10°C 1800-2200 mPa s at 4s-1 shear asphaltenes (IP 143/78): max 6,0%w/w pour point (IP 1567):<5°C. 2nd: dynamic viscosity at 10ºC 450-550 mPa s at 4s-1 shear. The 1st reference oil is diluted by kerosene to deliver the 2nd.	DOR = 1:25 for 3rd generation dispersant - type 3. DOR = 1:2,5 for 3rd generation dispersant – type 2.	Less than 1 hour for each of the three tests	The effectiveness index is the average of 3 separate determinations.	3rd generation type 2 dispersants: - 30 % minimum for 2000 mPa s fuel oil 3rd generation type 3 dispersants: -60% minimum for 2000 mPa s fuel oil -45% minimum for 500 mPa s fuel oil.
Italy	National Decree 25/02/2011 Modified by the Decree 3/02/2014 A mixed solution of oil and dispersant is prepared and manually shaken for 2 min. Total hydrocarbons are measured according to the method UNI EN ISO 9377-2-2002 water quality - determination of hydrocarbon oil index - method using solvent extraction and gas chromatography.	The effectiveness of the dispersant is determined in terms of suspended and emulsified oil after the addition of the product in standardized conditions of shaking.	Arabian light crude– Viscosity 14 cSt at 15°C	There is no specific indication of the type of dispersant addressed by the DD 2011 DOR = 1:10	2 minutes of manual shaking.	1 test with 1 control + 3 replicates.	The product must disperse at least 60% of oil.

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Toxicity test

Country	Test dispersed oil or only the dispersant	Oil type	Type of test & test protocol	Test Organism(s)	Test duration / exposure time	Number of tests	Threshold(s)	Objective(s)	Included in OSPAR Guidelines
France	Only dispersant product is tested for toxicity	Not pertinent as the test is completed on dispersant alone	Simple LC_{50} test (lethal acute toxicity) test. [French standard NF.T.90-349]	White shrimps (*Paleomonetes varians*)	The shrimps are exposed for 6 hours (tidal duration) followed by 24 hours recuperation time in clean waters, to see the mortality rate.	A large range of concentration (around 10 increasing concentrations)	The dispersant toxicity must be at least ten times lower than the toxicity of a reference toxicant (a cationic surfactant Noramium DA50) tested in the same conditions and on the same batch of shrimp as the dispersant.	This procedure compares the results of the dispersant test with those of a reference toxicant and intends to avoid any seasonal variation of sensibility of the test organisms.	No
Norway	Only dispersant product is tested for toxicity	No test-oil used	Simple EC50 test (measuring acute toxicity as the concentration(mg/l) inhibiting the growth of the algae by 50%. [Test procedure described in ISO/DIS 10253]	Planktonic algae (*Skeletonema costatum*)	Test temperature: 20 deg C . Exposure time: 72 h	Three replicates	The dispersant is not approved if it has a median effective concentration EC_{50} < 10mg/l (pass/fail test)	This is an acute toxicity on a relevant pelagisk organism. Pass and fail test. The aim is to avoid that new products coming on the market have not a significant higher acute toxicity than "well-known" dispersants that have previously undergone and documented toxicity / bio-assay testing in the laboratory or in the field.	Yes. The measurement determines the acute toxicity of the "whole" dispersant" (not "single component" test.
United Kingdom	The dispersed oil is tested for toxicity	The test oil used in both toxicity tests is the Kuwait crude (a medium crude oil relatively high in BTEX)	a) **Sea Test** (compulsory): Oil is treated with dispersant (at a DOR of 1:10) and is mechanically dispersed by two shielded propellers rotating at 800rpm. b) **Rocky Shore Test**: The common limpet is exposed to either oil or the test product (i.e. dispersant alone – or oil and product) on Perspex plates (This test is no longer compulsory for offshore products).	a) Brown shrimp (*Crangon crangon*) b) Common limpet (*Patella vulgata*)	a) The brown shrimp are exposed to dispersed oil at 100ppm concentration in the water for 100 minutes followed by a 24 hour recovery period in clean flowing seawater. b) Limpets are left exposed on the plates, in a moist controlled environment, for 6 hours before being rinsed with clean seawater and the plates suspended in recovery tanks of clean flowing seawater. The limpets are monitored for mortality and loss of adhesion to the plate for a further 72 hours (including a daily period of 6 hours air exposure to represent tidal conditions). Five replicates of each treatment are conducted and the test assessment is based on a statistical comparison of limpet 'mortality' between the exposure types.	a) Five replicates each of a 'treated' exposure (oil + product) and a control or 'non-treated' (oil only) are conducted simultaneously. b) Five replicates of each treatment are conducted.	a)Mean % mortality of the treatment must not be >20% above that of the controls. Borderline results require a retest. Statistical significance ($p<0.05$) between treatment and controls is also taken account of. b) As above.	a) This test compares the relative toxicity of an oil-dispersant mix to that of oil alone. The test assessment is based on a statistical comparison of shrimp mortality between the two exposure types. b) The test assessment is based on a statistical comparison of limpet 'mortality' between the exposure types.	No

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Toxicity test

Country	Test dispersed oil or only the dispersant	Oil type	Type of test & test protocol	Test Organism(s)	Test duration / exposure time	Number of tests	Threshold(s)	Objective(s)	Included in OSPAR Guidelines
Spain	Only dispersant product is tested for toxicity	No test-oil used	Various toxicity test protocols: 1) LC50 test, determining the dispersant toxicity based on ASTM Standard Guide E1440-91 (Spanish Standard UNE 77106:2014) 2) LC50 test determining the dispersant toxicity (UNE-EN ISO 11348-3 of 2009) 3) LC50 test determining the dispersant toxicity based on the French standard NF.T.90-349 (Spanish Standard UNE 77105:2014	1) Marine rotifer *Brachionus plicatilis* 2) Bioluminescent bacterium *Vibrio Fisheri* *3) Crustaceans Palaemon serratus and Palaemon elegans*	1) Marine rotifers are exposed for 24 hours to different concentrations of dispersant 2) Bacteria are exposed for 30 min to different concentrations of dispersant 3) Crustaceans are exposed for 6 hours followed by 24 hours recuperation time in clean waters, to different concentrations of dispersant.	1) range of 5 different concentrations of dispersant 2) 3 tests, each with a range of 9 different concentrations 3) range of 4 different concentrations	1) Negative result: After 24h CL_{50} must be higher than100mg/l. 2) Negative result: After 30 minutes CL_{50} must be higher than100mg/l. 3) The dispersant toxicity must be at least ten times lower than the toxicity of a reference toxicant (benzalkonium chloride) tested in the same conditions.	This method consisting in several tests evaluates the toxicity of the dispersants available in the market. The dispersant is considered non-toxic if the results for either test 1 or test 2 are negative. If not, test 3 must be performed considering the fixed threshold. This two phase method determines if the dispersant is non-toxic. The new regulations for dispersants are currently being developed by the Maritime Authority and will include these tests in the dispersant approval process.	No
Greece	Only the dispersant is tested for toxicity	Not pertinent as the test is completed on dispersant alone	Ministerial Decree No 5219 (2000) ANNEX III	1) Microscopic Organisms (*Artemia, Brachionous, Acartia*) 2) Shrimps (Species Palaemon)	1) Microscopic Organisms: Concentration of dispersant-sea water mixtures: 0,001%-0,01% - 0,1% - 1% - 10% 10 ml of every mixture is used - 24 hours (at 25 °C) 2) Shrimps: Concentration of dispersant-sea water mixtures: 0,01% - 0,1% - 10% 3 litres of mixture is added in 4 litres of sea water - 48 hours (at 15 °C)	Five increasing concentrations	1) Microscopic Organisms: EC_{50} or LC_{50} (24 hours) > 100 ppm 2) Shrimps: EC_{50} or LC_{50} (48 hours) > 10.000 ppm	It intends to avoid permission of using dispersants that its EC_{50} or LC_{50} is below 100 ppm	No
Italy			Various toxicity test protocols for algae, crustaceans and fish are used. -EC50 test on algal	**1. Diatoms:** *Skeletonema costatum, Phaeodactylum tricornutum*	Test duration varies according to test species and protocol, as previously specified .	One for each trophic level, so at least 3 tests.	1. EC_{50} > 10mg/l 2. EC_{50} > 10mg/l 3. EC_{50} > 10mg/l	Evaluation of toxicity of the dispersant product for three different trophic levels: algae, crustaceans and fish.	Toxicity tests for algae in the OSPAR guidelines are the same

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Toxicity test

Country	Test dispersed oil or only the dispersant	Oil type	Type of test & test protocol	Test Organism(s)	Test duration / exposure time	Number of tests	Threshold(s)	Objective(s)	Included in OSPAR Guidelines
	Only the dispersant product is tested for toxicity	No test oil used	growth inhibition at 72h according to UNI EN ISO 10253:2006, AND; -EC50 at 48h for the crustacean *Acartia tonsa* according to UNICHIM pr MU 2365 (2010), OR -EC50 at 96h for the crustacean *Artemia franciscana* according to APAT-IRSA-CNR 8060 (2003), OR -EC50 at 48h for the crustacean *Amphibalanus amphitrite* according to UNICHIM pr MU 2245 (2010), OR -EC50 at 96h for the crustacean *Corophium orientale* according to UNICHIM pr MU 2246 (2010), OR EC50 at 96h for the crustacean *Tigriopus fulvus* according to UNICHIM pr MU 2396 (2010), AND -EC50 at 96h for the fish *Dicentrarchus labrax* or *Sparus aurata* according to OECD n. 203 (1992).	2. **Crustacean**: *Acartia tonsa* *Artemia franciscana* *Amphibalanus amphitrite* *Corophium orientale* *Tigriopus fulvus* 3. **Fish**: *Dicentrarchus labrax, Sparus aurata*					as those used in Italy, but not the tests for crustaceans and fish.

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Biodegradability test		Re-test/checking of stockpiles
Country	**Specification of test(s), if performed**	**Type of tests, thresholds(s) and frequencies of tests**
France	[French standard NFT90-346]. The test assesses the dispersant's biodegradability in 28 days by measuring how much carbon dioxide (CO2) has been produced. The dispersant is considered as a whole (surfactant and solvent) and its biodegradability should be at least 50% of the non-evaporable fraction (fraction which is not stripped during the test by the bubbling of CO2 in the flasks).	The operational stockpiles are subjected to periodic quality controls, physical parameters and effectiveness tests (IFP tests) are performed every five years.
Norway	N/A	In the guidelines to the Regulations are recommendations to the enterprice responsible of the stockpiles for retesting the products in stock. As a general rule: dispersant stored in original containers are tested every 5 year. For dispersant in tanks on response vessel: is going to be tested every 3 year. Test parameters are: Visual observations (colouring, transparance, precipitation, viscosity, density, effectiveness (same criteria as the screening test, effectiveness minimum 2/3 of the original dispersant effectiveness test result using the IFP test).
United Kingdom	N/A	Effectiveness tests (WSR test) required on one sample of each batch of dispersant 10 years after manufacture and while container remains unopened. Then every 5 years. If opened then every 5 years thereafter.
Spain	Evaluation of the biodegradability of dispersants under the action of aerobic microorganisms. For 28 days the biological oxygen demand (BOD) is measured in a manometric respirometer. The dispersant's biodegradability must be over 50%. (Spanish Standard UNE 77103:2014)	Currently, there are in place Spanish standards for effectiveness, toxicity and biodegradability tests for dispersants. The Spanish Maritime Administration is currently working on new regulations for approving dispersants, including the frequencies of re-test of dispersants.
Greece	French standard NF T 90 346 (as above) 50% minimum	The Ministerial Decision No 5219/F.11.4.2000 (Government Gazette 455/B/4.4.2000) foresees that re-check is performed whenever needed. The WSL test is used when re-check is performed.
Italy	"Closed bottle" method OECD n. 306 (17 July 1992). All the product's components shall be biodegradable with an oxygendepletion greater than 60% of the ThOD.	The approval granted by the Italian Ministry of the environment land and sea is valid for 5 years and it can be renewed for further 5 years if the composition of the product remains identical. Re-test is required if even one single component of the product has been changed.

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Annex 2. Further Information

Guidance documents, hyper links, comments etc.

France	List to approved dispersants, which fulfil acceptance criteria for effectiveness, toxicity and biodegradability according to French standards: http://wwz.cedre.fr/en/content/download/3070/32680/file/dispersants_sea_gb.pdf
Norway	Norwegian regulation for use of dispersants: http://www.miljodirektoratet.no/no/Regelverk/Forskrifter/Regulations-relating-to-pollution-control-Pollution-Regulations/Chapter-19-The-composition-and-use-of-dispersants-and-shoreline-cleaning-agents-to-combat-oil-pollution/ The Norwegian Control Form and Decision Matrix: http://www.kystverket.no/Documents/Beredskap/Skjemaer/Kontroll-%20og%20beslutningsskjema%20for%20bruk%20av%20dispergeringsmidler%20(inkl%20veiledning).doc
United Kingdom	Link to approved oil spill treatment products: https://www.gov.uk/government/publications/approved-oil-spill-treatment-products Protocols for effectiveness- and toxicity testing: http://www.marinemanagement.org.uk/protecting/pollution/documents/approval_lr448.pdf
Spain	The Maritime Authority maintains an updated list of approved dispersants considering the effectiveness, toxicity and biodegradability tests performed in other countries. The new regulations for dispersants are currently being developed by the Maritime Authority and will consider the Spanish Standards for effectiveness, toxicity and biodegradability tests in the dispersant approval process.The legislation is not yet in place, but the standards used for testing will be the following: UNE 77101:2014 Evaluation of the potential efficacy of oil dispersants in marine environment. Dispersants efficiency test (2014-02-05) UNE 77103:2014 Evaluation of biodegradability of dispersants and bioremediation agents by determination of biological oxygen demand in a manometric respirometer (2014-05-07) UNE 77104:2014 Bioassay for the characterization of the ecotoxicity of oil pollution response products by the bioluminescent bacterium Vibrio fischeri (2014-05-07) UNE 77105:2014 Bioassay for the characterization of the ecotoxicity of dispersants by the crustacean species Palaemon serratus or Palaemon elegans (2014-05-07) UNE 77106:2014 Bioassay for the characterization of the ecotoxicity of dispersants by the marine rotifer Brachionus plicatilis (2014-05-07)
Greece	According to Ministerial Decision No 5219/F.11.4.2000 (Government Gazette 455/B/4.4.2000): - the use of 1st generation oil spill dispersants is banned - the use of 2 nd generation oil spill dispersants was allowed until 31.12.2003 and only if they complied with the provisions of Ministerial Decision No 5219/F.11.4.2000 - the use of 3rd generation oil spill dispersants is allowed. Information for oil spill dispersants, national legislation and approval procedure in Greece: http://www.gcsl.gr/index.asp?a_id=289&txt=y&show_sub=1
Italy	The approval procedure is carried out according to the Italian Decree D.D. 25.2.2011. The list of approved products and other information can be found on the WEB Site of the Italian Ministry of the environment land and sea: http://www.sidimar.tutelamare.it/tutelaEcosistemiMarini.do
Other	IPIECA report from December 2014: "Regulatory approval of dispersant products and authorization for their use". http://www.ipieca.org/ (go to Library & select "oil spill preparedness")

Annex 3. Decision trees for the use of dispersants

This Annex includes:

1. **The Norwegian Control Form and Decision Matrix**
2. **The UK decision tree**
3. **French operational guide on dispersant use**
4. **Decision tree for the Dutch Caribbean**
5. **Decision tree, IMO Dispersant Guidelines**

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1. The Norwegian Control Form and Decision Matrix (3 pages)

Provided by the Norwegian Environment Agency

Dato: 31.01.14

Unofficial translation **Use of dispersants at sea: control form**

KYSTVERKET

From (name of company etc):	Email:
Contact person(s):	Telephone:

Filled out forms should be sent to the Norwegian Coastal Administration, Department for Emergency Response.
24-hour hotline: +47 33 03 49 00, Fax: +47 33 03 49 49, email vakt@kystverket.no.

If your company's emergency response plan as approved by the Norwegian Environment Agency does not include use of dispersants, you must apply for a permit from the Norwegian Coastal Administration before any such use. In such cases, filling out and submitting both the control form and the decision matrix (compiled by the Norwegian Environment Agency and the Norwegian Coastal Administration) constitutes applying for a permit.

If your company's emergency response plan does include use of dispersants, it is not necessary to apply for such use. The control form must however be filled out and submitted to the Norwegian Coastal Administration as soon as possible. (The decision matrix may be submitted at a later time.)

Is dispersant use included in the emergency response plan? If yes, send in the control form as soon as possible	YES	NO
Are you applying for a permit to use dispersants? If yes, send in both the control form and the decision matrix as soon as possible	YES	NO

Information on the incident:

Provide as much information as possible given the circumstances.

1.	**Time and date of spill, start and duration**						
2	**Position of the spill** Latitude, longitude, placename	N		E			
3.	**Source of spill** (name of vessel, installation, etc.)						
4.	**Description of spill** (oil type, surface/water column/seabed, presence of gas). Has release been stopped?						
5.	**Estimated size of spill (m³):** Tick a box or fill in quantity	< 10 m³	10 – 100 m³	100 – 500 m³	500 – 1000 m³	1000 – 5000 m³	> 5000 m³
6.	**Estimated area of slick** (total area) If possible, give % of area covered by each category defined in the Bonn Agreement Oil Appearance Code or detectable using FLIR IR camera	km x km = km²					
		Sheen	Rainbow	Metallic	True colours	IR detectable	
7.	**Current weather conditions and wind forecast for next 24 hours**	Temp (°C) Sea Air	Wind Speed m/s	Direction	Rising/ falling?	Wave height (significant)	
8.	**Visibility and light conditions**	Cloud base: (m)	Horizontal visibility (m)		Daylight (from – to)		
9.	**Application method and quantity/type of dispersant to be used**						

Doe the decision matrix show that :

I. **Dispersant use will give less overall environmental damage than taking no action or mechanical recovery?**
Yes ..... / No..... (tick one)

II. **The operational conditions are suitable for dispersant use?**
Yes ..... / No..... (tick one)

Updated 2014

KYSTVERKET

Use of dispersants at sea:decision matrix

I	**Will dispersant use give less overall environmental damage than taking no action or mechanical recovery?** *Fill out points 1 – 4 before answering question I (tick the appropriate box)*	YES	NO
II	**Are the operational conditions suitable for dispersant use?** *Fill out points 5 – 12 before answering question II (tick the appropriate box)*	YES	NO

Criterion		Basis for evaluation Effectiveness codes: A – Dispersant use will be very effective B – Dispersant use will be effective/of limited use. Further assessment by experts needed C – Dispersants should not be used If A or B options are selected for all points below, dispersant use is considered to be suitable. (Dispersants should not be used if option C is selected in any case)	Effectiveness Select one of the A, B or C options for each criterion	Comments See the guidelines below for further details. This column can be used to provide information on how the effectiveness code for each criterion has been chosen.
Potential environmental damage/exposure (points 1-4):				
1	Slick lifetime on sea surface	A: Lifetime on surface > 24 hours B: Lifetime on surface: < 24 hours C: Lifetime on surface: < 5 hours		
2	Natural resources in possible trajectories	A: Large seabird concentrations or priority shoreline locations along the trajectory, but low density of eggs and larvae (spawning products) in the water column B: High densities of both seabirds and spawning products C: High density of spawning products, few seabirds		
3	Water depth, distance to shore	A: Depth > 20 m, distance to shore > 200m B_1: Depth < 20 m, distance to shore > 200m B_2: Conditions in A and B_1 not met, but dispersant use indicated for other reasons (e.g. presence of seabirds, wind or current direction) C: Conditions in A, B_1 and B_2 not met		
4	How likely is stranding if dispersants are used?	A: Stranding of surface oil emulsion can be prevented B_1: Stranding of surface oil emulsion can be considerably reduced B_2: Treated oil may strand on moderate- to high-energy shoreline C: Treated oil will strand on low-energy shoreline or sandy beach		
Operational conditions (points 5 – 12):				
5	Chemical dispersibility of oil slick	A: Dispersible at planned time of dispersant application B: Dispersibility will be limited at planned time of dispersant application C: Not dispersible at planned time of dispersant application		
6	Wind conditions	A: Wind speed next 24 h < 15 m/s B: Wind speed next 24 h >15 and < 20 m/s C: Wind speed next 24 h < 2 or > 20 m/s		
7	Application strategy	A_1: From helicopter using FLIR camera with option of visual observation A_2: From plane with aerial guidance A_3: From vessel with aerial guidance and downlink of FLIR data B: From vessel without aerial guidance (vessel's radar/IR camera as only support)		
8	Operations in the dark	B: From vessel with aerial guidance and downlink of FLIR data C_1: From vessel without aerial guidance or downlink C_2: From helicopter or plane only		

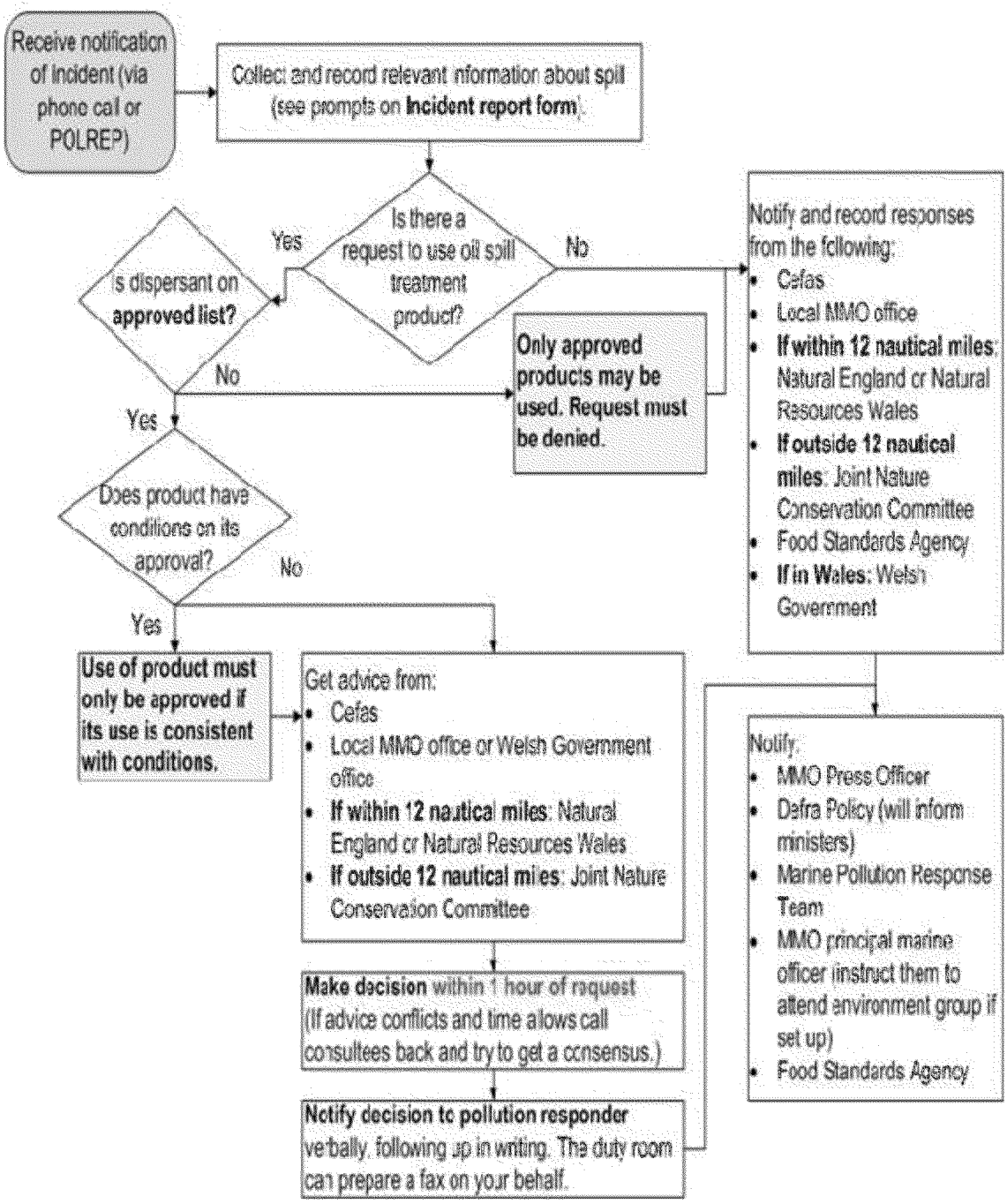
Updated 2014

9	**Application capacity**	A_1: B_1: B_2: C	Sufficient application capacity and dispersant available quickly enough to treat entire slick during time window for dispersant use Sufficient application capacity and dispersant to treat a substantial part or priority areas of the slick Sufficient application capacity and dispersant available, but not until oil has become less dispersible Dispersant spraying equipment not available within time window for dispersant use	
10	**Salinity**	A_1: A_2: B C	Dispersant to be used in open sea or coastal water of normal salinity Dispersant to be used in brackish water. Dispersant available is documented to be effective at low salinity Dispersant to be used in brackish water. Only marine dispersant available Dispersant to be used in freshwater (lake/river)	
11	**Remote sensing/ monitoring**	A B C	Remote sensing and monitoring possible Remote sensing or monitoring possible Neither remote sensing nor monitoring possible	
12	**Quantification and monitoring before dispersant operation is concluded**	A B_1 B_2 C	Remaining surface oil can be quantified from plane or helicopter and properties and dispersibility of surface oil can be monitored Oil concentration below surface can be measured by UVF, analysis of remaining surface oil Aerial monitoring Remaining surface oil cannot be quantified	

A guideline for filling out the Norwegian Decision Matrix is also available (not included in this document).

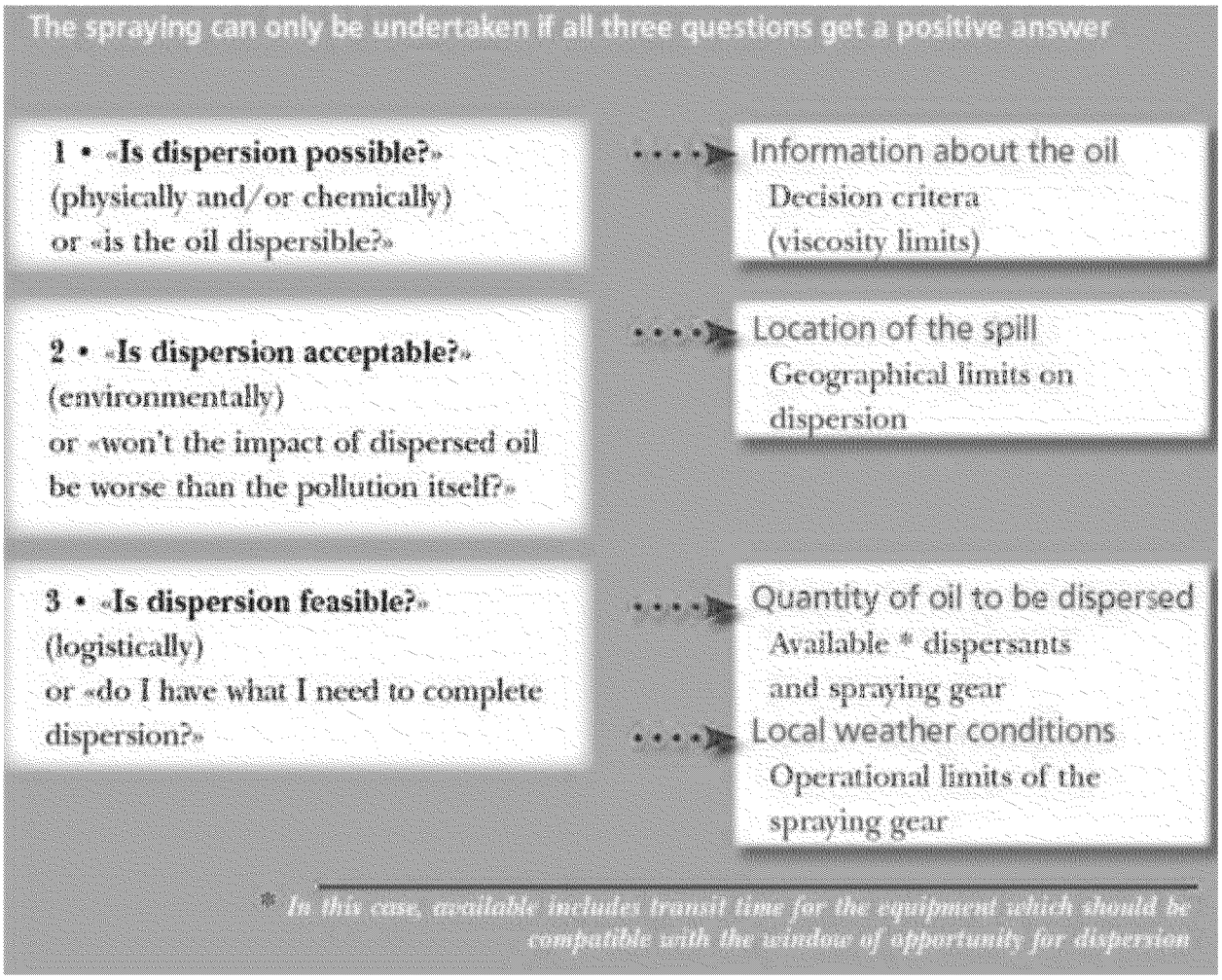
2. The UK decision tree (1 page)

Provided by the MCA



3. French operational guide on dispersant use (1 page)

Provided by Cedre



4. Decision tree for the Dutch Caribbean (5 pages)

Rijkswaterstaat
Ministry of Infrastructure and the Environment

Decision tree for the use of dispersants during oil spills in the Dutch Caribbean

National Committee for Environmental Incidents in Water (LCM)

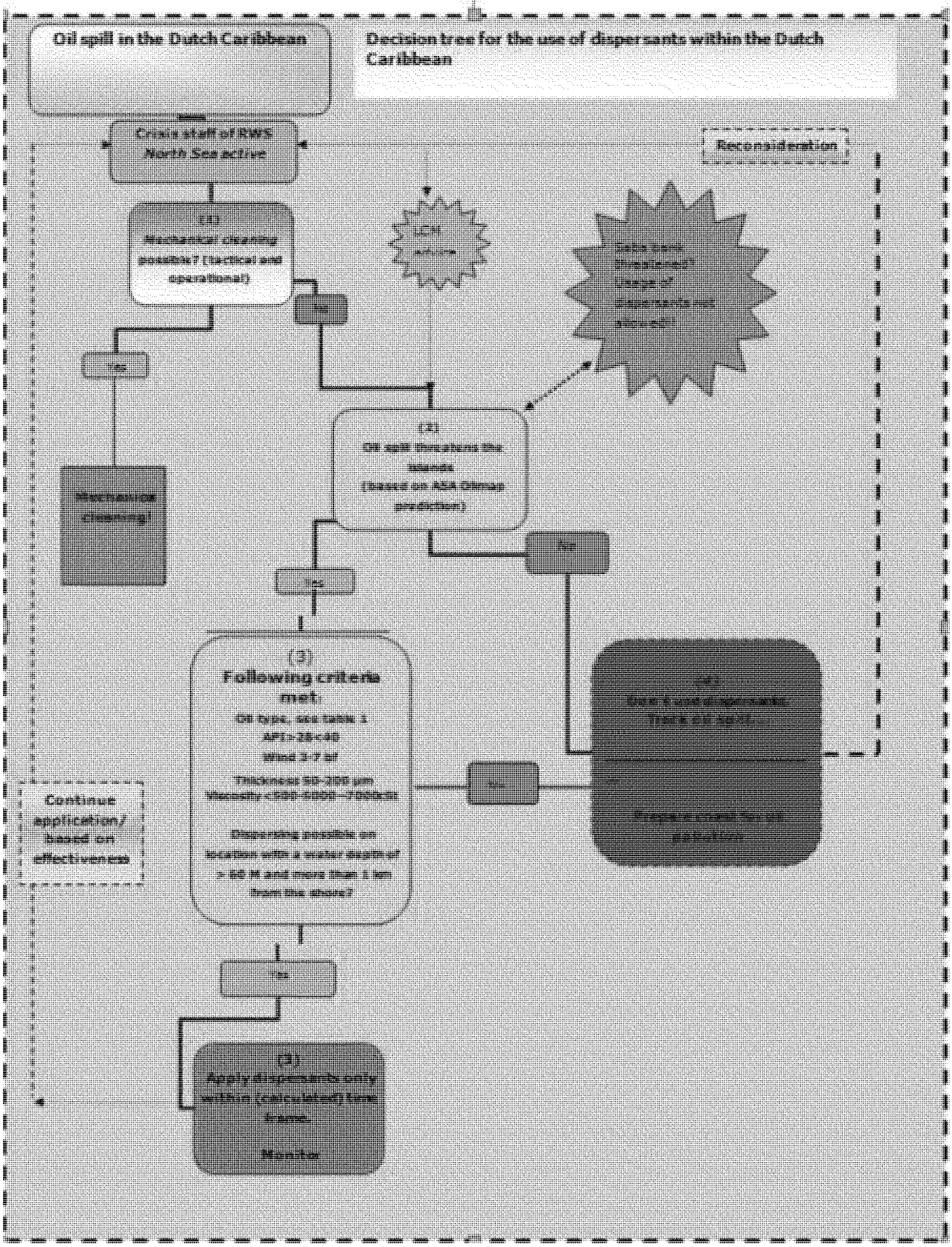
Version: 1.04
Bert van Munster (RWS-VWM)
Serge Rotteveel (RWS-WD)
23 januari 2013

Findings during visit to the Dutch Ceribbean, March 2012

People indicate that dispersants are toxic and therefore should not be used. Indeed, application of dispersants in shallow water may lead to additional damage to the environment. However, this is not caused by the dispersants itself but by the concentration of dispersed oil which may lead to negative environmental effects in shallow water. The toxicity of modern dispersants is low. When the water depth is 20 meters or more the possibility of negative effects in the water is small. The decision tree accounts for this by applying dispersants on locations with a water depth larger than 60 m. This way the concentration of dispersed oil stays limited (<10 ppm). The criterion of application 1 km out of the shallow areas is added to prevent to oil, treated with dispersants, to reach the shallow areas. It is important to realize that the affectivity of dispersants is less than 100% and always a residue remains.

The visit confirmed the basic principles of the decision tree.

For an oil slick that threatens the Saba Bank, based on an ASA oil-map prediction, we propose not to use dispersants. The area is relatively shallow and vulnerable (coral) for dispersed oil.


Oil spill in the Dutch Caribbean
Decision tree for the use of dispersants within the Dutch Caribbean
Crisis staff of RWS North Sea active
Reconsideration
(4) Mechanical cleaning possible? (tactical and operational)
LCM
Yes
No
Mechanical cleaning!
(2) Oil spill threatens the islands (based on ASA Oilmap prediction)
Yes
No
(3) Following criteria met:
Oil type, see table 1
API>28<40
Wind 3-7 bf
Thickness 50-200 µm
Viscosity <500-5000 ~7000cSt
Dispersing possible on location with a water depth of > 60 M and more than 1 km from the shore?
Continue application/ based on effectiveness
Yes
(3) Apply dispersants only within (calculated) time frame.
Monitor

Explanation decision tree Dutch Caribbean

1. **Mechanical cleaning** of oil in the Dutch Caribbean is the preferred option. This is in line with the principles that are used for the North Sea and the Wadden Sea. The area is large. Therefore mechanical cleaning may not always provide a solution. For instance when the means and capacity are not available in time.

2. **ASA-model**: via the ASA-EDS server available information about current and wind is limited, but it is the best there is available in the short term for the Dutch Caribbean. The reliability of the oilmap-predictions is therefore lower than we take into account for the North Sea/ Wadden Sea. This is an important reason that the total coastline of the islands is regarded as vulnerable. With the ASA-model you can have an indication whether it is probable that an oil spill will hit an island. Off course the quality of the prediction improves the more the slick approaches the island. The use of dispersants in this case (close to the island) will usually not outweigh the disadvantages (dispersed oil on land). These improved predictions however are of importance in order to prepare the areas where the oil will come ashore.

3. **Use of dispersants** within the Dutch Caribbean is, based upon effectiveness criteria, applied more often than in the North Sea. A number of factors determine the successful application. In principle, the conditions do not deviate from the Dutch (European) situation. The water depth and the higher temperature are more favourable. The vulnerability of coastal zones (corals, mangroves) for dispersed oil is probably high. Use of dispersants in these areas should be avoided. Also it should be avoided that dispersed oil can reach these areas in high concentrations.

   For safe use of dispersants, it's important to use a water depth in which the dispersed oil can be absorbed without serious effects on the ecosystem. In the North Sea we use a water depth of 20 meters, in exceptional cases even 10 meters. At this depth, the oil concentration will not reach a toxic concentration (<10 ppm). For the Dutch Caribbean we propose to apply a depth of at least 60 meters (marine park boundary). Reasons for this are: the steep sea floor and the potential vulnerability of coral reefs.
   Besides the criterion of water depth (60 meters), it is also important to apply a certain distance from the shore (shallow zone). The LCM suggests using a distance of 1000 meters from the coast. This is important because it has to be prevented that oil, treated with dispersants, reaches the coast where further dispersion may occur in the most vulnerable zone. In the European Netherlands only class III dispersants are allowed for containment of oil spills under strict conditions. Our proposal is to use only this class of dispersants also in the Dutch Caribbean.
   Dispersed oil, in a high concentration, can have negative effects on fish larvae and coral larvae. Prediction on the occurrence of coral spawning are available online, for 2012: (http://www.researchstationcarmabi.org/news/latest-news/103-coral-spawning-predictions-for-2012-) The use of dispersants in this period (September-October) is not recommended. For small spills the crisis organisation can consider, based on the amount of dispersants, oil type and expected damage when no dispersants are used. There is no information available on the occurrence of fish larvae.

Saba-bank
The Saba Bank is a fragile reef with special economic and ecological value. A part of the Saba Bank is relatively shallow. There are many coral species here. Application of detergent at or near the Saba Bank is likely to cause more damage than would occur when an oil slick is floating over the Saba Bank. Therefore application of dispersant is not allowed. This is reflected in the decision tree.

4. In situations where mechanical cleaning at sea and the use of dispersants, according to the decision tree, are not an option, measures should be taken to mitigate the effects and/or accelerate subsequent cleanup actions. Vulnerable bays or coasts can possibly be temporarily protected with oil booms. For successful mitigation the most vulnerable areas need to be known and obviously means and capacity need to be available. Therefore it requires essential local area knowledge which was gained during the site visit (Annex 1). Alternative control methods and accepting a low effectiveness when nevertheless a dispersant is applied are options in this. This consideration should be made in the operational crisis team. For the final assessment, a Net Environmental Benefit Analysis (NEEBA) can be developed. In this supplementary assessment framework mainly the economic aspects are of interest.

Preconditions for carrying out the recommendation of use of detergents

1. Actions to make the ASA model optimally suited (link wind and current data, enter geo-data, scenario development)
2. Train people to use the model in the Dutch Caribbean
3. The organizational embedding must be in order: agreements so that communication between islands HMCN / CT / WMCN / LCM goes well and it is clear who has which responsibility. Practice realtime scenarios.
4. Area Knowledge (cards, coast, depth, most vulnerable zones) must remain up to date and available
5. Information on oil type, size and location of spill in an emergency must be known. (in preparation for this scenarios can be developed).
6. Information about the possibilities and (timely) availability for use of dispersants: mechanical capabilities and type, quantity and availability of dispersants.

Table 1: Applicability of dispersants with different oil types

Oil type	DISPERSE?	WHY?
Gasoline	NO	Dispersants would work, but would force toxic components of oil into water column
Kerosene (Jet fuel)	NO	
Marine Gas Oil	NO	
Marine Diesel Oil	NO	
Crude oil (paraffinic)	YES	Until the time "Window of opportunity" runs out
Crude oil (naphthenic)	YES	
Crude oil (asphaltic)	YES	
Crude oil (waxy)	MAYBE	Pour Point?
Hydraulic oil	NO	Refined products should not be dispersed
Lube oil	NO	
IFO-30	YES	Until the time "Window of opportunity" runs out
IFO-80	YES	
IFO-180	YES	
IFO-380	MAYBE	Only at high sea temperature or rough sea
IFO-500	NO	Viscosity too high
IFO-700	NO	

5. Decision tree, IMO Dispersant Guidelines (4 pages)

Lee, K. and Merlin, F. (2012), as reproduced in document "Updating of the IMO Dispersant Guidelines", Technical Group of the MEPC OPRC-HNS, 14th Session, Agenda item 3, IMO Doc. OPRC-HNS/TG 14/3/2, 6 August 2012

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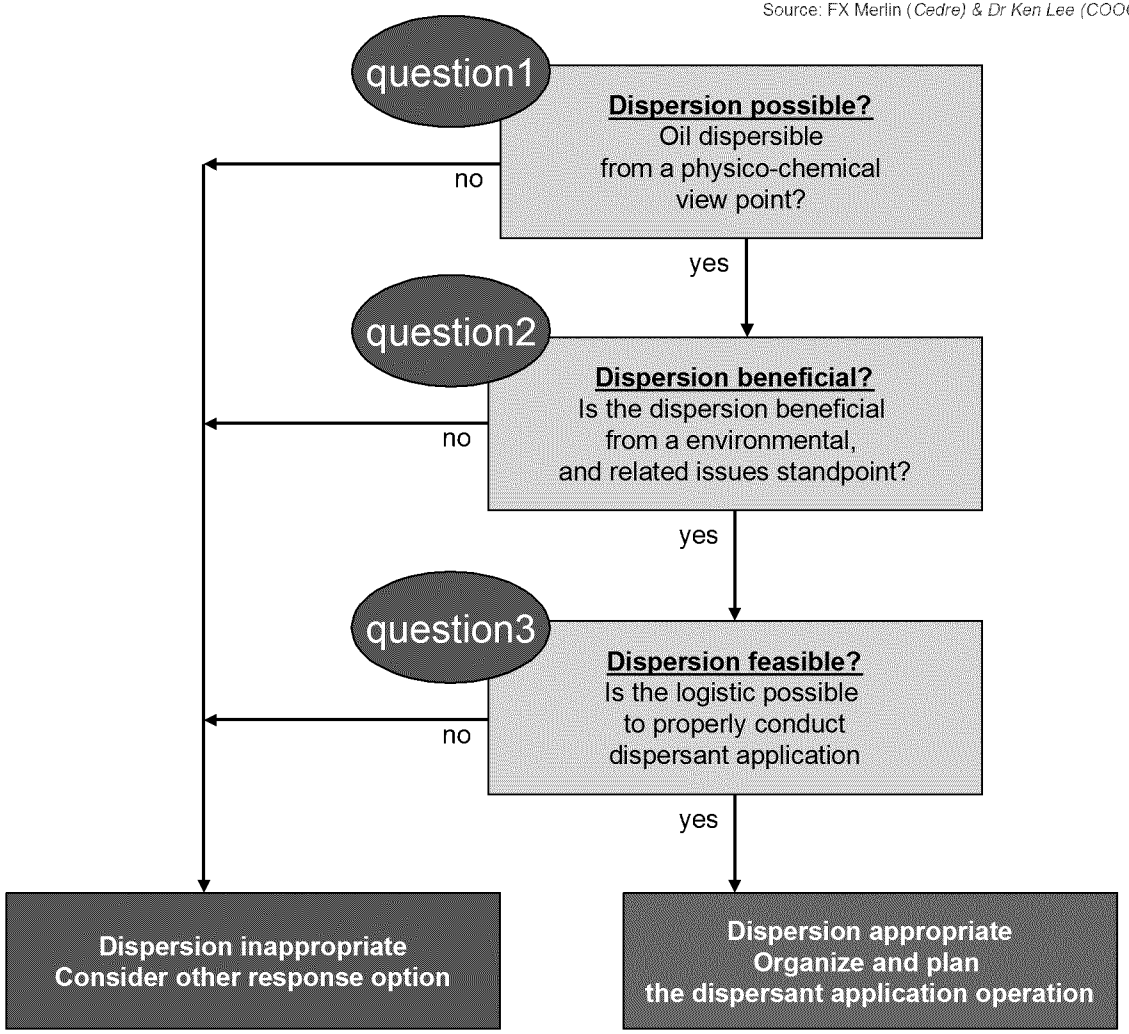
DECISION MAKING PROCESS

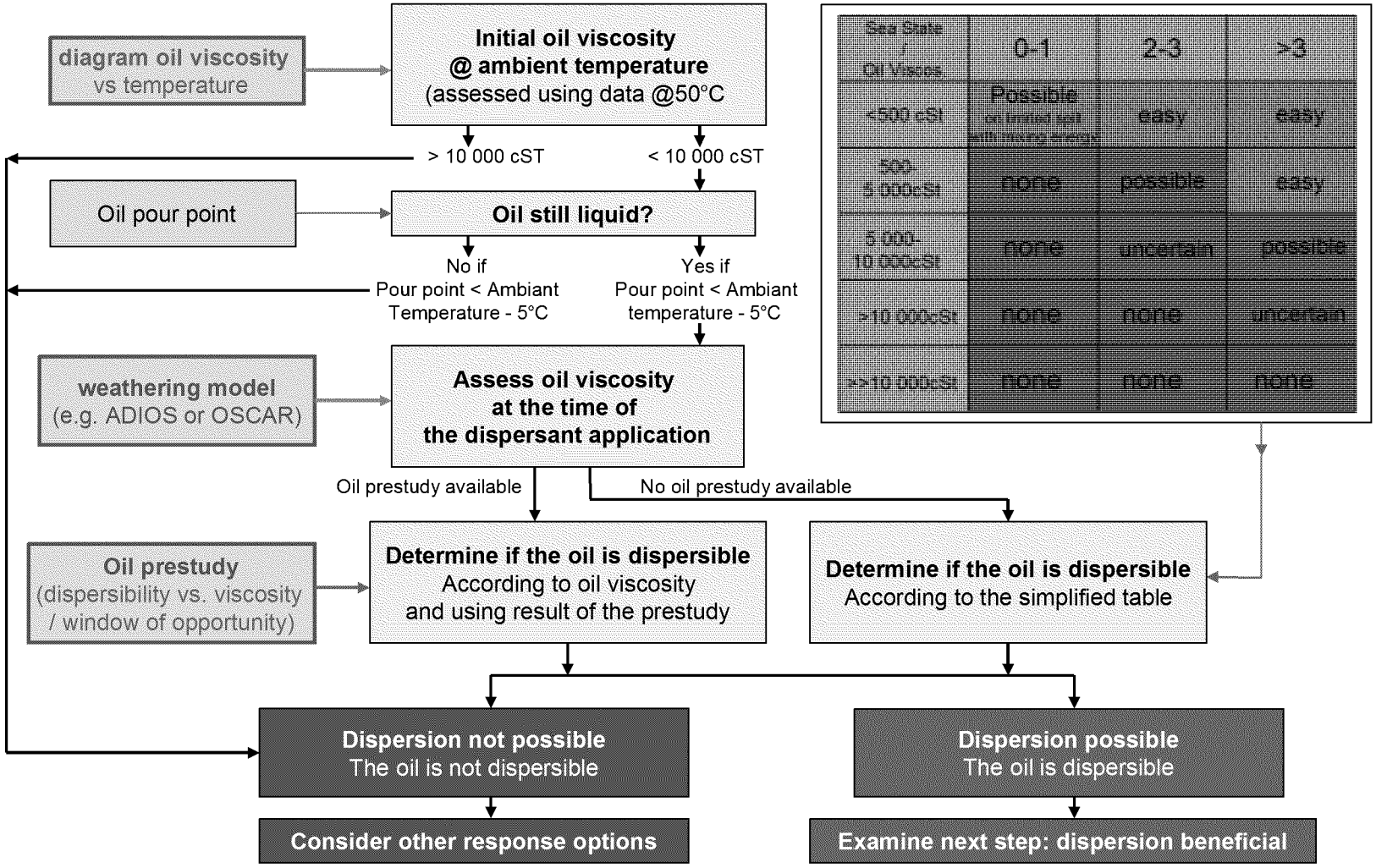
Source: FX Merlin (*Cedre*) & *Dr Ken Lee (COOGER)*



question1

Oil dispersible from a physico-chemical viewpoint?

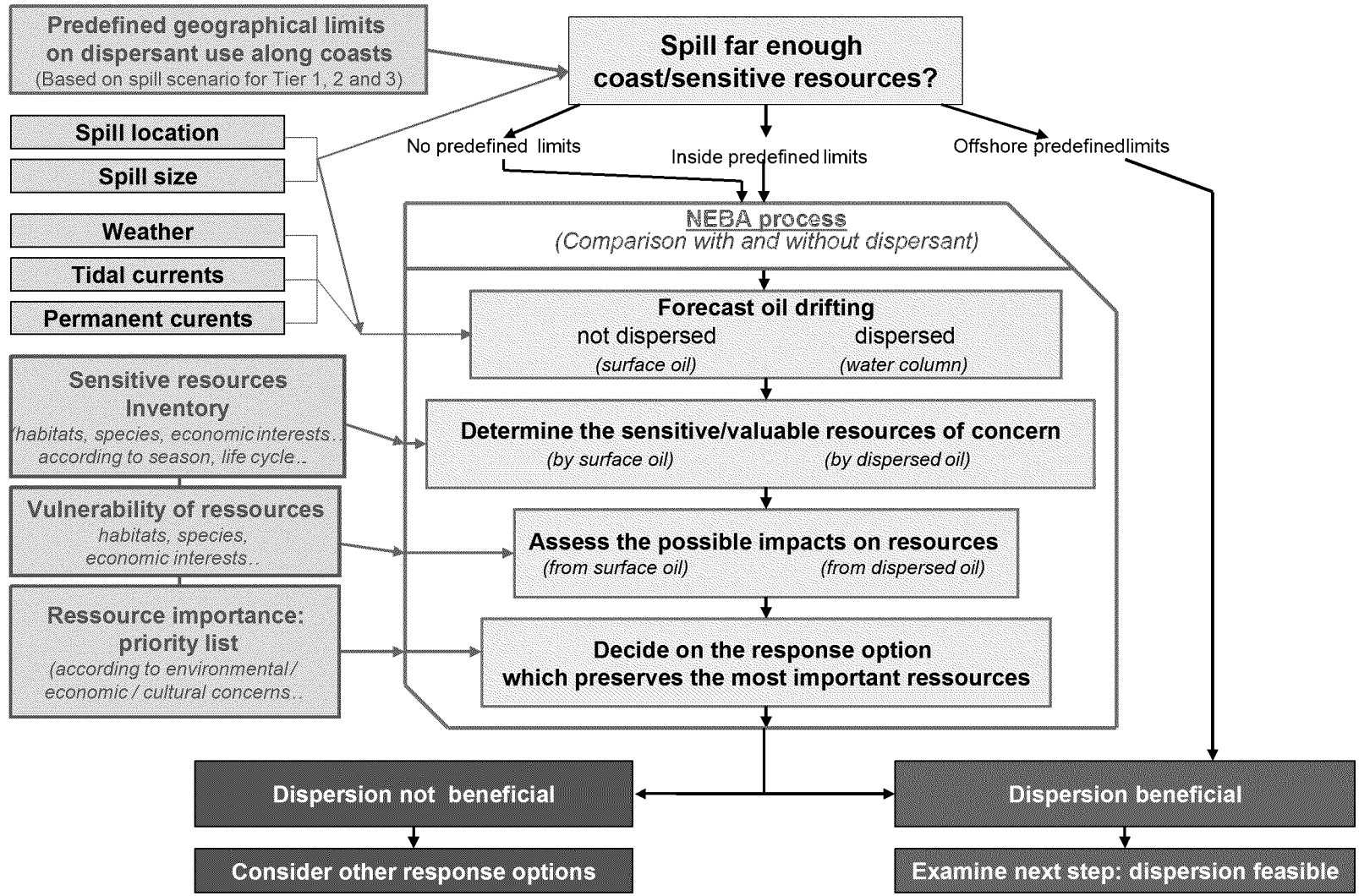
Source:FX Merlin (*Cedre*) & *Dr Ken Lee (COOGER)*



Sea State / Oil Viscos.	0-1	2-3	>3
<500 cSt	Possible	easy	easy
500-5 000cSt	none	possible	easy
5 000-10 000cSt	none	uncertain	possible
>10 000cSt	none	none	uncertain
>>10 000cSt	none	none	none

question2 Dispersion beneficial from an environmental / economic.. viewpoint?

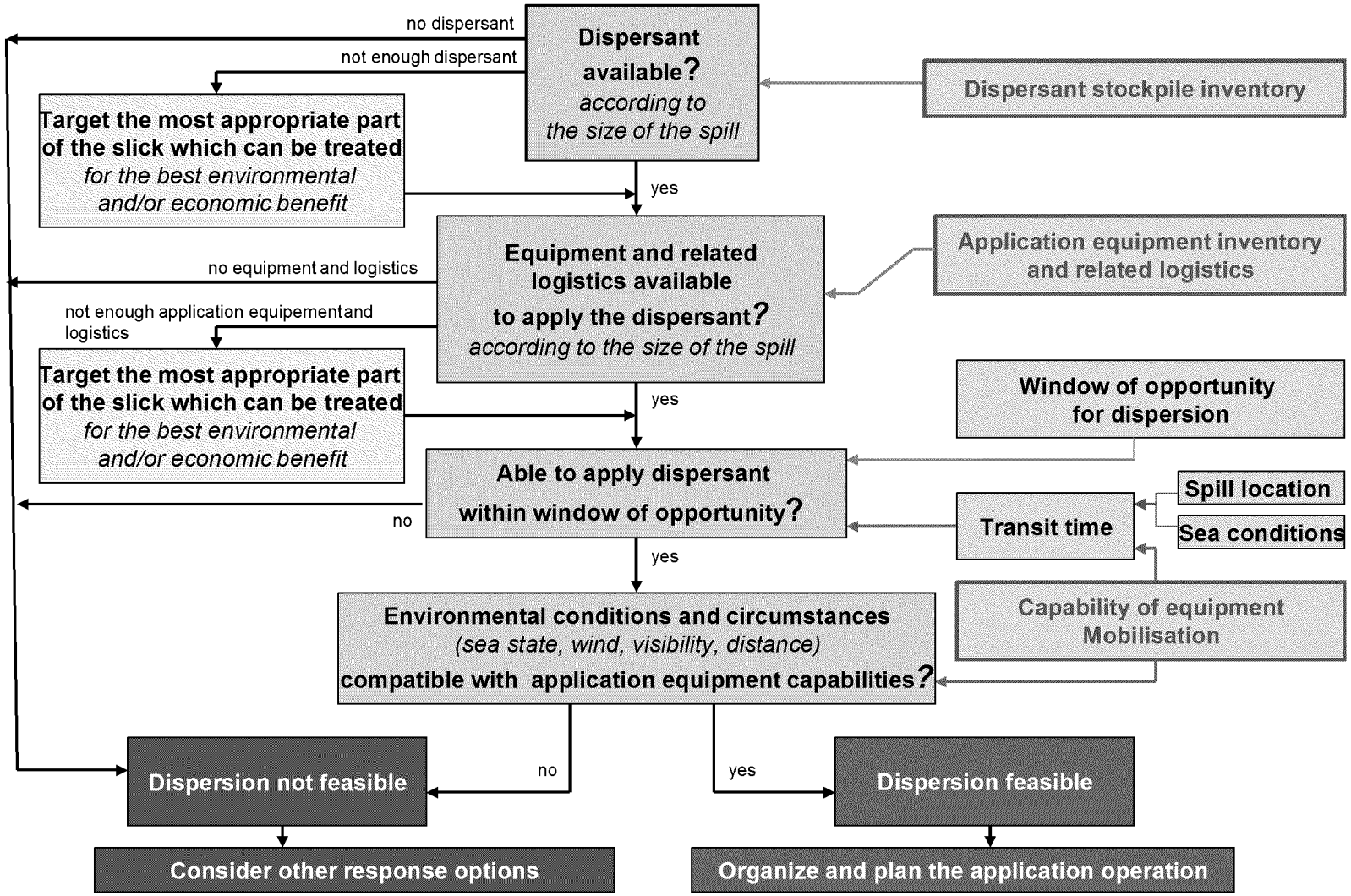
Source: FX Merlin (*Cedre*) & *Dr Ken Lee (COOGER)*



question3

Dispersion feasible from a logistical view point?

Source: FX Merlin (*Cedre*) & *Dr Ken Lee (COOGER)*



European Maritime Safety Agency
Praça Europa 4
1249-206 Lisbon, Portugal
Tel +351 21 1209 200
Fax +351 21 1209 210
emsa.europa.eu

EMSA

HWCG – Subsea Dispersant Project

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Presentation to RRT VI
18 May 2016

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- Consisting of 16 owner/member companies
- All Deepwater Operators in the Gulf of Mexico

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- *Cobalt International Energy, L.P.*
- *Deep Gulf Energy, LP*
- *ENI U.S. Operating Co. Inc.*
- *Energy Resource Technology GOM, LLC*
- *EnVen Energy Partners, LLC*
- *LLOG Exploration Company, LLC*
- *Marathon Oil Company*
- *Marubeni Oil & Gas (USA), Inc.*
- *Murphy Exploration & Production Company – USA*
- *Noble Energy, Inc.*
- *Freeport-McMoRan Oil & Gas LLC*
- *Repsol Services Company*
- *Stone Energy Corporation*
- *Walter Oil & Gas Corporation*
- *W&T Offshore, Inc.*

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Event Disclaimer

- Events for this drill are **Fabricated!**
- They are used to help drive the drill
- These events were designed to allow for exposure to multiple severe problems at a common time
- Events are to mimic actual possible events to assist in maintaining preparedness to the ER

LLOG / HWCG Drill Scenario

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- **2016 HWCG/LLOG Source Control Exercise Scenario**
  - **Event Conditions**

- **At 0545 CST 07 May 2016 the Sevan Louisiana suffered a loss of power resulting in a drift off.**

- **At the time of the incident the Sevan Louisiana had just completed drilling operations and the well was at TD of 21,020' MD and the drill bit was still on bottom.**

- **At that time the rig lost power and went "deadship" losing all mechanical and station keeping capability.**

- **At the time the rig was also in a severe thunderstorm with straight-line winds of 50 knots for 45 minutes. The crew assessed the situation, however the rig was well into the "red zone" prior to activating the emergency disconnect system (EDS). The rig was at a substantial offset when the vessel's crew activated the subsea BOP EDS.**

- **The EDS worked and the riser and LMRP disconnected from the BOP stack.**

  - **All personnel responded to General Quarters and are accounted for; non-essential personnel have made preparations for possible evacuation.**

- **The rig moved to a safe zone, jumped ROV and inspected the riser and associated subsea equipment. The LMRP is attached to the riser.**

Location:

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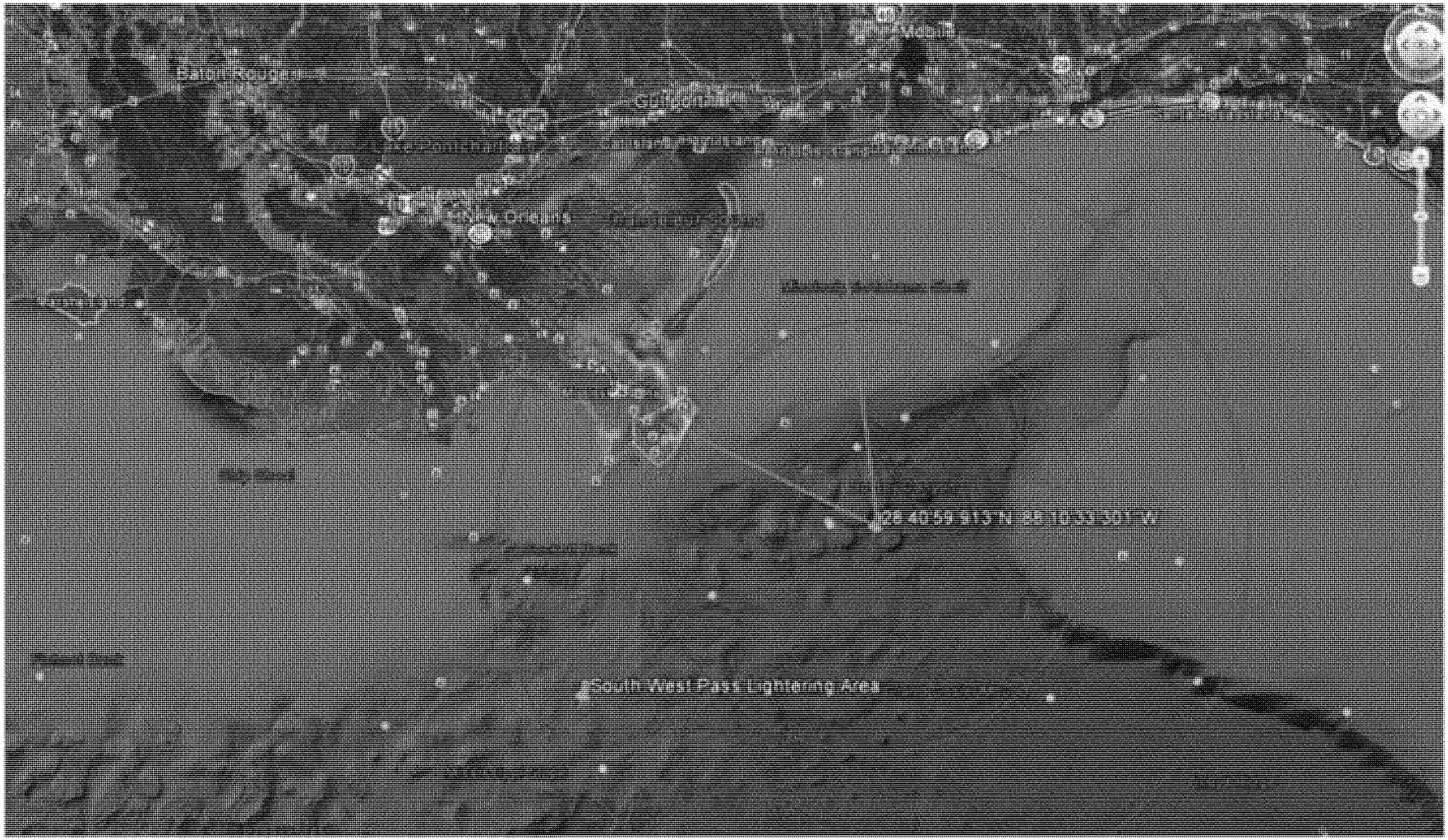
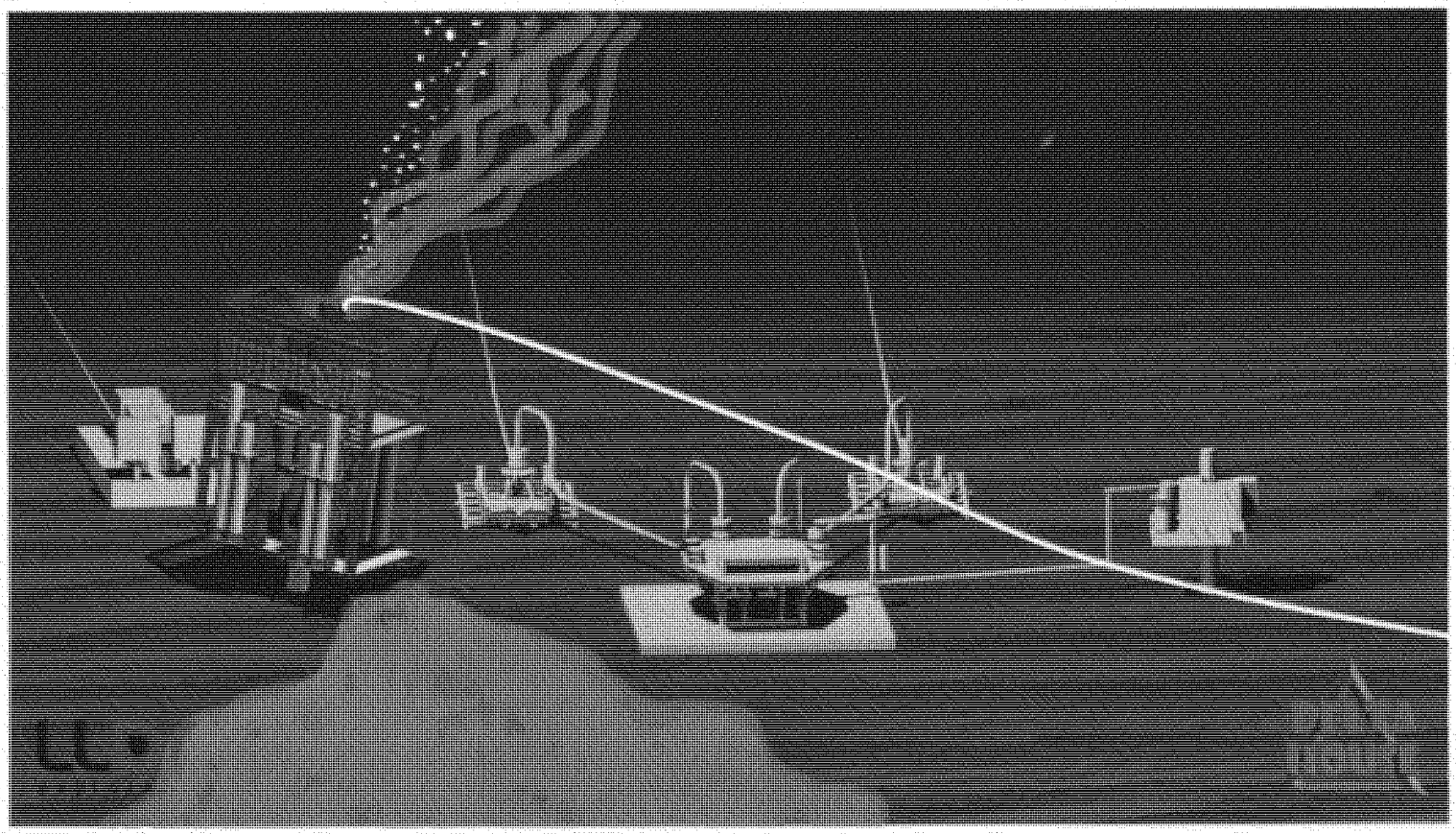


Approx 52 miles to South Pass
Approx 100 miles to Dauphin Island

Subsea Situation

5. LLOG HWCG Drill 2016 Sub-Sea Conditions

5-8-2016 19:45 – ROV Notes Gas & Oil Flow at BOP, no solids.



Seafloor - Wellhead

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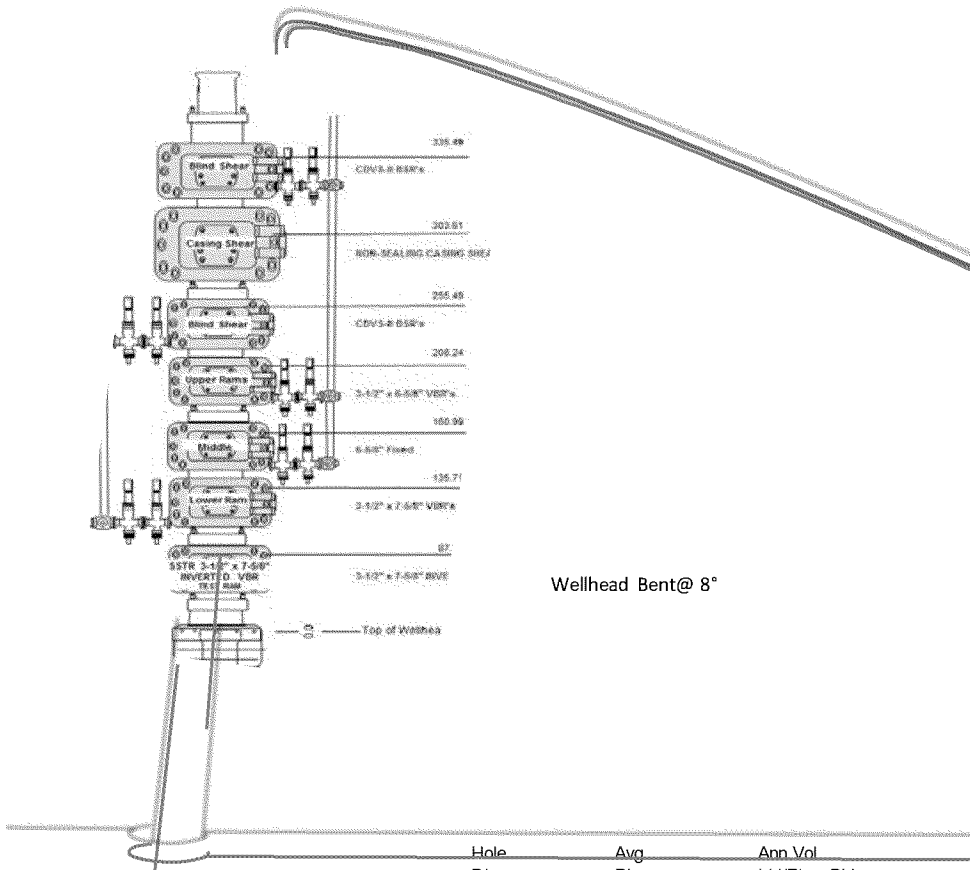

Wellhead Bent@ 8°

		Hole Diam	Avg Pipe	Ann Vol bbl/Ft	Bbls
13 5/8" Casing	6,242				
		9784 12.375	6.625	0.1062	1038.8
11 7/8" Liner Top	16,026				
		2940 10.711	6.625	0.0688	202.39
11 7/8" Csg Shoe	18,966				
		2054 12.125	7.250	0.0918	188.54
Open Hole TD	21,020				
					1429.7

Field Operations – Subsea Dispersant

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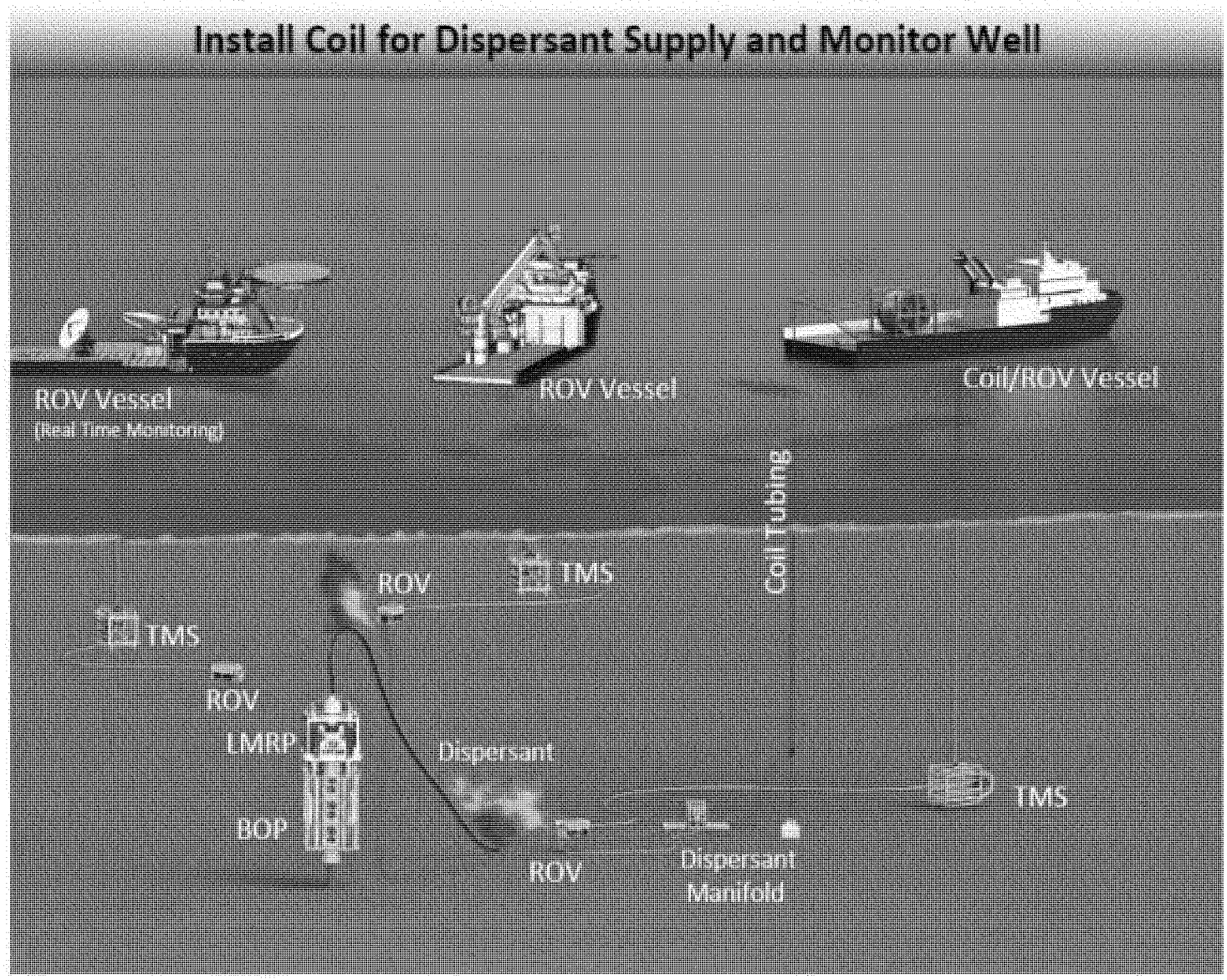
This is a picture depicting the overall field operation needed to supply dispersant subsea



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Parts of Application Outline

- Signature page for approval by UC
- Comprehensive incident data sheet
- Subsea Dispersant Operations Plan
- Subsea Dispersant Monitoring Plan
- Identification of Resources at Risk
- 3-D modeling information used to predict oil and dispersed oil trajectories
- Subsea Dispersant Injection Minimum Criteria Checklist
- Analysis of potential NEBA and Risk Assessment associated with SSDI

Resources at Risk

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NOAA's preparation of Resources at Risk document April 27, 2016

DRILL- DRILL- DRILL Resources at Risk for the northern Gulf of Mexico (GOM) - 15 pages

DRILL- DRILL- DRILL Resources at Risk for the northern Gulf of Mexico (GOM)

I. Spill Source Information

This report was prepared on 27 April 2016. Information in this report is meant to cover a release of approximately 6,500 barrels per day of Louisiana crude originating on May 10th at 28°40'59.913" N and 88°10'34.391" W. The spilled product is moving north and east, and will impact the shoreline primarily in Mississippi, Alabama, and Florida if it makes landfall.

II. Geographic Region Covered

The resources covered in this report are those expected to be found in the offshore area corresponding to block MC-300, the adjacent continental shelf, and coastal zone extending from lease block MC-300 to the shore from the Chandeleur Islands, LA to Destin, FL.

III. Oil type, behavior and effects to impacted species

Louisiana crude is a light crude that has an API of 37. It has moderate concentrations of toxic compounds and is moderately volatile. Observations during aerial surveys indicate that the crude oil readily emulsifies (both during its 5,000 ft rise to the water surface and by wave action on the sea surface). Thick emulsified oil occurs as large patches (tens of meters in diameter), long streamers, and smaller tarballs. Large areas of sheens are associated with the emulsified oil. The oil could concentrate in convergence zones, in patches of Sargassum (where sea turtles and birds may also concentrate).

Oil that reaches nearshore and coastal areas will mostly be weathered crude oil from the well. These relatively large accumulations of emulsified oil can heavily coat intertidal areas. The emulsified oil could also become mixed with sand, either in the surf zone or after stranding onshore. These oil:sand mixtures are heavier than water and could accumulate as submerged oil mats in nearshore areas off Gulf sand beaches. They can become buried by the movement of offshore bars, be buried within the beaches, and persist for years. The oil can become trapped in and form thick deposits along fringing marsh shorelines. The stability of the emulsions, once stranded on the shoreline and sheltered from wave action, is uncertain. One possibility is that the emulsion could break, releasing liquid oil that could be only moderately weathered (emulsification slows weathering processes such as evaporation and dissolution). The release of liquid oil inside the marsh fringe or on beaches could cause significant additional impacts to benthic, water-column, and water-surface resources in these shallow water habitats. Animals may not avoid the weathered emulsified oil, particularly if it does not provide any indication of hazards (e.g., it might not smell oily, could look like natural debris), and animals could still attempt to feed in the open areas between the patches that would still have some sheen. Further away from the source, tarballs (oil <10 cm in diameter), tar patties (oil >10 cm), and occasional tarmats may strand along the shoreline. These oil deposits could range in texture from soft, emulsified oil to semi-hardened outer layers. The oil may adhere to aquatic vegetation, birds, fur-bearing mammals, and reptiles. Oil coming ashore will be weathered so oil effects are likely to

be a result of coating and smothering of shoreline resources, ingestion of tarballs by sea turtles, and the persistence of oil in sediments.

Background on Potential Effects

The impacts arising from oil spills on aquatic species in open waters likely varies by species and with the rate at which oil partitions and dilutes in the water column, and with the co-occurrence of sensitive life stages and both physically and chemically dispersed oil. Species that may be at increased risk of exposure to chemically dispersed oil are those entrained within and traveling with the water mass containing the chemically dispersed oil (e.g., small species, embryos, larvae, zooplankton), followed by slow-moving species and life stages. Highly mobile species (e.g., adult shrimp, pelagic fish) may be less likely to be exposed to high concentrations of chemically dispersed oil due to dilution and avoidance.

Toxicity Studies

Exposure of aquatic species, and in particular early life stages, to physically and chemically dispersed oil can lead to lethal and non-lethal but ecologically important impacts (Teal and Howarth, 1984; Albers, 1995; NRC, 2005), but the onset of these impacts depends on several factors including oil concentrations and exposure duration. A growing body of literature (e.g., Carls *et al.*, 1999; Heintz *et al.*, 1999; Heintz *et al.*, 2000; Incardona *et al.*, 2004; Incardona *et al.*, 2005; Incardona *et al.*, 2011; Incardona *et al.*, 2013; Mager *et al.*, 2014; Esbaugh *et al.*, 2016) has shown that under controlled laboratory conditions fish embryos exposed for several hours post hatch to low oil concentrations (>1 mg/L oil, dissolved polycyclic aromatic hydrocarbons [PAHs] in the low µg/L range) develop gross abnormalities, with permanent impacts potentially causing reduced survival later in life (Incardona *et al.*, 2013). These impacts have been documented under laboratory conditions on embryos of pelagic species (i.e., yellowfin tuna [*Thunnus albacares*], Southern bluefin tuna [*T. maccoyii*], yellowtail amberjack [*Seriola lalandi*], and mahi mahi [*Coryphaena hippurus*]), some of which occur in the Gulf of Mexico (Incardona *et al.*, 2014; Mager *et al.*, 2014; Esbaugh *et al.*, 2016). However, the impacts arising from oil spills on fish embryos in open waters and their recruitment to the larval stages likely varies with the rate at which oil partitions and dilutes in the water column, as well as with the co-occurrence of fish embryos and the chemically dispersed oil. As a point of reference, a large proportion of water samples (75%) collected during the *Deepwater Horizon* oil had total PAH concentrations <1 µg/L, though water samples in the immediate vicinity of the wellhead had concentrations >1,000 µg/L (Boehm *et al.*, 2016). In contrast to these sensitive life stages, juveniles and adults are generally highly mobile and may only be temporarily exposed to chemically dispersed oil given their ability to move in and out of the water masses containing the entrained oil.

One of the greatest limitations in understanding the potential impacts related to dispersant use in open waters is the lack of data derived using relatively realistic exposure conditions. Even greater uncertainties and data limitations exist on the potential impacts of subsea dispersants. Despite these limitations, toxicity data from controlled laboratory studies could provide

conservative estimates of potential impacts. Toxicity data are commonly reported as lethal or effects median concentrations (LC50 and EC50, respectively[1]). With regards to dispersants alone, data based on spiked exposures[2] show that most data fall within the slightly to practically nontoxic range[3], with most data falling within the practically nontoxic range. Even for sensitive species, most toxicity values for COREXIT 9527 and COREXIT 9500, regardless of exposure conditions, are >20 mg/L, falling within the range of what is considered slightly toxic. Similarly, the reported toxicity of South Louisiana crude oil chemically dispersed with COREXIT 9500 from 96-h (LC50s and EC50s combined) constant static exposure[4] ranges from 4.84 to 18 mg THC/L (n=8 records) (NOAA/ERD, 2015), falling within the moderately to slightly toxic range.

Potential Levels of Concern

Derivation of potential thresholds of concern could be achieved by the use of Species Sensitivity Distributions (SSDs). SSDs are cumulative distributions of toxicity data that allow for comparisons of the relative sensitivities of aquatic species dispersed oil, and they are useful in that they could be used to calculate the 5th percentile Hazard Concentration (HC5), or concentrations assumed to be protective of 95% of all species in the SSD. While HC5 values may not be necessarily protective of all aquatic organisms, and particularly of those known to be most sensitive to oil, their derivation is often conservative enough to a large range of sensitivities. Conservative estimates HC5s for COREXIT 9527 and COREXIT 9500 are 8.38 mg/L and 4.04 mg/L, respectively, falling within the moderately toxic range. However, these concentrations are assumed to be worst case, as exposure concentrations under standard dispersant applications (ASTM, 2010a; ASTM, 2010b) are not expected to remain constant in the water column, and at any given moment are likely below these concentrations. Based on modeled information of toxicity data (96-hr exposures) for South Louisiana crude oil, the conservative HC5 estimate is 0.97 mg THC/L with a 95% confidence interval of 0.63-1.49 mg THC/L (Bejarano and Barron, 2014). These values fall within the upper and lower ends of the highly toxic and the moderately toxic range, respectively. As a point of reference the range of oil concentrations in the chemically dispersed underwater plume range from non-detectable levels to 6,130 mg/L, with a geometric mean of 1.09 µg/L (Boehm *et al.*, 2011). Given that this oil release

[1] The LC50 is the concentration lethal to 50% of the exposed test population, while the EC50 is the concentration that causes an adverse non-lethal effect to 50% of the exposed test population. As a general rule, the smaller the LC50 or EC50 values, the greater the toxicity.

[2] Spiked or spiked flow-through tests are tests that address the dilution that occurs in open waters by reproducing under laboratory conditions rapid changes in concentrations within the water column.

[3] Toxicity LC50 and EC50 categories for aquatic organisms are as follows: Very highly toxic <0.1 mg/L, Highly toxic 0.1-1 mg/L, Moderately toxic >1-10 mg/L, Slightly toxic >10-100 mg/L and Practically nontoxic >100 mg/L. Source: [illegible]

[4] Exposures that do not account for the natural dilution that occurs in open waters.

Application for Subsea Dispersant Use

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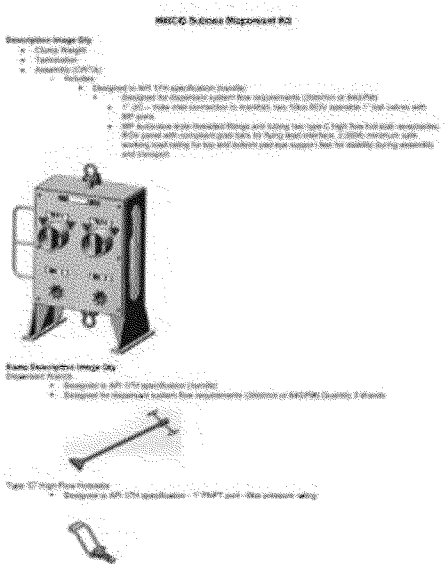
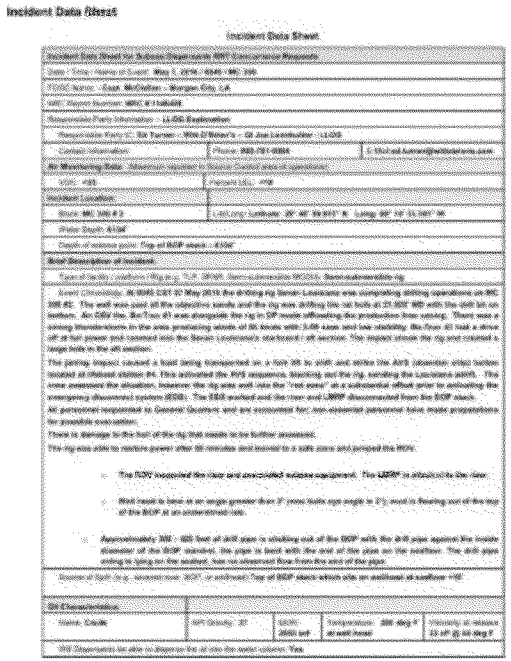
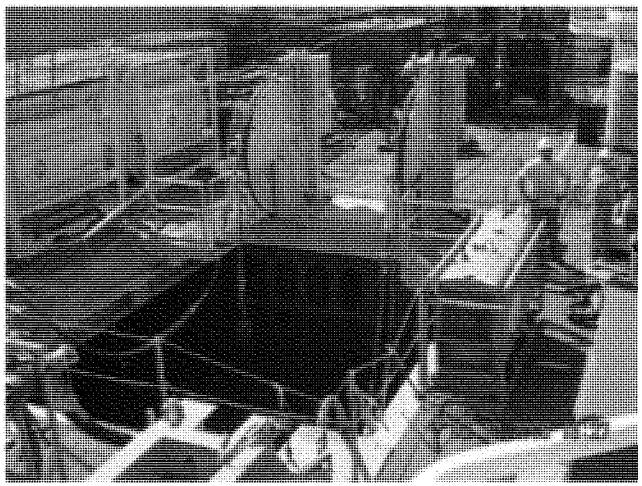
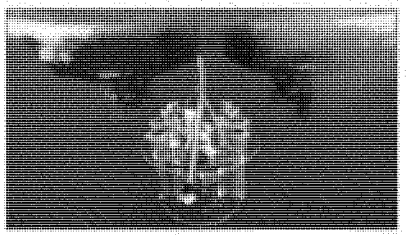
Package

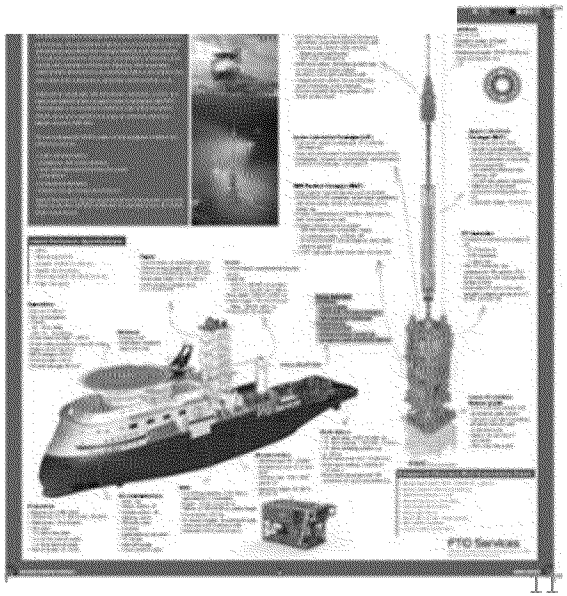
- Subsea Application
- Subsea Monitoring
  - Monitoring personnel & Equipment
- Dispersant Equipment
  - Subsea injection
  - Coil Tubing
  - Vessels











Spill Trajectory

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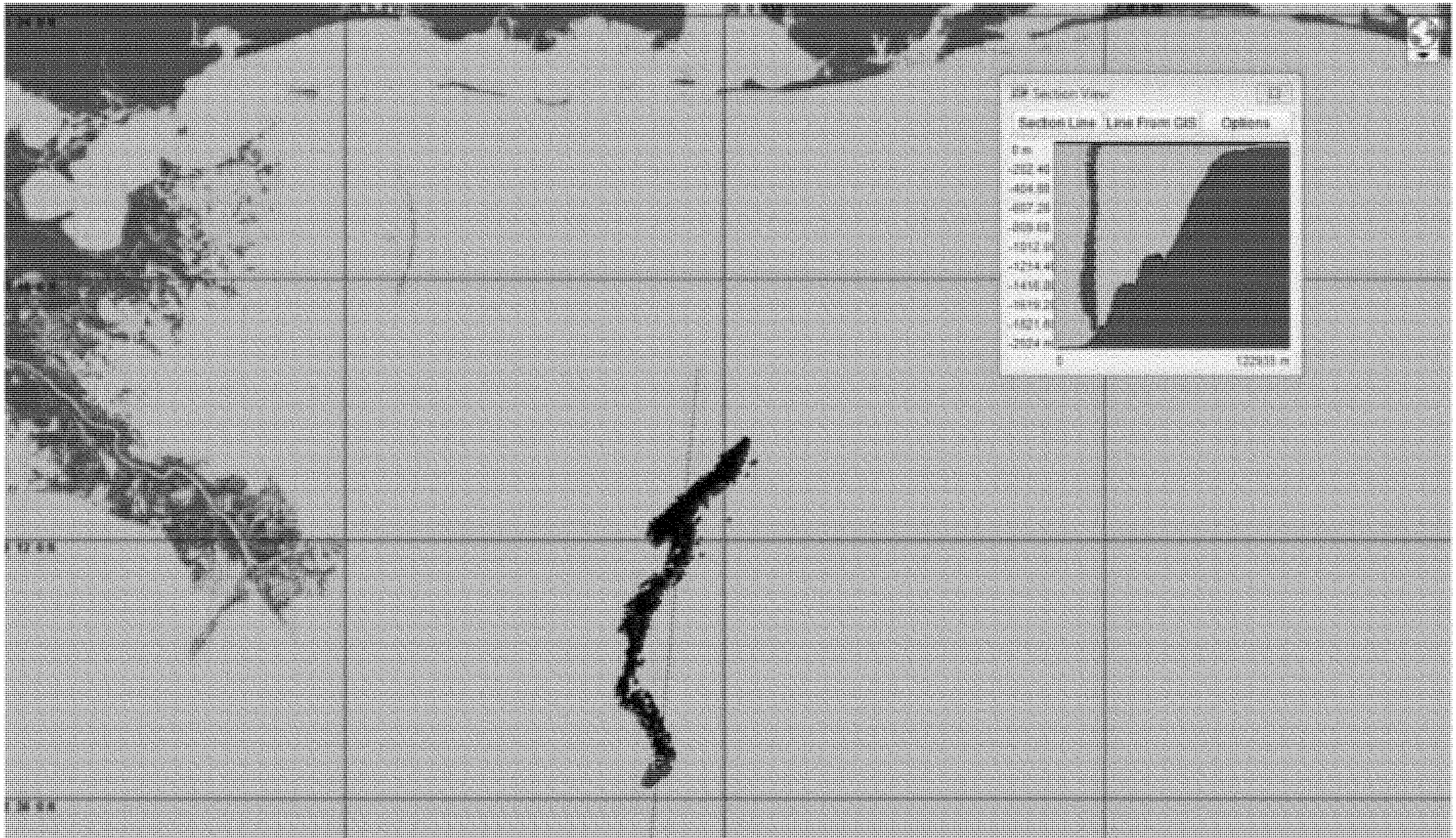

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Dispersant

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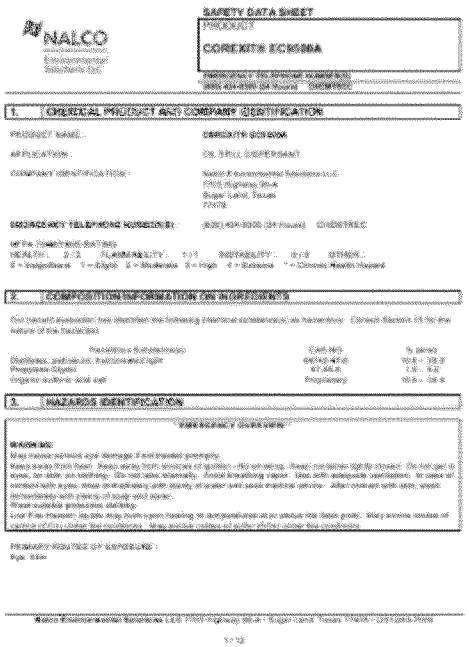
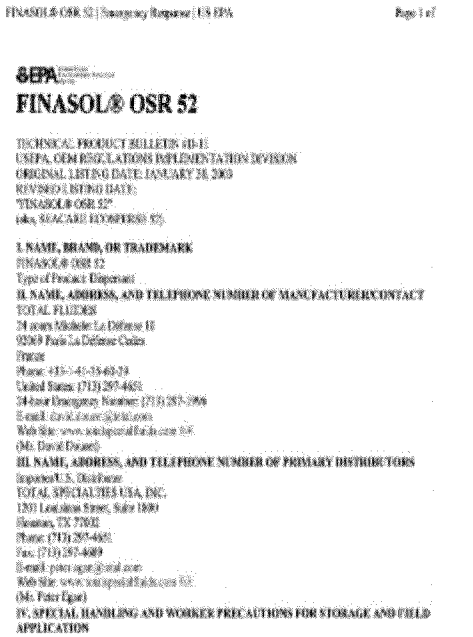
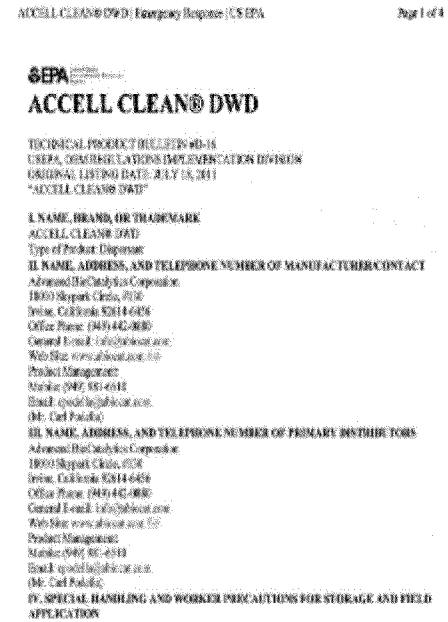
Dispersant

- Corexit
- Finasol
- Accell







A request was made for the use of all three

That request was taken into consideration by the RRT that concurred with their use

Dispersant - Cascade

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Cascading of dispersant to a dock facility for offshore transit

Indicative Sequencing Plan for US Deployment of Global Dispersant Stockpile to New Orleans USA

Destination = New Orleans Airport

Elapsed Deployment Time (Hours)

Sequence	Type	m3	US Gal	Location	Comment		12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192
1	Corexit EC9500A	200	53,000	OSRL Base Ft Lauderdale USA	Air Freight			100	100													
1	Corexit EC9500A	300	79,500	OSRL Base Ft Lauderdale USA	Road Freight				180			120										
2	Corexit EC9500A	500	132,500	OSRL Base Brazil	Air Freight				100	100		100	100									
3	Finasol 52	500	132,500	OSRL Base Southampton UK (Finasol)	Air Freight				100	200		100	100									
4	Finasol 52	1,500	397,500	Supplier Warehouse - Europe	Air Freight				100	200		100	100	200		300	100	100		300		
5	Finasol 52	350	92,750	OSRL Base Singapore (Finasol)	Air Freight									300								
5	Finasol 52	800	212,000	OSRL Base South Africa	Air Freight									300				300				300
		4,150	1,099,750	Number of IBCs		No of IBCs	0	100	580	500	0	420	300	800	0	300	100	400	0	300	0	300
				Amount of Dispersant in US Gallons		US Gallons	-	26,500	153,700	132,500	-	111,300	79,500	212,000	-	79,500	26,500	106,000	-	79,500	-	79,500
				Cummulative Dispersant in US Gallons		Cumm Gals	-	26,500	180,200	312,700	312,700	424,000	503,500	715,500	715,500	795,000	821,500	927,500	927,500	1,007,000	1,007,000	1,086,500

Assumptions

Note 1: This Plan is presented as indicative. Actual shipment methods and timing are the responsibility of the Subscriber and driven by their sequencing needs.

Note 2: The GDS Sequencing Plan is dependent on the number of aircraft available during this mobilization event.

This simulation utilized 12x B747 aircraft in the first 96 hours. Past the 96 hour mark, considerable efficiency may be gained by retasking contracted aircraft for longer duration re-supply mission profile.

Sequence	Type	m3	US Gal	Location	Comment	Assumptions
1	Corexit EC9500A	200	53,000	OSRL Base Ft Lauderdale USA	Air Freight	2 x B747, 50 IBC per load, 4 loads
1	Corexit EC9500A	300	79,500	OSRL Base Ft Lauderdale USA	Road Freight	10 Trucks, 18 IBC per truck, two trips each truck
2	Corexit EC9500A	500	132,500	OSRL Base Brazil	Air Freight	4 x B747, 50 IBC per load, 10 loads
3	Finasol 52	500	132,500	OSRL Base Southampton UK	Air Freight	5 x B747, 50 IBC per load, 10 loads
4	Finasol 52	1,500	397,500	Supplier Warehouse - Europe	Air Freight	5 x B747, 50 IBC per load, 30 loads
5	Finasol 52	350	92,750	OSRL Base Singapore	Air Freight	5 x B757, 50 IBC per load, 6 loads
5	Finasol 52	800	212,000	OSRL Base South Africa	Air Freight	4 x B747, 50 IBC per load, 16 loads
6	Dasic Slickgone NS	500	132,500	OSRL Base Southampton UK	Air Freight	TBD
7	Dasic Slickgone NS	350	92,750	OSRL Base Singapore	Air Freight	TBD
		5,000	1,325,000			

30-Day Advanced Biocatalytics Cascading Plan for Accell Clean® DWD

Day	Plant	Amount	Cummulative	Transport Time to Port Forchon, LA	Transport Time to Fourchon, LA	Amt Delivered	Date/time Delivered	Cummulative
May 9	Chattanooga, TN	15,000		10.5 hrs		15,000	10-May	15000
9-May	Dallas, TX	15,000			11 hrs	15,000	10-May	30,000
10-May	Chattanooga, TN	15,000		10.5 hrs		15,000	11-May	45,000
10-May	Dallas, TX	15,000			11 hrs	15,000	11-May	60,000
11-May	Chattanooga, TN	15,000		10.5 hrs		15,000	12-May	75,000
11-May	Dallas, TX	15,000			11 hrs	15,000	12-May	90,000
12-May	Chattanooga, TN	15,000		10.5 hrs		15,000	13-May	105,000
12-May	Dallas, TX	15,000			11 hrs	15,000	13-May	120,000
13-May	Chattanooga, TN	15,000		10.5 hrs		15,000	14-May	135,000
13-May	Dallas, TX	15,000			11 hrs	15,000	14-May	150,000
16								

Incident Command Call to RRT-6

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May 10, 2016

Incident Command Call to RRT-6 requesting use of Subsea Dispersant for drill event.

Phone followed a pre submittal of application on April 29th.

Members of the RRT present agreed to the use of subsea dispersant as a viable solution.

HWCG Dispersant Team

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- Owen Francis (LLOG Dispersant Lead)
- Roger Scheuermann (HWCG Lead)
- Jodi Harney (CSA Inc.)
- Robert Simmons (ES^2)
- Gina Coelho (Spill Response Science)
- Jim Staves (Environmental & Emergency Management Consultant)

Special thanks to Page Doelling with NOAA for her "Resources at Risk" efforts that helped guide the team

...A comprehensive well containment response model – made up of equipment, people, procedures and processes – Ready to be activated immediately in the event of a deepwater well control incident...

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Michael Sams, USCG D8

RRT-6 ART – Subsea Dispersant Checklist

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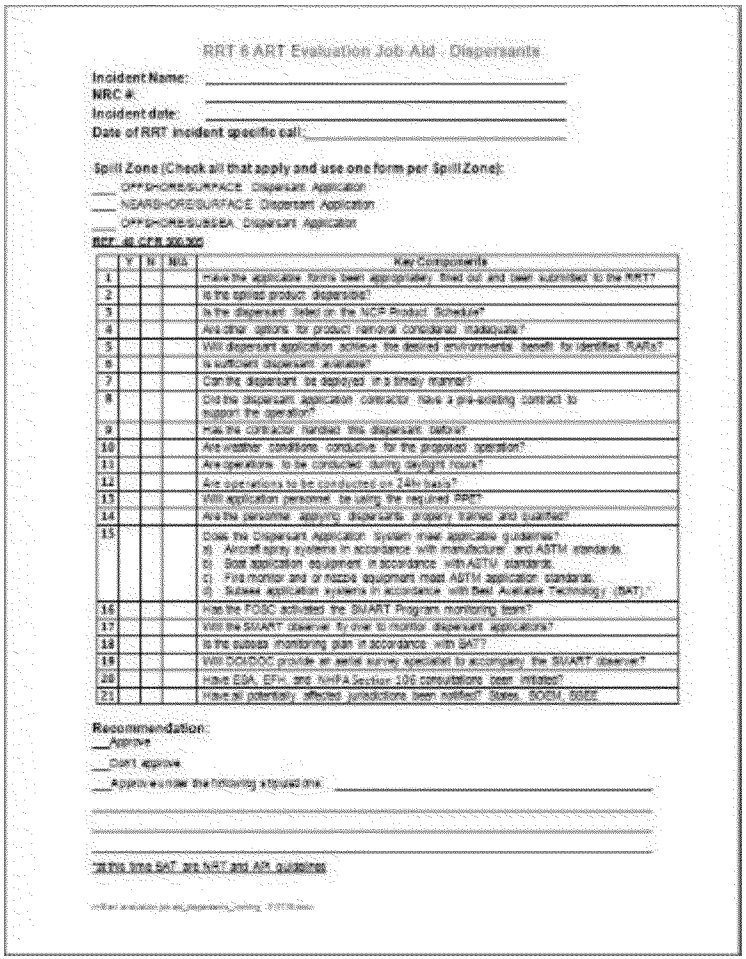

RRT 6 ART Evaluation Job Aid - Dispersants

Incident Name: _____
NRC #: _____
Incident date: _____
Date of RRT incident specific call: _____

Spill Zone (Check all that apply and use one form per Spill Zone):
___ OFFSHORE/SURFACE Dispersant Application
___ NEARSHORE/SURFACE Dispersant Application
___ OFFSHORE/SUBSEA Dispersant Application

REF: 40 CFR 300.905

	Y	N	N/A	Key Components
1				Have the applicable forms been appropriately filled out and been submitted to the RRT?
2				Is the spilled product dispersible?
3				Is the dispersant listed on the NCP Product Schedule?
4				Are other options for product removal considered inadequate?
5				Will dispersant application achieve the desired environmental benefit for identified RARs?
6				Is sufficient dispersant available?
7				Can the dispersant be deployed in a timely manner?
8				Did the dispersant application contractor have a pre-existing contract to support the operation?
9				Has the contractor handled this dispersant before?
10				Are weather conditions conducive for the proposed operation?
11				Are operations to be conducted during daylight hours?
12				Are operations to be conducted on 24hr basis?
13				Will application personnel be using the required PPE?
14				Are the personnel applying dispersants properly trained and qualified?
15				Does the Dispersant Application System meet applicable guidelines? a) Aircraft spray systems in accordance with manufacturer and ASTM standards. b) Boat application equipment in accordance with ASTM standards. c) Fire monitor and or nozzle equipment meet ASTM application standards. d) Subsea application systems in accordance with Best Available Technology (BAT).*
16				Has the FOSC activated the SMART Program monitoring team?
17				Will the SMART observer fly over to monitor dispersant applications?
18				Is the subsea monitoring plan in accordance with BAT?
19				Will DOI/DOC provide an aerial survey specialist to accompany the SMART observer?
20				Have ESA, EFH, and NHPA Section 106 consultations been initiated?
21				Have all potentially affected jurisdictions been notified? States, SOEM, SSEE

Recommendation:
___Approve
___Don't approve
___Approve under the following stipulations: _____

*at this time BAT are NRT and API guidelines

ISRRT Telcon - Sample Agenda Topics

1. Welcome & roll call (Sams)
2. Purpose (Sams)
3. Situation brief (RP rep)
4. Discussion (All)
5. Consultation with natural resource trustee reps (DOC-NOAA; DOI-USFWS)
6. Federal/State concerns (EPA, USCG, LA, & TX)
7. Concurrence to use subsea dispersants (EPA & States)
8. Identify issues/concerns – Action Items (RRT-6 participants & RP)
9. Adjourn

Michael Sams, USCG D8

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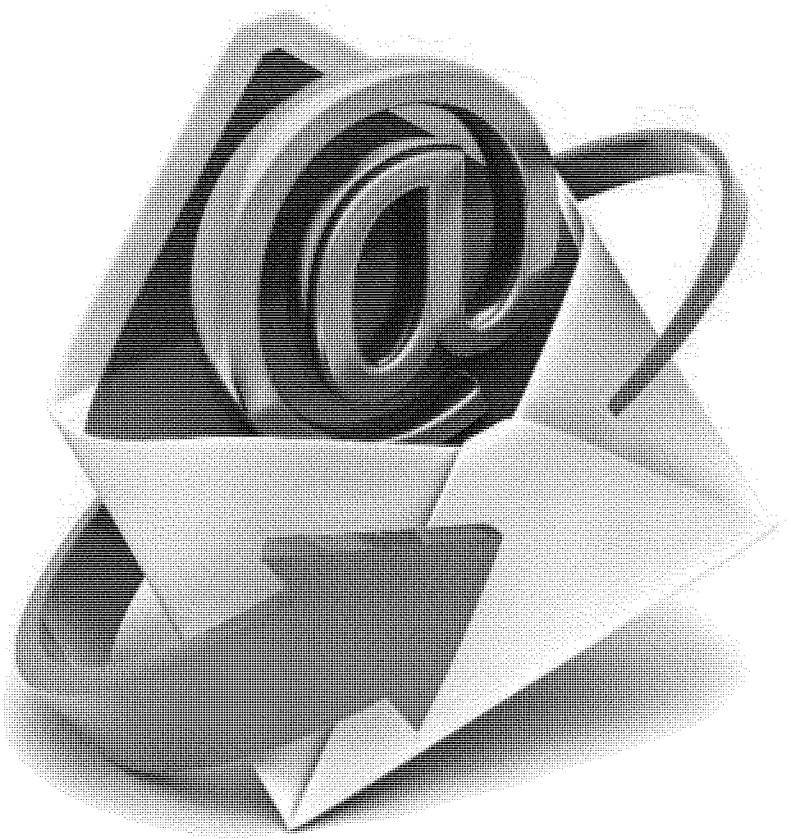
- Submit package to USCG Coordinator and Co-Chair at least one-week prior to ISRRT Telcon
- Coordinator sends out invite; package attached.



Michael Sams, USCG D8

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To: Loring, Joseph B CAPT[Joseph.B.Loring@uscg.mil]; Weaver, James (USCG)[James.D.Weaver@uscg.mil]; Scott.A.Stoermer@uscg.mil[Scott.A.Stoermer@uscg.mil]; Ottenwaelder, Thomas A CDR[Thomas.A.Ottenwaelder@uscg.mil]; Sligh, Kevin M CIV[Kevin.M.Sligh@uscg.mil]; Carnegie, Tammie R LT[Tammie.R.Carnegie@uscg.mil]; Crecy, Stacey L LCDR[Stacey.L.Crecy@uscg.mil]; Platt, Jeffrey R LCDR[Jeffrey.R.Platt@uscg.mil]; Brooks, Rebecca J LT[Rebecca.J.Brooks@uscg.mil]; Maghini, Monica K CIV[Monica.K.Maghini@uscg.mil]; Hall, Gregory CDR (EDU)[Gregory.Hall@USCGA.EDU]; Fletcher, James E CIV[James.E.Fletcher@uscg.mil]; kurt.a.hansen@uscg.mil[kurt.a.hansen@uscg.mil]; Balsley, Alexander CIV[Alexander.Balsley@uscg.mil]; DiRenzo, Joseph CIV[Joseph.DiRenzo@uscg.mil]; mark.g.vanhaverbeke@uscg.mil[mark.g.vanhaverbeke@uscg.mil]; Catanach, Curtis P CIV[Curtis.P.Catanach@uscg.mil]; Chaves, Wendy[Wendy.G.Chaves@uscg.mil]; Jenkins, Shannon R CIV[Shannon.R.Jenkins@uscg.mil]; dave.westerholm@noaa.gov[dave.westerholm@noaa.gov]; scott.lundgren@noaa.gov[scott.lundgren@noaa.gov]; steve.lehmann@noaa.gov[steve.lehmann@noaa.gov]; john.kucklick@nist.gov[john.kucklick@nist.gov]; jason.boehm@nist.gov[jason.boehm@nist.gov]; Elena.Melchert@hq.doe.gov[Elena.Melchert@hq.doe.gov]; Erica.Folio@Hq.Doe.Gov[Erica.Folio@Hq.Doe.Gov]; kevin.easley@hq.doe.gov[kevin.easley@hq.doe.gov]; david.moore@bsee.gov[david.moore@bsee.gov]; Lori.Medley@bsee.gov[Lori.Medley@bsee.gov]; william.vocke@bsee.gov[william.vocke@bsee.gov]; joseph.levine@bsee.gov[joseph.levine@bsee.gov]; Walter.Johnson@boem.gov[Walter.Johnson@boem.gov]; brian.zelenke@boem.gov[brian.zelenke@boem.gov]; Jeff.Ji@boem.gov[Jeff.Ji@boem.gov]; barry_Forsythe@fws.gov[barry_Forsythe@fws.gov]; holly_herod@fws.gov[holly_herod@fws.gov]; christina_kravitz@fws.gov[christina_kravitz@fws.gov]; michael.carter@dot.gov[michael.carter@dot.gov]; tom.thompson@dot.gov[tom.thompson@dot.gov]; robert.w.smith@dot.gov[robert.w.smith@dot.gov]; james.merritt@dot.gov[james.merritt@dot.gov]; David.Lehman@dot.gov[David.Lehman@dot.gov]; Steven.V.Cary@usace.army.mil[Steven.V.Cary@usace.army.mil]; Andrew.J.Bruzewicz@usace.army.mil[Andrew.J.Bruzewicz@usace.army.mil]; Nathan.J.Lamie@usace.army.mil[Nathan.J.Lamie@usace.army.mil]; Kemp.skudin@navy.mil[Kemp.skudin@navy.mil]; frank.stone@navy.mil[frank.stone@navy.mil]; abe.nachabe@navy.mil[abe.nachabe@navy.mil]; michael.s.dean@navy.mil[michael.s.dean@navy.mil]; daniel.eldredge@navy.mil[daniel.eldredge@navy.mil]; Stephanie A. Brown[stephanie.a.brown@navy.mil]; Conmy, Robyn[Conmy.Robyn@epa.gov]; Principe, Vanessa[Principe.Vanessa@epa.gov]; Wilson, Gregory[Wilson.Gregory@epa.gov]; michael.j.green-1@nasa.gov[michael.j.green-1@nasa.gov]; wayne.yoder@dhs.gov[wayne.yoder@dhs.gov]; jfarrell@arctic.gov[jfarrell@arctic.gov]
From: Brooks, Rebecca J LT
Sent: Fri 7/8/2016 2:05:03 PM
Subject: ICCOPR Presentations (Reduced Size PDF)
ICCOPR FY16 Qtr3 Meeting Presentations1.pdf

Good morning ICCOPR Members,

As discussed, attached is a PDF with all of the presentations and agency updates slides. I had to reduce the size of the file to send it so please let me know if you want to see an original of one particular presentation.

Additionally, the draft minutes will go out for your review next week. Thank you!

Very respectfully,

LT Becca Brooks
U.S. Coast Guard Headquarters STOP 7516
Office of Marine Environmental Response Policy (CG-MER-3)
2703 Martin Luther King Jr. Ave SE
Washington, DC 20593-7516
Phone: 202-372-2259

To: Barron, Mace[Barron.Mace@epa.gov]
Cc: Conmy, Robyn[Conmy.Robyn@epa.gov]; Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Wilson, Gregory
Sent: Fri 10/21/2016 3:42:03 PM
Subject: BA - RRT IV
2015_11-05 1045 Dispersant Alternatives.pdf

https://www.nrt.org/sites/52/files/RRT4_BiologicalAssessments_Dispersants&ISB.pdf see Table 2-1

Presentation with toxic date that was presented to RRT 6 (attached)

Clean Gulf Associates

HWCG

Ready to Respond

Alternative Dispersants II

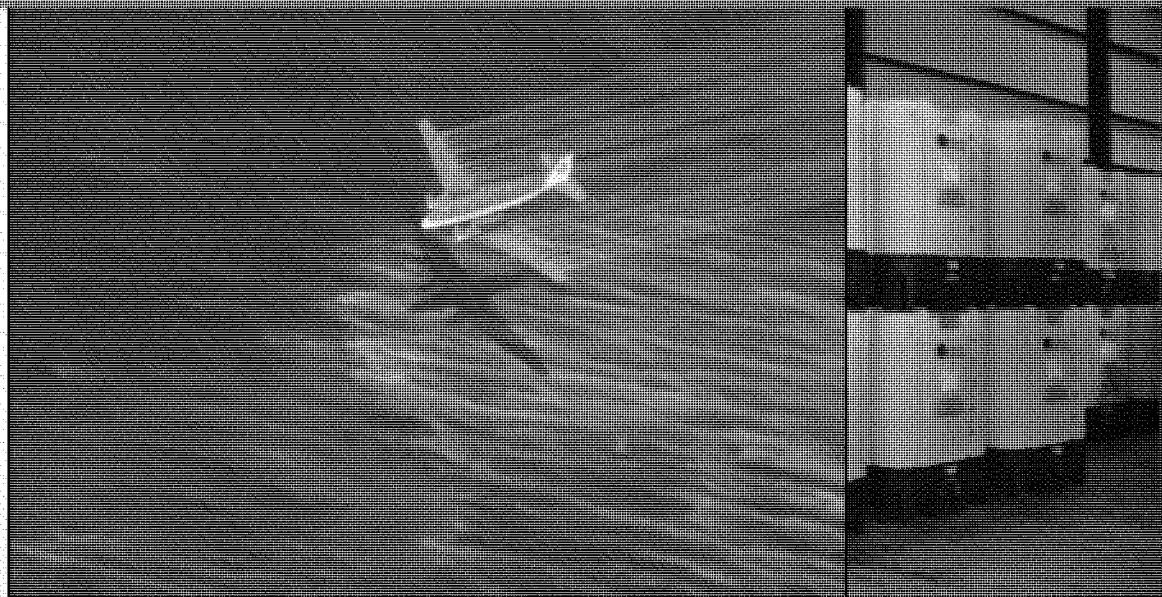
James Hanzalik

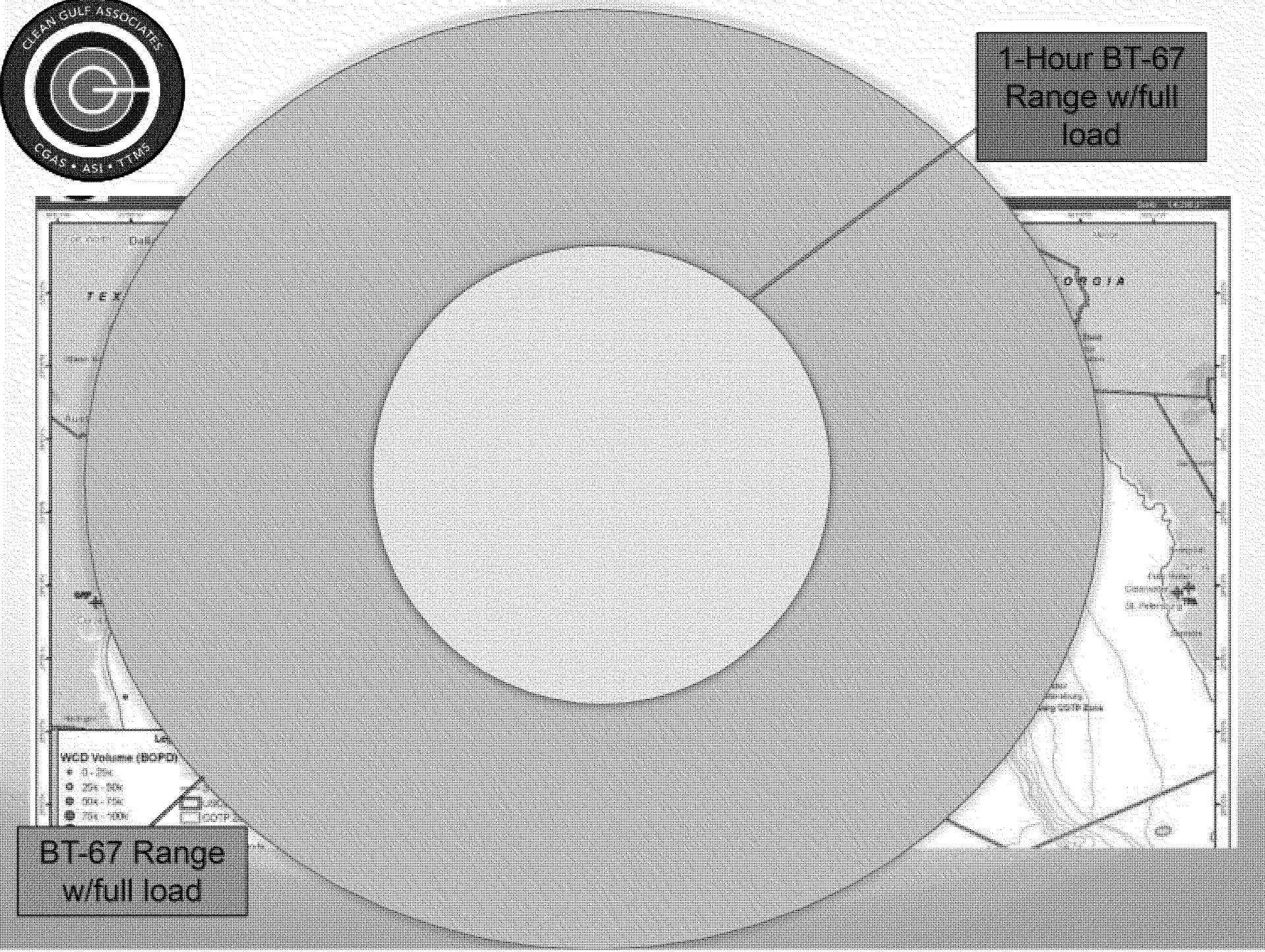
Clean Gulf Associates

* A Not-For-Profit Oil Spill Cooperative
* Formed By 33 Operators in 1972
* "By Industry for Industry"
* Mission focused on Gulf of Mexico Exploration & Production Oil Spill Response
* Currently has 118 Members

Airborne Support, Inc.

- Airborne Delivery Capabilities via Contract with Airborne Support, Inc. (ASI)
- (1) Spotter & (3) Spray Aircraft
- 16K/day application capacity
- 64K gallons of Corexit 9500A co-located at facility




CLEAN GULF ASSOCIATES
CGAS • ASI • TTMS
1-Hour BT-67 Range w/full load
WCD Volume (BOPD)
BT-67 Range w/full load

* HWCG formed in 2011 to meet BSEE requirements for Deep Water drilling.
* Mission focused on Well Containment for U.S. Gulf of Mexico.
* HWCG has 16 Members
* HWCG has all the necessary equipment to support subsea dispersant operations.

Goals

* Joint Venture by CGA and HWCG for the last three years
* Identify for use an alternative dispersant to Nalco Corexit products
* Have an inventory of equally effective dispersant with less toxicity
* Educate RRT VI & IV and FOSCs alternative dispersant solutions
* Alternative(s) selected and stocked in limited quantities available for aerial and subsea use
* FOSC is free to use dispersants without an indemnification from the manufacturer or cooperatives

Product Selection Criteria

* EPA Subpart J Product Schedule
* Effective on Louisiana light sweet crude
* Similar toxicity to Corexit
* Additional Testing (e.g., EXDET, OHMSETT, others)
* Manufacturing capacity and product turnaround
* No Indemnification requirement for product use

Dispersant Testing Status

Dispersant	Toxicity (C50 values in ppm) W/No 2 Fuel oil		Effectiveness (%)		
	Menidia (96-hr)	Mysidopsis (48-hr)	Prudhoe Bay Crude Oil	South Louisiana Crude Oil	Average of Crude Oils
BIODISPERS	5.95	2.66	51.00	63.00	57.00
COREXIT® EC9500A	2.61	3.40	45.30	54.70	50.00
FINASOL OSR 52	5.40	2.37	32.50	71.60	52.10
Accell Clean ® DWD	8.05	1.32	58.70	96.03	77.36
JD-2000™	3.59	2.19	60.40	77.80	69.10
Marine D-Blue Clean	32.00	18.00	45.00	55.59	50.30
SUPERSPERSE™ WAO2500	3.70	2.53	77.84	87.56	82.70

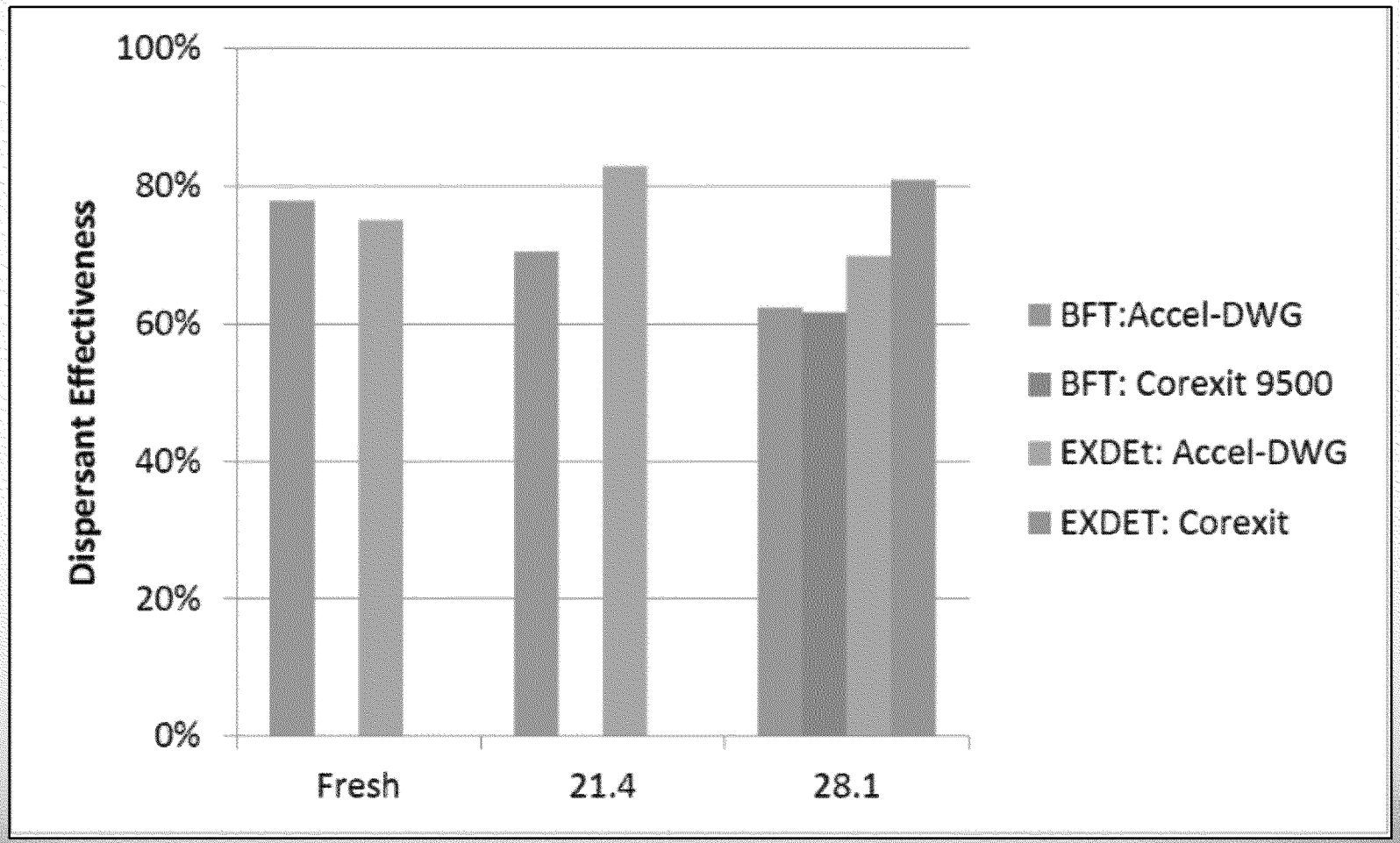
Source: EPA Product Schedule

Dispersant Effectiveness (EXDET)

Dispersant	Replicate	1	2	3	4	Average
Accel-DWG	Fresh	69.6	76.9	77.9	75.7	**75.0**
	21.4%	79.9	86.8	81.5	83.1	**82.8**
	28.2%	72.7	52.1	72.8	81.7	**69.8**
Corexit 9500	28.2%	84.5	76.8			**80.7**

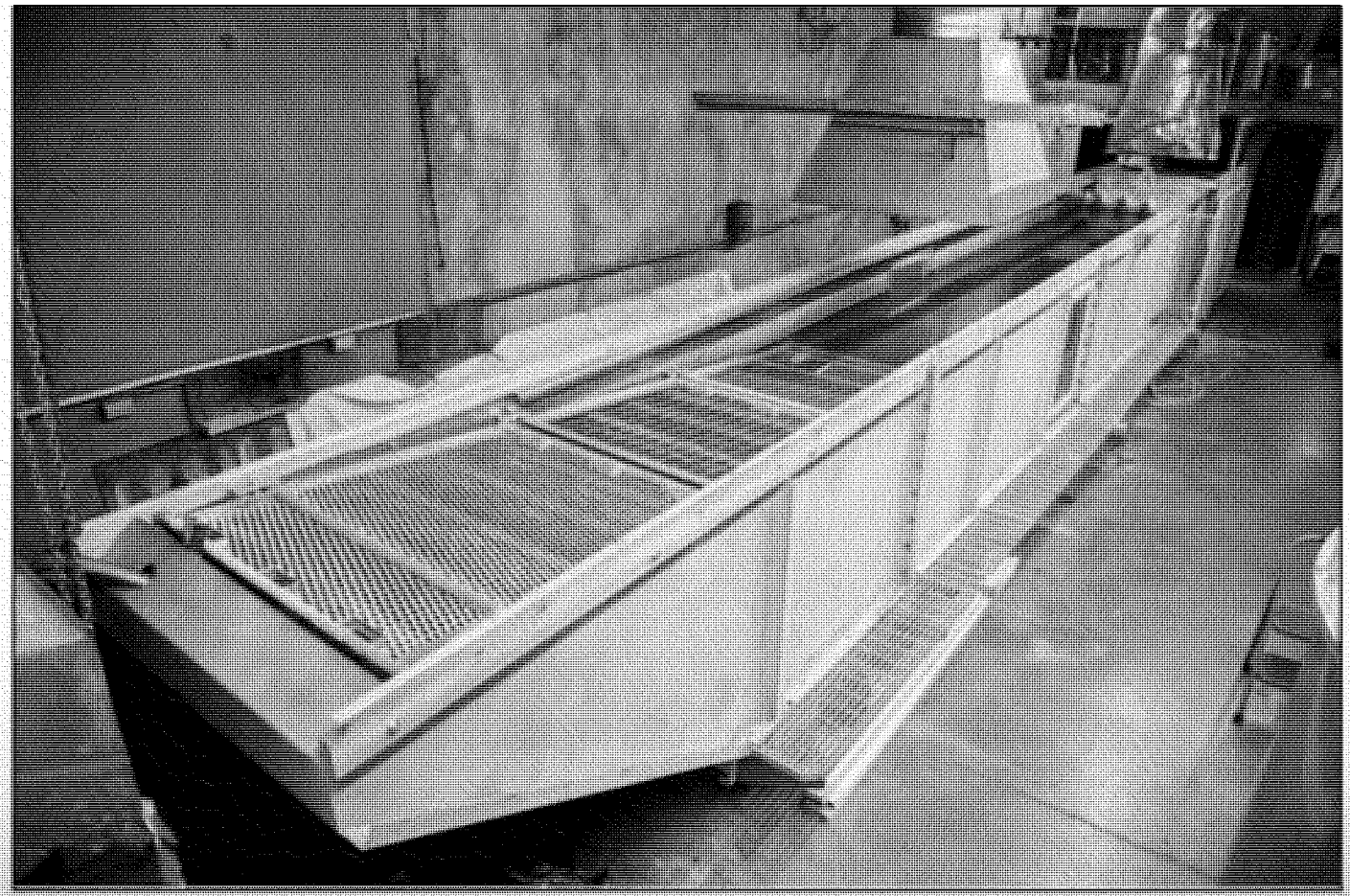
S.L Ross, 2015

Dispersant Effectiveness (EXDET)



S.L Ross, 2015

Dispersant Effectiveness
(MESO Scale Wave Tank)



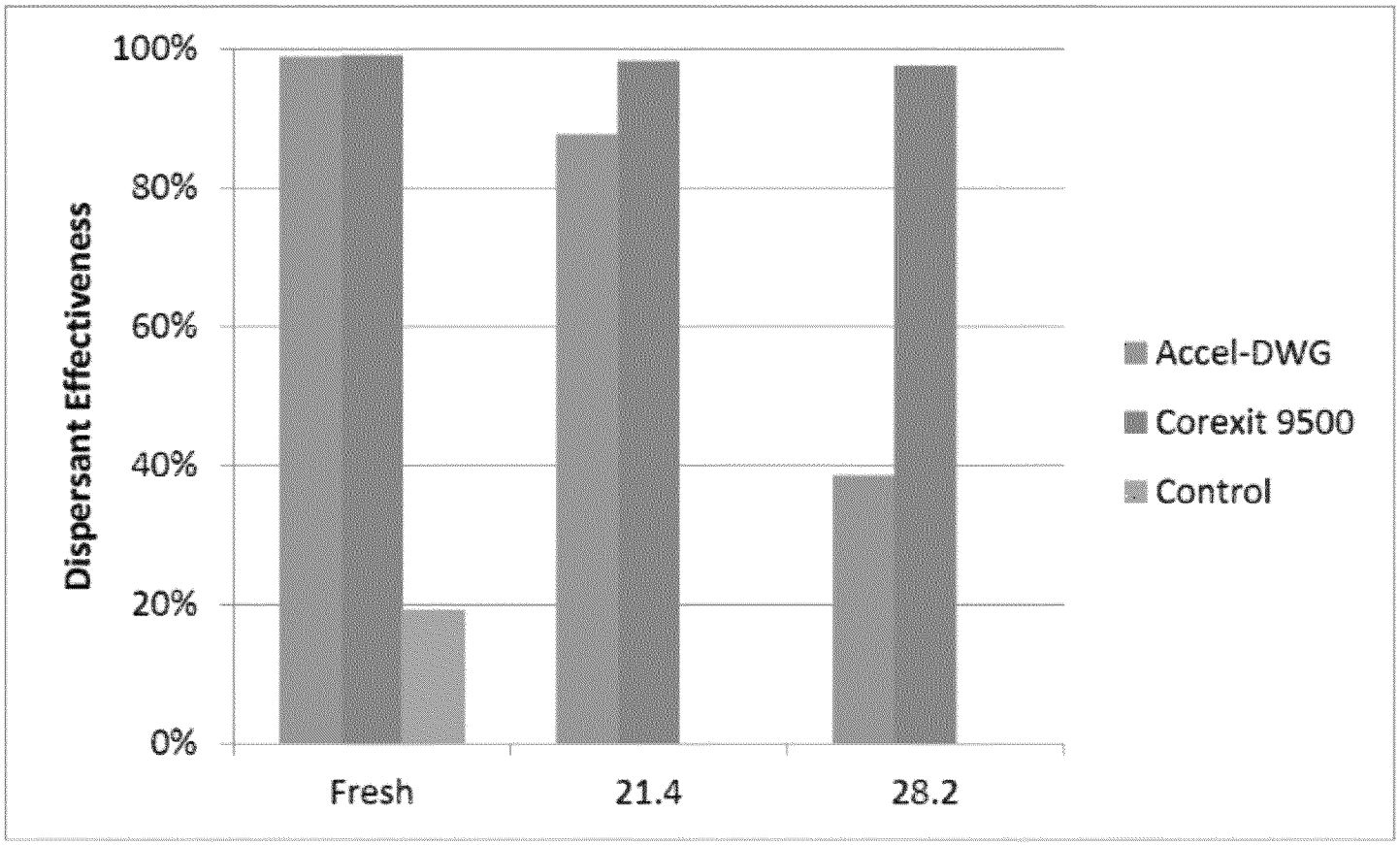
S.L Ross, 2015

Dispersant Effectiveness
(MESO Scale Wave Tank)

Dispersant	Fresh	21.4%	28.1%
Accel-DWG	98.8	87.7	38.6
Corexit 9500	99.1	98.2	97.6
Control	19.1		

S.L Ross, 2015

Dispersant Effectiveness
(MESO Scale Wave Tank)



S.L Ross, 2015

Dispersant Toxicity
(NCP Tests)

Material Tested	Species	LC50 (ppm)
ACCELL CLEAN® DWD	Menidia beryllina Mysidopsis bahia	6.58 96-hr 1.55 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	38.0 96-hr 3.61 48-hr
ACCELL CLEAN® DWD & No. 2 Fuel Oil (1:10)	Menidia beryllina Mysidopsis bahia	4.21 96-hr 2.21 48-hr
Reference Toxicant (Sodium Dodecyl Sulfate – SDS)	Menidia beryllina Mysidopsis bahia	2.43 96-hr 5.95 48-hr

Environmental Enterprises USA (EE USA) Toxicity Data for Accell Clean® DWD (2015)

Dispersant Toxicity
(NCP Tests)

Material Tested	Species	LC50 (ppm)
ACCELL CLEAN® DWD	Menidia beryllina Mysidopsis bahia	5.66 96-hr 2.07 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	11.10 96-hr 1.68 48-hr
ACCELL CLEAN® DWD & No. 2 Fuel Oil (1:10)	Menidia beryllina Mysidopsis bahia	8.05 96-hr 1.32 48-hr
Reference Toxicant (DDS)	Menidia beryllina Mysidopsis bahia	6.60 96-hr 30.80 48-hr

Retrieved from http://www2.epa.gov/emergency-response/accell-cleanr-dwd

Accell Clean ® DWD

* Listed on EPA Subpart J Product Schedule (2011)
* Very effective on Louisiana light sweet crude (E&P crude)
* Similar toxicity to Corexit
* Positive Results EXDET, Meso-scale (BSEE to test at OMSETT)
* 30K gallons/day manufacturing capacity 5-7 days
* <u>No Indemnification</u> for product use
* Protein-based Dispersant

CGA/HWCG Actions

* Agreement finalized between Advanced BioCatalytics, Corp. (ABC), CGA and HWCG
* CGA is planning to stock approximately 5K gallons at Airborne Support in Houma, LA.
* Dispersant will be available for “Spills of Opportunity”

Questions?

API SIMA Workshop Overview

Background

In recent years the oil and gas industry has placed significantly greater emphasis on the use of the net environmental benefit analysis (NEBA) methodology in the development of oil spill response strategies for at least the more significant incidents. While the general NEBA concept was well understood and many companies had developed their own NEBA methodologies, it was recognized there was not a common approach on how NEBAs should be conducted. Industry also recognized the NEBA term did not accurately represent the intent of the analysis in addition to it now addresses socio-economic and cultural impacts in addition to environmental. Consequently, IPIECA, IOGP and API collaborated on a project to develop a basic methodology for conducting NEBAs and have adopted the more descriptive term of spill impact mitigation assessment (SIMA).

API Reasoning for Workshop Need:

- Lack of a common approach/understanding of NEBA methodology - currently inconsistent
- Terminology should include socio-economic and cultural impacts in addition to environmental

SIMA Overview

The new SIMA guidelines can be summarized in the following four stages:

1. **Compile and evaluate data** for relevant oil spill scenarios.
2. **Predict outcomes/impacts** for the "No Intervention" option as well as the relative mitigation potential of other feasible response options for each scenario.
3. **Balance trade-offs** by weighing and comparing the range of benefits and drawbacks of each response option, including No Intervention, for each scenario.
4. **Select the best response option(s)** to form the strategy for each scenario that will minimize ecological, socio-economic and cultural impacts and promote rapid recovery.

The four stage process was adopted from the IPIECA/IOGP NEBA Good Practice Guide published in 2015 and the methodology was informed by the Consensus Ecological Risk Assessment (Aurand et al, 2000) as well as other NEBA/SIMA related documents and tools. The new methodology is a qualitative approach that is recommended for use in the planning phase with the outcomes modified during the response phase as necessary to account for incident specific conditions and circumstances. It can also be used independently in the response phase or in a more quantitative form for either phase if it is expected to materially change the outcomes and not time constrained.

It is important to note that this new SIMA methodology is not intended to be an industry standard applied to all oil spills but rather a methodology that can be utilized in the absence of other methods and particularly for more significant spills.

SIMA is argued as a qualitative approach, not intended as an industry standard. To be applied particularly for more significant spills.

SIMA Guidelines:

- Compile/evaluate data for relevant oil spill scenarios.
- Predict outcomes/impacts for feasible response options for each scenario, including no Intervention
- Balance trade-offs of each response option.
- Form strategy selecting best response option(s) to minimize impacts (including socio-economic, cultural) and promote rapid recovery

Workshop Objective

To better ensure the new SIMA method will be a viable approach in mitigating oil spill impacts and to promote broader acceptance within the spill response community, this workshop was organized to review the SIMA method and apply it to selected oil spill scenarios (i.e., stress test). It will involve key regulatory and industry representatives from the US. Another workshop involving international regulators and industry representatives will likely be organized as well.

The primary objectives of the workshops are to:

- identify potential significant gaps/flaws in the approach and obtain input on how best to address them, and
- obtain feedback on the suitability of the SIMA method for mitigating oil spill impacts and any potential application limitations

The primary objectives of the workshops are to:

- identify potential/significant gaps/flaws in approach and obtain input on how best to address them
- obtain feedback on suitability of SIMA method for mitigating oil spill impacts and any potential application limitations

Gina Coelho email 3-2-2016: "**The American Petroleum Institute and IPIECA have undertaken several projects to help industry improve understanding and consistent application of the "Net Environmental Benefit Analysis (NEBA)" process for spill response decision making.** One effort (in which I am involved) involves taking the IPIECA GPG and tweaking it to make it more relevant to U.S. stakeholders. **Industry recognizes the importance of involving Federal and state agencies in this process, and suggested that I seek your input. I have developed a short survey to help inform that effort. If you agree to participate, I will schedule a 30 minute phone interview during which you may verbally share your thoughts and ideas.**

The information you share with me will be kept confidential and will not be publicly distributed; it will be used to help my team (comprised of myself, David Fritz, and Jim Staves) tailor the IPIECA GPG to the US spill response framework. I understand that you may not have the same experience as other individuals within your agency, and would ask you to share information based on your own personal understanding of NEBA concepts as they apply to oil spill planning and response in the US."

- Gina Coelho is an industry consultant and was a BP contractor for DWH, Dave Fritz was a BP employee during DWH, and Jim Staves worked for EPA Region 6 during DWH, but now retired from EPA and works as an industry consultant.
- OGC raised potential ethics concerns with responding to the survey. RID sent out an email to EPA personnel (including region 6) noting OGC's concerns.
- R6 referenced the IPIECA guidance in their two page NEBA justification for subsea dispersant use as part of the 2014 Green Canyon Exercise (see attached email). At that time we raised concerns with DOI's statement (attached email train) that indicated that if "subsea dispersant application is contemplated for an actual incident, this is what the justification will likely look like as it is put forward by the offshore exploration and production industry." We have significant concerns with the lack of detailed documentation and with the conclusions of the analysis that was offered as part of that exercise.
- The IPIECA guidance was also referenced in the RRT VI Subsea Dispersant Use Guidelines (draft version in the attached RRT Subsea Guidance Email) that were developed by the ILC (those were not finalized as an RRT document, but API has hinted to developing that document into an API recommended Practice).

Industry Efforts to date [EPA concerns]:

- API and IPIECA update of their NEBA guidance, focused on relevance to US stakeholders [qualitative/general analyses, focused on shoreline protection]
- API contracted survey/phone interview of Federal/state agency representatives [EPA declined due to ethics concerns]
- Development of API Industry Guidelines on Requesting Regulatory Concurrence for Subsea Dispersant Use document [based on RRT VI draft Guidelines developed by Industry Liaison Committee; committee since disbanded due to ethics/legal concerns]
- Development of API OSRP RP document [EPA comments relative to their analyses and to clearly state in a disclaimer this was an industry effort were not taken]
- API sponsored work to develop a *Comparative Risk Analysis* "..to provide decision makers with objective, science-based and transparent information to facilitate obtaining consensus regarding appropriate strategies for mitigating impacts from oil and gas released during a deep water blowout." Expected to be incorporated into the NEBA/SIMA analysis in API Subsea Dispersant Use RP [CRA developed is but one example, not worst case, focused solely on shoreline protection)
- NEBAs developed and presented to RRTs for concurrence as part of industryled Prep 4C exercises for WCD scenarios [technical concerns with 1-2 page "expedited"/back of the envelope qualitative analyses]

RIDconcerns: Sign-off of industry developed "NEBAs." Further, industry is interpreting that concurrence to mean concurrence with their expedited "NEBAs."

CWA and NCP Requirements

Area Contingency Planning - 40 CFR 210(c):

- The ACP shall include the following…A description of the area covered by the plan, including the areas of special economic or environmental importance that might be damaged by a discharge;

Fish and Wildlife and Sensitive Environments Plan (FWSEP)

- All ACPs incorporate detailed annex containing FWSEP
- Consistent with the RCP and NCP
- Prepared in consultation with the USFWS and NOAA and other interested natural resource management agencies/parties.
- Among other requirements, the annex is to:
    - identify and establish priorities for fish and wildlife resources and their habitats and other important sensitive areas requiring protection from any direct or indirect effects from discharges,
    - provide a mechanism to be used during a spill response for timely identification of protection priorities of those fish and wildlife resources and habitats and sensitive environmental areas that may be threatened or injured by a discharge, and
    - identify potential environmental effects on fish and wildlife, their habitat, and other sensitive environments resulting from removal actions or countermeasures, including the option of no removal
    - Based on the evaluation of potential environmental effects, the annex should establish priorities for application of countermeasure and removal actions to habitats within the geographic region of the ACP

ACPs requirements under the NCP:

- Description of area covered by the plan, including those of special economic or environmental importance
- Incorporate detailed annex containing Fish and Wildlife and Sensitive Environments Plan (FWSEP)

Legal Authorities specific to Subpart J –

- Schedule identifies not only 1) the agents (e.g. dispersants), but also 2) the waters in which they may be used and 3) the quantities that can be used safely in such waters.
- Delegated to EPA Administrator
- Reference: http://www.ecfr.gov/cgi-bin/text-idx?SID=f9a9c0ef0be4091830b5282ad7c0d670&mc=true&node=pt40.30.300&rgn=div5

- 33 USC 1321 (d)(2)(G) – Prepare a schedule, in cooperation with the States, identifying—
  (i) dispersants, other chemicals, and other spill mitigating devices and substances, if any, that may be used in carrying out the Plan,
  (ii) the waters in which such dispersants, other chemicals, and other spill mitigating devices and substances may be used, and
  (iii) the quantities of such dispersant, other chemicals, or other spill mitigating device or substance which can be used safely in such waters,

  which schedule shall provide in the case of any dispersant, chemical, spill mitigating device or substance, or waters not specifically identified in such schedule that the President, or his delegate, may, on a case-by-case basis, identify the dispersants, other chemicals, and other spill mitigating devices and substances which may be used, the waters in which they may be used, and the quantities which can be used safely in such waters

- EO 12777 delegates 33 USC 1321(d)(2)(G) to the EPA Administrator

- Implemented under Subpart J of the NCP

Authorization of use Under Subpart J

- Government develops plans at the Area (ACPs) and/or Regional (RCPs) levels
- ACPs address response strategies including agent use, protection priorities, and environmentally sensitive areas,
- Any preauthorization plan included in ACPs must address "specific contexts in which such products should and should not be used"
- While there is no specific "NEBA" requirement under Subpart J, "specific context" must address agent quantities used, duration of use, water depth, distance to shoreline and proximity to populated areas. Other parameters that should be considered include environmentally sensitive resources that may be impacted, available means to monitor product application and effectiveness.

Authorization of Use (40 CFR 300.910)

- Mechanical recovery is NOT subject to authorization of use under Subpart J
- No specific "NEBA" requirement under Subpart J; rather response strategies are developed under the ACs
- RRTs and ACs address the desirability of using appropriate dispersants, other products listed on the NCP Product Schedule, and burning agents
- RCPs and ACPs shall, as appropriate, include applicable preauthorization plans and address the specific contexts in which such products should and should not be used
- The RRT representatives from EPA and the states with jurisdiction over the waters of the area to which a preauthorization plan applies and the DOC and DOI natural resource trustees shall review and either approve, disapprove, or approve with modification **the preauthorization plans developed by Area Committees**, as appropriate.
- Pre-authorization plans require approval of:
    - EPA RRT representative
    - States with jurisdiction over the waters of the area to which a preauthorization plan applies and;
    - DOC and DOI natural resource trustees
- Authorization of use for spill situations that are not addressed by the preauthorization plans requires:
    - Concurrence of the EPA representative to the RRT
    - As appropriate, concurrence of the RRT representatives from the states with jurisdiction over the navigable waters threatened by the release or discharge
    - Consultation with the DOC and DOI natural resource trustees

- Exception only to prevent or substantially reduce threat to human life
    - Insufficient time to obtain the needed concurrences/consultations
    - OSC must inform the EPA RRT representative and, as appropriate, the RRT representatives from the affected states and, when practicable, the DOC/DOI natural resources trustees as soon as possible
    - Not intended to circumvent preauthorization or case-by-case use authorizations
        - NCP addresses worker health and safety under 40 CFR 300.150

BSEE OSRP Regulations (30 CRR 254) required:

- An appropriate trajectory analysis specific to the area in which the facility is located, which must identify onshore and offshore areas that a discharge potentially could affect. The trajectory analysis chosen must reflect the maximum distance from the facility that oil could move in a time period that it reasonably could be expected to persist in the environment,
- **A list of the resources of special economic or environmental importance that potentially could be impacted in the areas identified by the trajectory analysis and the strategies used for their protection**. At a minimum, this list must include those resources of special economic and environmental importance, if any, specified in the appropriate Area Contingency Plan(s),

- A description of the response equipment that will be used to contain and recover the discharge to the maximum extent practicable and how to cope with the initial spill volume upon arrival at the scene and then support operations for a blowout lasting 30 days. This description must include the types, location(s) and owner, quantity, and capabilities of the equipment,
- A description of the personnel, materials, and support vessels that would be necessary to ensure that the identified response equipment is deployed and operated promptly and effectively, and
- Must ensure that the response equipment, materials, support vessels, and strategies listed are suitable, within the limits of current technology, for the range of environmental conditions anticipated at the facility

BSEE Oil Spill Response Plan (OSRP) regulatory requirements (30 CRR 254):

- Trajectory analysis specific to area where facility is located, reflecting maximum distance that oil could be expected to persist in the environment
- Identify resources of special economic/environmental importance - at a minimum those identified in ACPs - potentially impacted and strategies used for their protection
- Description of response equipment to contain/recover discharge to maximum extent practicable and support operations for a blowout lasting 30 days. Description to include types, location(s) and owner, quantity, and capabilities, personnel, materials, and support vessels
- Ensure that the response strategies are suitable for anticipated environmental conditions range

http://www.ecfr.gov/cgi-bin/text-idx?SID=ae9d48e87e273e549942f003d6bc7f29&mc=true&node=se30.2.254_126&rgn=div8

Note: BOEM incorporates the same BSEE requirements into Exploration/Production Plans requirements at 30 CFR 550.219 (Exploration Plans), and 30 CFR 550.250 (for Development and Production Plans (DPP) and Development Operations Coordination Documents (DOCD))
http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title30/30cfr550_main_02.tpl

USCG DWH ISPR

- Overall, the team found these ACPs to be inadequate for this incident, and possibly for smaller, more localized incidents. (pg 5)

In the Gulf of Mexico or anywhere offshore oil production occurs, there must be direct linkage between the Oil Spill Response Plan (OSRP) and local ACPs.

- The ISPR Team found that not including worst case discharge (WCD) scenarios from offshore oil exploration, development, and production activities in ACPs for areas in which such activities are occurring was unacceptable.
- The NCP directs Area Committees to address ESAs and include booming and protection strategies to address a WCD.
    - In some planning areas, the ESAs were simply not identified in any plan. In some plans where the areas were listed, they were not prioritized.
    - In few instances, ESAs did have protection strategies for the areas that were most heavily impacted.
    - The equipment, trained personnel, and other response resources needed to implement the protection strategies were not included in many plans.
    - While many responders stated that impact to wildlife and habitat could have been much worse in the Deepwater Horizon incident, there is a consensus among team members that, had ESAs been given appropriate attention during the planning process, the adverse impacts could have been much less. ESAs have been given uneven, and in some cases, inadequate attention in the ACP development process throughout the Gulf of Mexico. There must be a comprehensive national planning process that identifies ESAs and assures that there are trained personnel,

equipment, and strategies adequate to protect these resources. The Coast Guard needs to work with Federal, State, local, tribal, and natural resource trustee stakeholders to select an exemplar among those ACPs that adequately addresses ESAs and make that a benchmark for future planning efforts.

The use of two alternative response technologies, **dispersants and in situ burning (ISB), proved critical to prevent wholesale impacts to ESAs** because the characteristics of the spill were favorable to the use of both technologies. However, **important concerns and questions remain about their impacts on the environment, and more research is necessary before bringing them into the mainstream of spill response options**.

- Although pre-authorization of dispersant use was approved by the Regional Response Team (RRT) and implemented by the Federal On-Scene Coordinator (FOSC), significant public concern was expressed over the volume being used and toxicity of the dispersants, causing EPA to develop protocols for dispersant application and monitoring.
    - While the FOSC always has the authority to approve use of dispersants to protect human life, in this case, to control volatile organic compounds in the source area, EPA intervened to address the volume and toxicity issues, as well as subsea application at the source. **This resulted in a temporary suspension of dispersant application, which may have resulted in more oil reaching the coastline.**
    - While the issue of subsea application may not have been reasonably foreseen, **other issues such as toxicity and volumetric limitations should have been foreseen as part of the National Oceanic and Atmospheric Administration/Environmental Protection Agency preparedness programs, and should have been researched and addressed well before this event.**
- The use of dispersants in the Deepwater Horizon incident identified a need for a thorough review of this response option, its efficacy in minimizing environmental impacts, its overall effect on the environment, and conditions under which they are most effective. Dispersant protocols and authorization procedures should be established and articulated in ACPs, and the degree to which dispersants may be used in ESAs should be addressed.

For DWH the USCG ISPR noted that the estimated flow rate was substantially less than the WCD scenario for the OSRP, EP, and VRP—over 100,000 barrels per day less than the planned WCD scenario in the BP EP, and almost 200,000 barrels per day less than that reflected in the BP OSRP (which was based on MC Block 462 with the daily flow rate 250,000 barrels of oil per day).

- The USCG ISPR also noted that "The BP OSRP identified the OSROs as having various skimming systems that would be used in the hypothetical spill event with a cumulative "Effective Daily Recovery Capacity" (EDRC) of almost 492,000 barrels per day…." and
- "On face value and under optimal conditions, mechanical recovery systems alone should have been more than adequate to recover the oil both anticipated and actually released."

Reference: https://www.uscg.mil/foia/docs/dwh/bpdwh.pdf

EPA Subpart J Proposed Rule

The EPA representative to the RRT, the Department of Commerce and the
Department of the Interior natural resource trustees and, as appropriate the RRT representative from the state(s) with jurisdiction over waters and adjoining shorelines within the preauthorization plan area shall review and either approve, approve with modification, or disapprove **the preauthorization plans developed by the RRT and/or the Area Committees.**

Reference: https://www.epa.gov/emergency-response/revisions-national-oil-and-hazardous-substances-pollution-contingency-plan

API Comments on Subpart J

API General Comments

(pg 1-2) To this end, woven into every operational endeavor are release prevention measures, preparedness methods and plans for rapid, effective response should an incident resulting in a release occur. Developed alongside regulatory agencies, operators submit to and follow a distinct set of response principles which protect shared values. The framework by which these principles are employed and tradeoffs are made in order to protect these shared values is called Net Environmental Benefit Analysis (NEBA). NEBA is a process used by the response community for making the best choices to minimize impacts of oil releases on people and the environment. NEBA aids in protecting people and the environment, and is the matrix through which every decision is made in a response event. In the offshore context, oil dispersing agents are a primary tool in the NEBA process and the response toolkit, as they are a principal tool used for protecting human health and defending environmentally sensitive areas. When a release occurs, judgment and response speed are critical. In an offshore setting, dispersants are essential in creating a safe environment and are a key ingredient in marshaling an effective, swift response.

(pg 4-7) *A Net Environmental Benefit Analysis Process Ensures Response Choices that Minimize the Impacts of Oil Spills on People and the Environment*

Any changes to the rule must take into account the Net Environmental Benefit Analysis (NEBA)[2] process. When a spill occurs, the OSC must make time-critical choices about which response options to implement immediately and effectively to manage the potential impacts of the spill. The NEBA process helps the OSC select choices that minimize the impacts of the spill on people and the environment. **NEBA is a consensus-based planning tool** that is used to bring natural resource trustees, regulators and stakeholders together to address resource-management decision-making needs for an oil spill response. It provides a structured, scientific method to evaluate the likely net reduction, or possible increase, **in environmental and socio-economic impacts** resulting from the implementation candidate response options as compared to the natural recovery or "do nothing" alternative. An assessment of the trade-offs associated with each option is then conducted taking into consideration the potential impacts to sensitive environmental resources and local community values. The NEBA process determines which response option or combination of options can best reduce the overall impact of spilled oil to common values and promote the fastest overall ecosystem recovery. **Of particular note, the NEBA process considers the potential effects to a wide range of concerns, ranging from likely environmental effects (i.e., deep marine to terrestrial, etc.) to possible economic consequences**. When initially considering the potential outcomes, no individual area receives a greater priority over another. Instead, all are weighed from an equal footing and only after evaluating all the likely effects is a determination made regarding the response option that offers that greatest environmental benefit. In so doing, **decision-makers ensure that an unbiased process is used, with input from relevant stakeholders,** to determine the best course of action. This process has been adopted all over the world to identify response methods that will yield the greatest benefit with the least impact.[3]

The NEBA process can be used in both oil spill preparedness planning and response. In the United States, **a formal NEBA process is conducted during the planning phase at the Area Committee and Regional Response Team (RRT) levels with input from state and Federal participants to determine the benefits and limitations from using each response technology within their individual areas of responsibility. In most offshore regions of the U.S., this is accomplished in the form of the Consensus-Based Ecological Risk Assessments (CERA) process (NEBA equivalent) used by the U.S. Coast Guard (USCG)[4] and supported by the National Oceanic and Atmospheric Administration (NOAA), EPA, other Federal and state agencies, and academia.** More than twenty workshops were held in various locations around the continental U.S., Caribbean, and Alaska from 1995 to 2011 to compare the benefits and risks of various response options when considering resource trade-off decisions. All of the workshops resulted in final publications (available from USCG) that were delivered to the Area Committees and RRTs to assist with response planning. One example of how this CERA/NEBA process was used to inform dispersant use decision-making is summarized in several papers authored by regulators in the state of California.[5] The applicability of the CERA/NEBA process

as a tool for facilitating dispersant decision-making during spill response and planning was also evaluated by NOAA and published in a 2008 paper.[6]

In 2014, the practice of incorporating a NEBA review during Source Control drills in the Gulf of Mexico was implemented by RRT VI during several large scale spill response exercises,[7] which has fostered good cooperation between the agencies to focus on the goal of minimizing shoreline community and ecosystem impacts by selecting response options that can maximize the effective treatment of oil offshore. NEBA discussions during both of these recent spill drills resulted in the concurrence of the RRT to authorize dispersants (both aerially and subsea) to treat the offshore oil slick.

Government decision-makers and/or the Responsible Party can conduct a rapid NEBA during actual spill responses to compare and rank the strengths and weaknesses of different response options for the incident-specific conditions. Lessons learned following a spill are incorporated into future policies and plans. Ecological recovery studies of the 1996 *Sea Empress* spill in the UK demonstrate the benefit of dispersant application along the coastline to prevent persistent oil from stranding in shoreline habits.[8] A more recent publication examined the recovery rates for a tropical ecosystem during a controlled study of dispersed versus untreated shoreline oil slicks and concluded that better recovery occurred in the areas where dispersant was used.[9]

Regrettably, the Proposed Rule lacks a NEBA perspective. It incorrectly focuses on intrinsic, hazard-based criteria for substance listing and ignores the more appropriate risk-based trade-off decision process responders must consider during an oil spill response. It does not recognize that dispersants are only applied when regulators and response decision-makers deem them necessary to prevent more significant and harmful consequences. The Proposed Rule favors protecting pelagic and benthic species while putting **critical habitats, such as the ocean's surface and near-surface zones,** as well as sensitive shorelines, at greater risk to environmental damage. **Modeling results** presented at the 2005 International Oil Spill Conference concluded that:

> *"...the **results of the modeling** support the contention that there are more opportunities to save wildlife, shorelines, and sensitive habitats along the shore with dispersant use than there are risks of impacting water column biota. If the areas that would be impacted by surface oil are those where wildlife are concentrated, as they typically are near shore, and the water column impacts resulting from dispersant use would be offshore where water column biota are lower in abundance, the trade-off is much more heavily weighted toward dispersant use before oil comes near the shoreline. In fact, for medium or smaller spills, or even larger spills where sensitive species and life stages are not present, the impact of dispersant use on water column biota could be negligible."*[10]

For oil spills where dispersant use is contemplated, a typical NEBA will predict the potential impacts to aquatic organisms from an increased exposure to dispersed oil droplets. Dispersant use is typically restricted to water depths greater than 10 to 20 meters so that dilution will minimize exposure or impacts to the benthic community. Studies have shown the dispersed oil concentrations are rapidly diluted within the large volume of receiving water from a high of a few hundred parts per million to a few parts per million within a few hours. Consequently, exposure to the toxic effects of the dispersed oil will be of short duration and limited to those aquatic organisms that inhabit near surface waters. The NEBA will also estimate the reduction of impacts to waterfowl, shoreline ecosystems and coastal communities resulting from the reduction in, or elimination of, the quantity of floating oil. The trade-offs of a short term increase in exposure of selected aquatic organisms to dispersed oil versus an increase in oil impacting coastal environments and communities must be evaluated and take into

account local community values to determine if dispersant use is warranted.

Given the challenges of implementing other response options, a decision not to have dispersants available to responders could result in oil stranding on shorelines where it may persist for an extended time. Effectively dispersed oil will biodegrade rapidly so that the majority of the oil will persist for a much shorter period of time. Reducing the persistence of the oil in the environment is critical to reducing the overall impacts.[11] This is not to say that water column organisms are less intrinsically important than surface or shoreline species but using NEBA can and does provide a critical framework for deciding what is best for the overall ecosystem. Important considerations to understand in assessing this tradeoff include:[12]

- The impacts to the water column are mitigated by dilution – that is the potentially toxic levels of dispersed oil are limited in duration and physical coverage/extent and effected populations (e.g., plankton) tend to be ones that recover quickly.
- Oil effectively dispersed in the water column will generally biodegrade after a few days or weeks while oil stranded in near shore and shoreline areas can persist for years.
- Near shore and shoreline areas are the nursery grounds for many species, even those that live offshore as adults, so protecting the near shore areas also protects organism that live as adults offshore.
- The bio density of near shore areas (swamps and marshes) is far greater than the bio density in pelagic waters offshore.
- Dispersants also protect surface dwelling organisms offshore, i.e., marine mammals, birds, and turtles, through removal of floating oil.
- Slicks on the water surface are far more likely to impact fish eggs and larva that tend to float at or near the water surface than quickly removing oil from the surface with dispersants.
- In certain geographies, slicks can impact mangroves and other shoreline vegetation that can subsequently die off and result in shoreline erosion that increases sediments in the near shore water column and potentially affects corals and other species.

The Agency should consider the NEBA process and how and why dispersants are used before making changes to the Subpart J Regulations.

[2] NEBA is similar to the Consensus Ecological Risk Assessment (CERA) process developed by the U.S. Coast Guard in the mid-1990s.

[3] See, Incident management system for the oil and gas industry: good practice guidelines for incident management and emergency response personnel, IPIECA, August 2014, http://www.ipieca.org/publication/incident-management-system-oil-and-gas-industry-good-practice-guidelines-incident-manage.

[4] Aurand, D., Walko, L., & Pond, R. (2000). Developing consensus ecological risk assessments: Environmental protection in oil spill response planning. Washington, D.C.: U.S. Coast Guard.

[5] Addassi, Y. N., & Faurot-Daniels, E. (2005). California oil spill dispersant plan-Achievement through cooperation. Proceedings of the 2005 International Oil Spill Conference, 2005(1), 433-437. doi:10.7901/2169-3358-2005-1-433; Addassi, Y. N., Sowby, Parker-Hall, H., & Robberson, B. (2005). Establishment of dispersant use zones in the state of California: A consensus approach for marine waters 3–200 nautical miles from shore. Proceedings of the 2005 International Oil Spill Conference, 2005(1), 187-191. doi:10.7901/2169-3358-2005-1-187.

[6] Mearns, A., & Evans, M. (2008). Evaluating the consensus ecological risk assessment workshop as a tool for facilitating decision-making during spill response and planning. *Proceedings of the 2008 International Oil Spill Conference Proceedings, 2008*(1), 739-741. doi:10.7901/2169-3358-2008-1-739

[7] **Freeport McMoran Source Control drill (April 30-May 1, 2014) and BP Source Control drill (Nov 5-6, 2014)**

[8] Lunel, T., Rusin, J., Bailey, N., Halliwell, C., & Davies, L. (1997). The net environmental benefit of a successful dispersant operation at the Sea Empress incident. *Proceedings of the 1997 International Oil Spill Conference, 1997*(1), 185-194. doi:10.7901/2169-3358-1997-1-185

[9] Baca, B., Rosch, E., DeMicco, E. D., & Schuler, P. A. (2014). TROPICS: 30-year follow-up and analysis of mangroves, invertebrates, and hydrocarbons. *Proceedings of the 2014 International Oil Spill Conference, 2014*(1), 1734-1748. doi:10.7901/2169-3358-2014.1.1734

[10] **French McCay, et al., Modeling Fates and Impacts of Hypothetical Oil Spills in Delaware, Florida, Texas, California, and Alaska Waters, Varying Response Options Including Use of Dispersants**. International Oil Spill Conference Proceedings: May 2005, Vol. 2005, No. 1 pp. 735-740. Also available at http://ioscproceedings.org/doi/pdf/10.7901/2169-3358-2005-1-735.

[11] Hazen, et al., Deep-Sea Oil Plume Enriches Indigenous Oil-Degrading Bacteria, Science, 330 (2010), pp. 204-208.

[12] (a) French McCay, D., and Graham, E. Quantifying Tradeoffs – Net Environmental Benefits of Dispersant Use. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 762-775.
(b) McManus, M.A., Woodson, C.B. Plankton Distribution and Ocean Dispersal. The Journal of Experimental Biology, 215 (2012), pp. 1008-1016.
(c) DeMicco et al., Net Environmental Benefit Analysis (NEBA) of Dispersed Oil on Nearshore Tropical Ecosystems: TROPICS – The 25th Year Research Visit, International Oil Spill Conference Proceedings, May 2011, Vol. 2011-282.
(d) Varela et al., The Effect of the "Prestige" Oil Spill on the Plankton of the N-NW Spanish Coast. Marine Pollution Bulletin 53 (2006), pp. 272-296.
(e) Addassi, et al., Establishment of Dispersant Use Zones in the State of California: A Consensus Approach for Marine Waters 3-200 Nautical Miles from Shore. International Oil Spill Conference Proceedings: May 2005, Vol. 2015, No. 1, pp. 187-191.

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Dispersant Toxicity Tests do not Accurately Simulate Real World Exposures.

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(pg 9) In the context of NEBA (and its forebear, the Consensus Ecological Risk Assessment, or CERA), scientists understand and accept that marine organisms may experience localized, transient toxic effects from exposure to dispersed oil, but these local effects are offset by the benefit of dispersant use in preventing or minimizing oil drifting ashore and causing severe and long-term harm to more sensitive coastal resources and communities. **While knowledge of the potential for toxic effects to marine organisms is useful for conducting a NEBA, it cannot be the sole indicator that dictates the use of dispersants.** All resources-at-risk as well as coastal communities must be considered in the response option decision-making process, with the emphasis on coordinating a response that will result in the least overall impacts while promoting the most rapid overall recovery of the affected ecosystem.

Section § 300.910 Authorization for Agent Use

The Unified Command (UC) determines the best use of response assets on a daily basis.

(pg 14) EPA should not establish a policy or rule that mechanical recovery is always the priority choice of countermeasures to use in a response. In the preamble for this section (column 1, 80 Fed. Reg. 3387), the Agency makes the following statement:

> *"During the DWH response, a priority countermeasures scheme was established to first use mechanical recovery via skimming/booming or in-situ burning followed by subsea dispersant and lastly surface dispersant use."*

This may have been the conceptual prioritization from the perspective of EPA, but in reality dispersants played a much larger role and it was the responsibility of the UC to determine the best use of response assets on a daily basis to account for weather conditions, VOC suppression, oil slick locations, response equipment availability, etc. Every spill is different and specific references to a single spill event can indirectly and inappropriately be perceived as a recommended practice and should be avoided. In any spill scenario, all response tools must be used to their maximum effect. The Agency's unprecedented use of "Directives" during the DWH incident severely limited the use of dispersants and **circumvented the NEBA decision-making process allowing significantly more oil reaching the water's surface and, subsequently, the shoreline.** This resulted in additional environmental impacts with no documented benefits to the marine ecosystem.

The Agency should reconsider this statement and prioritization as it puts unneeded complexity into the response decision-making process and inappropriately prioritizes mechanical recovery over other response options. The effectiveness of mechanical recovery can be limited in large, offshore spills as a result of typical environmental conditions, such as wave action/height or wind conditions as well as the extensive surface area that must be covered. **Further, the Agency's artificial prioritization of this technique over other viable response options is contrary to the NEBA concept to determine the best blend of response options (with no pre-determined or pre-existing bias) to achieve the best overall protection and recovery for the ecosystem.**

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Proposed changes involving preauthorization planning will increase the workload of all Regional Response Teams (RRTs) and Area Committees (AC) and restrict their flexibility.
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(pg 16) The Agency must provide specific examples to show how this rule assists responders, particularly in relation to the OSC duties of making timely operational decisions, **especially those decisions based on using the concept of NEBA to guide a response.**

Section § 300.910(a) Use of Agents Identified on the Schedule on Oil Discharges Addressed by a Preauthorization Plan
Area Committees should identify shoreline habitats that can benefit from the appropriate use of dispersants.
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(pg 17) API and NOIA support the requirement that Area Committees should identify shoreline habitats that can benefit from the appropriate use of dispersants or other response methods. **This will advance the use of the NEBA concept.** Note that many of these resources are already identified in Area Contingency Plans.

Section § 300.910(a)(1) Preauthorization Plan Development
Dispersant use should not be limited by the preauthorization plan.
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(pg 19) If the Agency wants to determine whether and how to limit dispersant use, we propose a joint EPA/industry study of existing research results to provide scientific credibility to any limitations that are established. Without scientific justification, artificially-set limitations on dispersant use would threaten the intent of using NEBA to support response decision-making and would limit the OSC's ability to make the best overall decision concerning the actual scenario and the environment.
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We suggest that the Agency confer with other Federal agencies involved in oil spill planning and response and revise the language in the Proposed Rule to specify that preauthorization should rely on the concepts of CERA/NEBA as the foundation for plans and response decisions, not on artificially set limits on dispersant volumes. The USCG has conducted more than a dozen CERAs to help inform the decision-making process, but **the Proposed Rule appears to contradict the CERA/NEBA tenets that were previously used to define preauthorization zones.**

Section § 300.910(b) Use of Agents Identified on the Schedule on Oil Discharges Not Addressed by a Preauthorization Plan
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(pg 23) ***Early dispersant use decision-making should focus on documenting that a NEBA justification exists to support dispersant application.***
The Proposed Rule would unnecessarily establish new requirements for an OSC to document the parameters used to authorize dispersants. This is discussed in the same section (column 2, 80 Fed. Reg. 3423), as follows:

> *"...the OSC must consider and document the parameters for the use of agents including the quantities to be used, the duration of use, the depth of water, the distance to shoreline and proximity to populated areas, and should address factors such as environmentally sensitive resources or restricted areas that*

might be impacted, agent inventory and storage locations, agent manufacturing capability, availability of equipment needed for agent use, availability of adequately trained operators and appropriate means to monitor agent use in the environment."

Because dispersants have a limited window of opportunity to be used on spills, it is important to decide quickly on their use. Decisions by the OSC should not be delayed to complete information that is not needed.

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As such, we believe that the immediate actions by the OSC should include a review of the pre-authorization plan(s) and **a rapid, incident-specific NEBA to support the selection of response options that may include dispersant application as a means to lessen or eliminate impacts to sensitive shoreline resources or to protect worker health and safety.**

Section § 300.910(g) Supplemental Testing, Monitoring, and Information

(pg 28) *API believes the standard efficacy and toxicity tests already required are more than adequate for regional use.*

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Regional data are unlikely to fundamentally change overall NEBA considerations for dispersant use.

Section § 300.910(h) Recovery of Agents from the Environment

The OSC has the authority to use the NEBA process to make decisions on recovery of agents from the environment.

(pg 29-30) In the preamble to this section, the Agency is requesting comments on new language that would require the Responsible Party, under OSC oversight, to remove specified products/agents from the environment after use. While the Proposed Rule hints at NEBA, it does not reference it specifically when suggesting that some situations (e.g., safety of personnel or greater harm to the environment) might preclude the removal of these agents. That would seem to contradict the main change in this section (h) while not providing any framework (e.g., NEBA) in which to make a determination for precluding the removal. The language is also potentially redundant as the OSC is already obligated to consider safety and additional adverse environmental impacts (i.e., via NEBA) as part of the normal decision-making process. Essentially, it is already an underlying tenet of the response process. Additionally, in some cases recovering 100 percent of these agents after application is not practical or even feasible regardless of the diligence of the Responsible Party

We suggest revising the proposed language to make it clear that the OSC has the authority to use the NEBA process to make these decisions:

(h) Recovery of Agents from the Environment. Depending on factors such as the safety of response personnel and harm to the environment (including consideration of Net Environmental Benefit Analysis [NEBA]), and as directed by the OSC, the Responsible Party shall, following application, endeavor to adequately contain, collect, store and dispose of the agents that are intended to be recovered from the environment.

Section § 300.913 Monitoring the Use of Dispersants

The appropriate use of spill mitigating products will reduce the overall impact of the spill and protect the health and safety of response personnel.

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(pg 30-31) The main threat to response personnel, communities, and the ecosystem comes from the oil, not from the spill mitigating products. The concept of CERA/NEBA accepts that some effects might be caused by the response (including the use of spill mitigating products), but also recognizes the greater benefit of reducing the overall impact of the spill that can be achieved by using them. The Agency needs to acknowledge the importance of NEBA in justifying the use of dispersants.

We believe that the focus on the potential for negative environmental impacts that could be caused by a dispersant ignores the essential point that dispersants are used to mitigate (minimize) the negative human health and environmental impacts that could be caused by the oil. The main threat to the ecosystem comes from the oil itself, not from the dispersant. The wording of the preamble to a final rule needs to:

- reflect the ultimate aim of dispersant use;
- clarify that the toxicity of dispersed oil comes from the oil (not the dispersant); and
- acknowledge and emphasize the importance of using a NEBA process in dispersant use decision-making.

We request that the Agency consider including the following two paragraphs (or equivalent language) in the preamble to the final rule to briefly explain dispersant use and the importance of NEBA in making dispersant use decisions.

> *"Dispersant Use and Net Environmental Benefit Analysis (NEBA)*
> *The aim of dispersant use is to protect response personnel from VOC exposure and to prevent oil from drifting ashore and potentially causing severe and long-term damage to coastal resources and communities, by dispersing the oil into the water column where it will be diluted rapidly to very low concentrations and the majority of the oil will subsequently be biodegraded. This common aim of dispersant use is the same, whether it is applied to oil on the sea surface or directly at the outflow source in the case of a subsea release. The potential risk of dispersant use is that, by dispersing the oil into the water column, there is an increased potential for toxic effects to be caused to marine organisms. The severity of the toxic effects that could be caused is related to the exposure of the marine organisms to the dispersed oil (or the partly water-soluble oil compounds) and exposure is a function of concentration of the oil in the water and the duration for which such exposure persists.*
>
> *The issue of the environmental trade-offs caused by dispersant use is addressed by Net Environmental Benefit Analysis (NEBA). NEBA is a process used to make choices about oil spill response techniques to be used to minimize the potential impacts of the oil on people and the environment. NEBA takes into account the likely effectiveness and feasibility of conducting alternative response techniques under the prevailing conditions. The main principle of NEBA is that an oil spill response technique (or combination of techniques) that is used should be that which minimizes potential impacts of the oil on the environment to the greatest extent and promotes the most rapid recovery and restoration of the affected area. In many cases of dispersant use, the potential risks to the offshore marine ecosystem are very low because dispersed oil concentrations are low and persist only briefly. There is benefit in using dispersants in offshore environments to prevent damage to coastal communities and sensitive near-shore resources where persistent stranded oil can cause longer-term environmental problems."*

The Proposed Rule also appears to focus more on the environmental effects during the response rather than the health and safety of response personnel. The Agency should make it clear that one of the primary objectives of characterizing the efficacy and understanding transport is to protect the health and safety of response personnel. That critical aspect is not mentioned in this section.

Section § 300.913(a) Documenting and Monitoring the Oil Discharged and Dispersants Used Requirements
The Responsible Party should not be required to document information at the beginning of a response that has already been determined in planning and preparedness activities.

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(pg 35) Given current dispersant stockpiles in the U.S. and in the Global Dispersant Stockpile, it should be assumed that sufficient dispersants will be available if their use is warranted by NEBA.

Section § 300.913(d) Ecological Receptor Characterization
Monitoring required to determine possible environmental effects is too time consuming to support dispersant operations decisions.

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(pg 40) Rather than requiring the Responsible Party to make this real-time assessment [species sensitivity distributions (SSD)], a CERA/NEBA process (conducted as part of contingency planning) should serve as the basis to make operational decisions on whether dispersants and/or other agents should be used during a response. A CERA/NEBA is the only mechanism that allows a full environmental trade-offs analysis of all response options to be conducted.

Section § 300.913(e)(1) Daily Sampling and Data Analyses Reporting
The Agency should not develop requirements for daily authorizations of dispersant quantities.
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(pg 40) Furthermore, it [placing daily limits on volumes of dispersants] circumvents the NEBA process that evaluates the best response options that protect the environment as a whole.

Section § 300.913(e)(2) Immediate Reporting of Ecological Receptors
Real-time ecological receptor analysis is unrealistic and should be part of a CERA/NEBA process.

(pg 41) The requirement in this section for real-time ecological receptor analysis is unrealistic. Such efforts need time and broad stakeholder participation to be meaningful. This information should be part of a NEBA process to document the resources at risk of the potentially affected ecosystem. Only through this detailed NEBA process can an adequate understating of overall ecosystem recovery be developed and assessed. Further, the process of overall environmental trade-offs is independent of individual species impacts and should be based at the ecosystem level.

Section § 300.915(b)(2) Dispersant Toxicity tests and listing criteria
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Testing of dispersants using the developmental assay for the purple sea urchin is not relevant.
(pg 47) The relevance of this test [EPA test protocol involving sea urchin embryos], which was developed for the assessment of wastewater effluents, to dispersant use is highly questionable. Again, trying to estimate potential real world consequences to dispersed oil exposure should be part of a NEBA decision-based process. The environmental trade-offs of using dispersants in offshore environments to protect sensitive shoreline habitats from oil exposure is being circumvented.

Dispersant testing should only be used for screening individual dispersant products.
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(pg 48) In summary, the Agency's suggested toxicity testing changes in the Proposed Rule do not take into account the essential role of NEBA in considering the potential benefits and risks of dispersant use as a response option for an offshore oil release. The Product Schedule should focus on the basic testing to compare the efficacy and toxicity of the dispersants against each other with the sole purpose of screening good products that should be listed. The Proposed Rule should not attempt to translate any laboratory data into possible real-world implications. This process should instead be defined by full stakeholder NEBA discussions specific to a given spill scenario.

Conclusions
(pg 51) The Proposed Rule does not recognize that response option decisions must be based on NEBA and that dispersing oil in offshore environments, where it may dilute and biodegrade, is often preferred over the long-

term environmental damages that will occur when untreated oil strands and persists in shoreline environments;

Gulf ACP Updates http://www.rrt6.org/ResponsePlans.aspx
Area Committee defined in the NCP (40 CFR 300.5): Area Committee (AC) as provided for by CWA sections 311(a)(18) and (j)(4), means the entity appointed by the President consisting of members from qualified personnel of federal, state, and local agencies with responsibilities that include preparing an area contingency plan for an area designated by the President.

BSEE Well Control and Arctic Rules

Arctic Rule (6-27-2016 version)

Previous draft BSEE preamble stated: "Oil discharged into the environment will always result in the potential for some level of toxic effects to organisms and their habitat. Spill response countermeasures have the potential to reduce or mitigate these toxic effects. **Conducting net environmental benefit analyses is the best way to plan for and make operational decisions regarding which spill response countermeasures will result in the most effective reduction of the harmful effects of spilled oil.**" (pg 178).

- EPA commented that the preamble "Should be clearly highlighted here that the analysis "to plan for and make operational decisions regarding which spill response countermeasures" to use is conducted as part of the ACP/RCP process as described elsewhere in this preamble."
- BSEE's response: deleted text at issue – not necessary to response. (the entire text cited above)

Previous draft BSEE preamble stated: BSEE also supports the use of a process to compare the environmental outcomes associated with using various response techniques and countermeasures in order to assess and select the most appropriate response technologies for use during an event. However, the selection and use of response technologies during a spill event is governed by EPA regulations contained within the NCP, and by the FOSC, which is a pre-designated senior USCG official. BSEE is not dictating the selection or use of any particular strategies for responding to any specific spill situation through its regulations or the OSRP process. **BSEE does have a separate regulatory rulemaking study underway that is considering a requirement for all OSRPs to include the use of an assessment process that would evaluate the environmental tradeoffs of various response countermeasures in their planning for a response.** (pg 258-259)

- EPA commented: How is this not relevant to the RCP/ACP effort, as opposed to the OSRP, which have the "…focus and purpose is to address how the operator will supply, manage, and sustain the necessary response resources for implementing the strategies and tactics." as stated in BSEE's response below?
- BSEE response: Revised – deleted language (in the bold text)

"One commenter recommended that strategies and tactics listed in the OSRP, including use of dispersants and burning, should be based on the latest regional-specific research, historical oil spill data, field tests conducted by the operator or its Oil Spill Response Organization (OSRO), and exercises, and environmental analysis.

While BSEE agrees that response strategies and tactics should be informed by all the methods recommended by the commenter, **BSEE disagrees with their assertion that plan holders are responsible for gathering this information, or that plan holders are responsible for field testing or validating these strategies and tactics as part of the process of developing and submitting their OSRPs. Rather, response strategies and tactics are developed and approved for use geographically and temporally, and should be exercised and validated by the Regional Response Teams and Area Committees, and should be contained in the appropriate RCPs and ACPs.** As such, Regional Response Teams and Area Committees would be the appropriate entities to review ongoing trends, new research or testing information, and to adjust the response strategies in the RCPs and ACPs accordingly. While OSRPs must be consistent with the strategies and tactics identified for use in the relevant RCPs and ACPs, their focus and purpose is to address how the operator will supply, manage, and sustain the necessary response resources for implementing the strategies and tactics."

"Two commenters recommend that the requirements in § 254.80 should contain specific protection and response strategies and maps for environmentally sensitive areas and subsistence resources. One of the commenters further suggests that plan holders should have response personnel and equipment pre-staged near those sensitive sites, and that the strategies and equipment should be tested through a plan holder's exercise program, prior to being included in an OSRP.

While BSEE agrees protection and response strategies for sensitive resources are a critical part of oil spill response, **BSEE disagrees that these strategies should be developed by industry plan holders, nor does BSEE believe it is feasible for a plan holder to pre-stage personnel and equipment throughout the Arctic wherever sensitive resources might be located. The correct place for the development of protection and response strategies for sensitive areas and resources, in accordance with guidance in the NCP, is in the**

ACP. In this case, the appropriate place would be within the North Slope SubArea Contingency Plan. Existing regulations do, however, require that operators address strategies for protecting environmentally sensitive areas in their OSRPs. See, e.g., §§ 254.23(i)(3)-(4); 254.26(c). BSEE does not believe that further treatment of this issue is necessary in § 254.80. The Alaska Regional Response Team and the North Slope SubArea Committee are responsible for testing and validating these strategies. **It is not the responsibility of an industry plan holder to develop these geographical response strategies, nor is it a requirement for a plan holder to test any strategies listed in an ACP prior to referencing them in their OSRP."**

In response to comments, BSEE disagreed with the commenter's assertion that plan holders are responsible for gathering this information, or that plan holders are responsible for field testing or validating these strategies and tactics as part of the process of developing and submitting their OSRPs.

- BSEE stated that response strategies and tactics are developed and approved for use geographically and temporally, and should be exercised and validated by the Regional Response Teams and Area Committees, and should be contained in the appropriate RCPs and ACPs.

Separately, BSEE rulemakings stated:

- Conducting net environmental benefit analyses is the best way to plan for and make operational decisions regarding which spill response countermeasures will result in the most effective reduction of the harmful effects of spilled oil.
- BSEE does have a separate regulatory rulemaking study underway that is considering a requirement for all OSRPs to include the use of an assessment process that would evaluate the environmental tradeoffs of various response countermeasures in their planning for a response
- In response to EPA comments asking for clarification on how NEBA and BSEE's separate study fits in with their comments on the ACP/RCP process as described elsewhere in the preamble, BSEE deleted the statements

BSEE disagreed that protection and response strategies for sensitive resources should be developed by industry plan holders. They stated that:

- The correct place for the development of protection and response strategies for sensitive areas and resources, in accordance with guidance in the NCP, is in the ACP.
- It is not the responsibility of an industry plan holder to develop these geographical response strategies, nor is it a requirement for a plan holder to test any strategies listed in an ACP prior to referencing them in their OSRP

DWH NRDA

RRT 6 Industry Liaison Committee

RRT VI Subsea Dispersant Use - Guidelines for Industry on Requesting Concurrence with Subsea Dispersant Injection (SSDI) Decisions

- Prepared by: RRT VI Industry Liaison Committee (ILC) and API D3 Subsea Dispersants Joint Industry Task Force (JITF) - March 2015

To clarify what type of information would be required by RRT VI to support subsea dispersant use decisions, the RRT VI Industry Liaison Committee (ILC) volunteered to assist in developing draft guidelines for industry on recommended procedures for seeking concurrence with subsea dispersant use requests. The ILC is a committee of RRT VI, which is composed of volunteer members from industry who serve on an ad hoc basis.

The purpose of this document is to provide guidelines, forms and checklists recommended for use by industry. **The guidelines describe the concurrence request process, proposed information submission recommendations that are specific to subsea dispersant injection and the role of Net Environmental Benefit Analysis (NEBA) as a decision support tool.**

Sections include:

Overview
Roles and Responsibilities of National Response System Components in Subsea Dispersant Use Authorization
RRT VI SSDI Concurrence Decision Information Requirements and Checklist

Section 3.7 Analysis of Potential Net Environmental Benefits and NEBA Associated with SSDI

Methods traditionally used for evaluating the potential net environmental impacts of various response technologies have traditionally included "Net Environmental Benefit Analysis" (NEBA), and "Consensus Ecological Risk Assessment" (CERA). Such analyses are typically conducted in support of planning activities, but principles and some of the methods employed can also be used during response actions, or response simulations and drills. Such analyses are typically referred to as "Expedited or Qualitative NEBAs" or Environmental Trade Off Analyses. Unless a NEBA has been conducted through applicable planning activities that take the release scenario into account, an "Expedited NEBA" should be conducted and included as part of the RRT concurrence package.

The objective of using NEBA as an SSDI decision support tool is to evaluate the potential net environmental benefits of using SSDI within the context of the overall response strategy. It is not intended to make specific recommendations but to help inform decisions. While the time frame for conducting an "expedited" NEBA during a response action is compressed, the factors that must be considered are largely the same as for "pre-event" NEBAs.

An example of a generic expedited NEBA is included in Attachment 1 for illustrative purposes. The expedited NEBA should address the following:

- Aquatic RAR: What are the specific aquatic resources deemed to be at risk from the non-chemically dispersed spilled product?
- Terrestrial RAR: What are the specific terrestrial resources deemed to be at risk from the shoreline impact of the non-chemically dispersed spilled product?
- Time to RAR Impact: What is the estimated time of impact to the resources identified in 1 & 2 above? (The NOAA SSC should be contacted for trajectory and environmental fate analysis.)
- Leading Edge Location: What is the estimated location of the leading edge of the spill at the proposed time of initiation of SSDI? (Using model results, lat/long, proximity to shore,

coordinate with the NOAA SSC, the RP, or other information sources to estimate the location of the leading edge of the spill at the proposed time of the first application of dispersants).

- Environmental Benefit /Trade Offs: Does it appear that dispersants can be applied at this location in a manner that will likely achieve the desired environmental benefit for the identified RARs? Are there any specifically known resources in the area targeted for dispersant use that might be negatively impacted by application of chemical dispersants? If so, what are the known resources, and is the negative impact to these resources anticipated to be great enough to offset the benefit to the identified resources?
- Are there ways to avoid or minimize adverse affects to known resources (e.g., observers watching for marine wildlife).

Decision Process for Employing SSDI
RRT Concurrence Request Process
IMT Positions with Significant SSDI Roles
References

Attachment 1 Analysis of Potential Net Environmental Benefits and Risk Associated with SSDI

The objective using NEBA as a Subsea Dispersant Injection (SSDI) decision support tool is to evaluate the potential net environmental benefits of using SSDI within the context of the overall response strategy. It is not intended to make specific recommendations but to help inform decisions. While the time frame for conducting an "expedited" NEBA during a response action is compressed, the factors that must be considered are largely the same as for "pre-event" NEBAs. As part of the NEBA evaluation, the consequences of using SSDI to maintain the oil within the water column is evaluated against the impacts of oil remaining on, or rising to, the water surface and potentially stranding on shorelines.

SSDI increases the amount of oil that dissipates into the water column, and reduces the amount of oil remaining on the surface. Dispersant use, therefore, reduces the potential for floating oil and associated volatile hydrocarbons to threaten worker health and safety, and reach ecologically and economically sensitive surface water and shoreline environments. The oil that disperses into the water column may pose temporary elevated exposures to organisms in the immediate area, but research and experience has shown that those exposures are rapidly mitigated by the effects of dilution and microbial degradation of the dispersed oil.

Background

The use of SSDI offers several advantages over other response techniques, such as

- SSDI can be utilized continuously, and is not limited by darkness or most weather conditions that adversely affect, or even preclude other response techniques.
- Dispersants are injected directly into the oil release, so the "encounter rate" is much higher than for surface dispersant use or mechanical recovery techniques.
- SSDI reduces the formation of surface slicks which are harmful to sensitive ecological and public health receptors.
- Reduction of surface slicks produces a concomitant reduction in airborne VOCs which reduces threats to worker health and safety.

The decision making process for employing SSDI as a response method is not significantly different from that used for surface dispersant application. Surface dispersant application has been used more commonly, and technologies, methods, regulatory frameworks, toxicity, and potential net environmental benefits are well understood. While mechanical recovery remains a preferred response option, past experience in responding to

open water oil spills has demonstrated that mechanical recovery alone has traditionally yielded limited rates of recovery for large spills. There are additional limitations posed by greater transit distances for boats supporting the response, and adverse weather conditions that can hamper safe operations and transits to and from port. For these reasons, the appropriate use of dispersants, applied either at the ocean's surface or subsea, may provide the only means of removing significant quantities of oil from the surface quickly, and therefore efficiently reducing overall environmental impacts from the spill to the water surface and near shore, shallow water environments.

The U.S. Coast Guard, with support from a variety of other federal and state agencies including NOAA, US Fish and Wildlife Service, and the Texas General Land Office, has sponsored several Ecological Risk Assessment workshops in the Gulf of Mexico and Caribbean that considered the impacts and ecosystem recovery rates from various oil spill response options at hypothetical open water spills near Galveston Bay, Gulf of Mexico region near the US/Mexico border, Puerto Rico, US Virgin Islands, and Florida Keys. In each of these workshops, participants evaluated dispersant use along with other oil spill response strategies and found that dispersants were effective in protecting many near shore and shoreline resources, and also offered some benefit to animals that utilize open ocean surface waters (such as birds and marine mammals) because of the ability of dispersants to quickly remove oil from the surface of the water. Similar conclusions are expected for subsea dispersant use since most undispersed oil will reach the water's surface over a large area making it difficult to recover and creating environmental impact scenarios consistent with or exceeding those of surface spills.

NEBA Approach

The objective of a NEBA, when applied to oil spills, is to conduct an evaluation that will allow spill responders and stakeholders to choose the response options that will result in the lowest overall negative impact on the environment. This process is addressed in detail in the IPIECA (2000) publication "Choosing Spill Response Options to Minimize Damage: Net Environmental Benefit Analysis". A practical approach to conducting the environmental analysis is provided in the USCG guidance document "Developing Consensus Ecological Risk Assessments: Environmental Protection in Oil Spill Response Planning: A Guidebook" (Aurand et al., 2000).

Several mesocosm and open ocean field trial experiments have demonstrated that the rates of mixing and dilution in open waters that are 3 nautical miles or more offshore and are 10 meters in depth or greater are sufficient to minimize the potential toxic effects of oil dispersed at the surface. At these depths and distances from shore, net environmental benefit analysis demonstrates that transient aquatic toxicological impacts in the water column are much less than the risks to birds, mammals, and coastal and shoreline communities by allowing oil slicks to persist on the water surface and eventually become stranded on the shoreline (Lewis and Aurand, 1997). The net environmental benefits of SSDI could be more pronounced since the depths and distance from shore are likely to be greater.

During an expedited NEBA analysis, factors that should be considered include:

- Concentrations of dispersed oil which may be expected above the subsea injection point, and the dilution potential in that specific body of water.
- Toxicity of the likely concentrations of dispersed oil to local flora and fauna.
- Distribution and fate of the dispersed oil in water, sediments and organisms.
- Distribution, fate, and biological effects of the oil if it is not treated with dispersant—for example, whether it will harm shore habitats or wildlife.
- Expected ability of affected ecosystem populations to recover from any potential toxic impacts.

When conducting an expedited NEBA, the following priorities should be considered in evaluating the potential

benefits of SSDI:

- Human health and safety
- Environmental protection priorities
- Minimize wildlife exposure
- Minimize habitat contamination
- Minimize oil stranding on sensitive shorelines
- Maximize ecological recovery potential

Other protection priorities that should be considered include:

- Amenity beaches
- Marinas, commercial activities
- Shoreline property values
- Subsistence and cultural values
- Archeological and historical preservation areas

The same justifications that have been previously demonstrated for aerial dispersant pre-approval remain valid for SSDI, as follows:

- Removing oil from the surface of the water minimizes impacts to critical surface and shoreline habitats as this oil will eventually strand in sensitive near-shore estuaries and habitats.
- The concentrations of dispersed oil in the water column from subsea dispersant injection are expected to rapidly dilute both vertically and laterally through the water column, which will result in lower concentrations within a few kilometers of the well head (Lee, 2013). Concentrations below 1 ppm are generally determined to be below the high level of concern threshold of impacts to most species, derived from the USCG-sponsored workshops described earlier.
- Observations from the Deepwater Horizon (DWH) event demonstrated that an effective subsea dispersant operation will reduce surface volatiles, which will enhance worker health and safety, as well as reduce the oil droplet sizes.
- Bacterial biodegradation studies summarized by Hazen et al. (2010) have indicated that the shift to a smaller dispersed oil droplet size due to subsea dispersant injection will increase biodegradation rates which will further reduce the persistence of high concentrations of subsea oil "plumes" over the course of several days.
- The biodegradation of subsea dispersed oil in deep waters more than 120 miles from shore will translate to reduced oil on the surface, reduced oil in sensitive shoreline habitats, and a substantial increase in the recovery times of the ecosystem as a whole.
- In addition to protection of near-shore and shoreline habitats, preventing untreated (non-dispersed) oil from surfacing in offshore waters will help protect offshore species, including migratory birds, marine mammals, and sea turtle populations which depend on access to clean surface waters for their survival.

NEBA Scope

The geographic scope of an expedited NEBA is determined by the release location, flow rate or volume, duration, and the influences of currents, weather, dispersion, dissolution, and ultimately biodegradation. These factors are used in 3D modelling to produce potential trajectories, accounting for uncertainty, which ultimately determine this geographic scope of an expedited NEBA. Since flow rate is subject to high levels of uncertainty,

initial modelling is often based on a Worst Case Discharge (WCD) scenario. This information should be included in the Incident Data Sheet, and modelling results should be included in the authorization request to the RRT.

Response Options

The six response options appropriate for consideration in an expedited NEBA in the GOM are summarized below. For an expedited NEBA, performed in support of an exercise or release event, time constraints require that they be evaluated qualitatively rather than quantitatively. While this may be accomplished by an exercise planning team in preparation for a drill, it should be performed in the Environmental Unit during an actual release, and should involve all emergency consultation with all appropriate trustees. A brief description of each method, and their potential uses and limitations should be provided. It is assumed that all response methods may be used, where appropriate, during a response that involves SSDI.

Natural Recovery

Natural recovery is defined as no human intervention to influence the fate of the spilled oil. It represents the baseline against which all response options are compared. With natural recovery, the spilled oil will drift with the winds and currents, and then gradually weather until it evaporates, dissolves, and disperses into the water column, or strands on the shoreline. Once stranded, weathering will continue and the oil will gradually biodegrade or be incorporated into the sediments. Portions of the relatively fresh oil may be released from the shoreline and redistributed several times until it finally degrades, is consumed by organisms, or is deposited permanently.

Natural recovery is considered an appropriate option for spills at sea which do not threaten shoreline or protected habitats. It is also appropriate for some sensitive shoreline habitats where intrusion by people and equipment may cause more environmental damage than allowing the oil to degrade naturally, or where recovery and cleanup are not feasible.

Logistics: Monitoring at sea and on affected shoreline is required; shoreline recovery may take weeks or up to months or years, depending on the ambient energy level.

Limitations: Does not meet public expectation that an attempt will be made to remove spilled oil from the environment. Since this is a passive response, it will not protect high value shoreline habitats. In the case of natural recovery the floating oil will weather on the sea surface. If on-shore winds drive this weathering oil into intertidal and coastal areas, in some cases (e.g., marshes and mangroves) any cleanup effort could potentially do more ecological harm.

On-water Mechanical Recovery

On-water mechanical recovery is defined as the removal of oil from water for disposal and possible reuse to prevent or minimize impacts to sensitive nearshore and offshore habitats. Open water mechanical recovery uses skimmers and booms to redirect and remove oil from the surface of the water. The success rate of oil removal by means of mechanical recovery is dependent upon factors such as wind, waves, and daylight.

Logistics: The equipment needed to carry out mechanical recovery will involve a large number of skimming vessels, support vessels, storage barges, spotter aircraft, and significant quantities of collection boom. The equipment will need to be transported to the spill site, which in this instance is approximately 120 miles offshore. Collected oil will need to be stored and ultimately returned to shore for proper disposal. Given the size of the continuing release, this will be a formidable challenge.

Limitations: There will be a lag time from the time of the spill to the time of conducting mechanical recovery; making the window of opportunity to conduct mechanical recovery smaller. The longer the oil is present, the more it disperses and is more difficult to recover, with the oil thinning out as it spreads. Even beyond the encounter rate, weather conditions and day length would be critical in this area. Open water boom begins to fail in sea states with waves over approximately six feet.

On Water In-situ Burning

On-water in-situ burning (ISB) involves the collection of oil in booms (as in on-water recovery), but then removes the oil from the water surface by burning, minimizing storage and disposal problems. ISB has the same weather and day length conditions as on-water mechanical recovery and realistically needs even lower wave heights, plenty of daylight available to monitor and track the burn, and minimal wind that allow the burn to be ignited and controlled.

Logistics: Equipment needs for vessels and boom are similar to on-water mechanical recovery, with the addition of fire boom, enhanced monitoring aircraft, ignition capability, and smoke-plume modeling.

Limitations: Limitations of weather and day length are similar to on-water mechanical recovery. The availability of fire boom, which becomes unusable over time, would be a factor in a spill of this duration.

Aerial Dispersant Application

Dispersants may be applied to surface slicks from airplanes, helicopters, or vessels. The volume of dispersant applied is a fraction of the volume of oil treated, with a typical dispersant to oil ratio (DOR) of 1:20. Surface dispersant application is pre-authorized by the Region VI RRT for most areas where SSDI could be considered for a subsea oil release. It is anticipated that both vessel and aerial applications will be used, in addition to SSDI, as appropriate. When the oil is treated with dispersants, it initially disperses within the upper 10 meters (30 feet) of the water column due to natural mixing processes. If these dispersed oil droplets are small enough (generally less than 0.01-0.02 mm diameter) the droplets will remain dispersed in the water column. The dispersed oil will be rapidly diluted due to spreading both horizontally and vertically by tides and currents (Lee, 2013). Historically, dispersed oil concentrations of 20 to 50 parts per million (ppm) have been reported in the upper 10 meters of the water column directly under the slick. These concentrations dilute rapidly as the oil moves through time and space in the water column.

Logistics: In the scenario analyzed here application from large, fixed wing aircraft is the most logical mode of application for surface slicks. It is likely that vessel based application will occur near the release point to reduce airborne VOCs.

Limitations: Dispersant operations require a 300-meter minimum cloud ceiling, three-mile forward visibility, daylight, wind speeds less than 35 knots, and wave heights of 0.15 to 3 meters. Effective application rates (DOR) are approximately 3-5 times higher than for SSDI. Aerial application is limited to daylight hours and as a result can only be operational for half of the amount of time compared to SSDI.

Shoreline Protection and Recovery

The shoreline acts as a natural containment barrier for oil spilled on water. Protective booming is seen as an important tool when oil cannot be effectively treated on-water. While protective booming can be valuable, it brings about a certain degree of risk of collateral damage due to physical disturbance by work crews installing, maintaining, and dismantling the boom. Additionally, there are impacts of disturbance and scarring from anchoring the materials to soils, sediments, or plants, along with increased erosion of shoreline and sediments

while the boom jostles in place.

Examination of the benefits and tradeoffs of shoreline protection and recovery are different than examining the benefits and tradeoffs of on-water response. Given the option, on-water cleanup will almost always be environmentally preferable to on-shore recovery.

Logistics: Both shoreline protection and recovery tend to be labor intensive and involve large numbers of responders who must be trained, transported, housed, and managed in a potentially hostile environment. In addition, worker personal protective equipment, hand tools, washing equipment, protective and containment boom, and any appropriate mechanical equipment must be provided, stored, transported, and maintained.

Limitations: The use of protective boom is highly dependent on weather, type of shoreline, topography, and hydrographic conditions. For shoreline recovery, heavy machinery on beaches and intrusion by humans on foot can have adverse impacts on some shoreline habitats. Adverse public reaction, restricted commercial and recreational use or access during cleanup, high cost, and difficulty in gaining access to impacted shorelines (due to logistic or topographical obstacles) can make shoreline protection and recovery difficult operationally.

In shoreline habitats, such as marshes and mangroves, the activity associated with the cleanup can often be more damaging than the oil itself; the cleanup operations can drive the contaminants below the surface and make them available to the root systems of plants and organisms that burrow into the sediments. It is common in these environments for oil to be allowed to remain on the surface of the sediments with sorbents placed at the edge of the water line in an effort to passively collect any oil that re-floats.

Subsea Dispersant Injection

SSDI has only been conducted during the DWH spill in 2010, where dispersants were applied at the well head opening at the sea floor. The same general chemical dispersion principles apply that are discussed in Aerial Dispersant Application, with a few key distinctions. First, with subsea injection, the encounter rate is extremely high because the dispersant is being applied directly to the oil source as it is released into the water, before the oil begins to rise and spread horizontally and vertically within the water column. Because of the high encounter rate, DORs of 1:50 to 1:100 should be sufficient to effectively disperse the oil. The higher DOR means that less dispersant is required for subsea dispersant injection versus aerial dispersant application. Because the injection is occurring at the sea floor, the dispersed oil will dilute vertically over a much greater volume of water, and transfer at depth will be driven by buoyancy of the dispersed oil droplets (vertically) as well as by deep ocean currents (horizontally). This rapid dilution equates to lower concentrations of dispersed oil than those typically measured after a surface application (where the dispersed oil is typically limited to 10 meters of vertical dilution) (Lee, 2013).

Logistics: Subsea dispersant injection takes more time to initially deploy than aerial application. Dispersant and ROV operation vessels must be deployed to the well location, a dispersant manifold needs to be positioned on the dispersant supply vessel, and coiled tubing is then deployed to the seafloor via ROVs. A minimum of two ROVs are needed for this operation. One will control the dispersant injection wand into the oil release point, and the second will supply lighting and videography. If a Cap and Containment system is installed on the well head, it may be possible to connect the dispersant supply hose directly to an injection port on the capping stack. Given the substantial distance from shore, it is anticipated that the specialized equipment would take approximately four days to be mobilized and set up at the Source Control location. Once deployed and connected, the system is designed to operate continuously via remote monitoring.

Limitations: Unlike most other response options, which are limited to daylight hours for aviation and boat

safety reasons, subsea dispersant injection can virtually be maintained 24-hours per day, seven days per week, provided that dispersant stockpile is available and on-site. A disruption to the dispersant stockpile would likely only occur during extreme sea states when dispersant tote transfers could not be conducted. Mobilization times for SSDI are longer (roughly four days) compared to aerial dispersant that could be mobilized in roughly one day. However, once the SSDI system is assembled and operational, it can run non-stop.

Implications for NEBA

This section should focus on the potential for exposures to resources of concern, based on the results of the trajectory modelling studies. Emphasis should be placed on identifying the potential for exposures to resources at risk, within potentially affected categories, such as S*horelines, Surface Layer, Shallow Layer, Water Column,* and *Benthos.* Refer to figures used to illustrate the results of trajectory modelling.

Risk Analysis

The impact of SSDI on risk to each of the resources at risk should be described. Typically, SSDI would be expected to reduce the exposures to hydrocarbons at the water surface, and increase exposures in the water column. Water column exposures should be highest near the release point where the subsea dispersant treatment occurs, and rapidly decrease with distance from the treatment location. a concomitant reduction in atmospheric VOC exposure would be expected, without a major increase in risk to water column resources.

Given that the injection occurs at the wellhead, the exposures to dispersed oil in the deeper water column do increase, but the areas exceeding the evaluation thresholds should be rarely exceeded, and sensitve resources should be uncommon. The effects of SSDI use on risks should be as follows:

- The risks to marine mammals and birds in the surface micro-layer and shallow surface waters should be reduced based on the reduction in floating oil.
- The risk to sea turtles in the surface micro-layer and shallow surface waters should be reduced for the same reasons.
- Effects on habitats, such as *Sargassum spp*. Should be reduced due to a reduction in floating oil.
- The risk to fish (eggs and larvae) and invertebrates in the shallow water column should be reduced due to the reduction in naturally dispersed oil that may occur near the surface.
- The risk to coral should be reduced since dispersed oil plumes are expected to be very deep, or near the surface.

Key Findings

Previous NEBAs conducted for scenarios in US waters have favored the use of surface dispersant application during larger spills in offshore waters over mechanical recovery. However, mechanical recovery is still the primary response option and SSDI is being requested to enhance the response thereby further reducing ecological and economic impacts. Key findings of the expedited NEBA, based on the modelled scenario should be presented here.

In general, the same justifications that have been previously demonstrated for aerial dispersant pre-approval should remain valid for subsea dispersant injection, as follows:

Overall

When oil droplet sizes are reduced through dispersant applications, biodegradation rates of components in dispersed oil are expected to increase. Smaller droplets generate larger oil-water interface areas for oil degrading

bacteria to attach to, and dissolution of water-soluble compounds is therefore expected to increase. Volatile oil compounds will rapidly dissolve during subsurface spills and thereby become subject to rapid biodegradation. In contrast, volatiles will largely evaporate after surfacing of the oil. Several laboratory studies have shown that dispersant treatment of dispersible oils increase oil compound biodegradation (Siron et al., 1995; Venosa and Holder, 2007; Hazen et al., 2010; Prince et al., 2013; McFarlin et al., 2014; Brakstad et al., 2014).

Subsea Dispersant Injection

- Natural dispersion and evaporation limit the thickness and geographic extent of floating oil, and when subsea injection of dispersants is used less oil remains on the surface.
- Subsea dispersant injection is the only response method that can be conducted at night, and during relatively high sea states. Subsea dispersant application would be a continuous response activity employed to mitigate a continuous and uncontrolled release from the well. Until the well can be mechanically capped, subsea dispersants are expected to provide the best short-term option to reduce oil reaching the ocean surface and lessen overall environmental impacts.
- Subsurface dispersant injection increases hydrocarbon concentrations in the deep oil plume, but the areas should be relatively small and do not represent a significant risk to sensitive biological resources. The subsea dispersed oil concentrations are expected to rapidly dilute both vertically and laterally through a very well mixed water column, which will result in concentrations well below 1 ppm within a few kilometers of the well head. This was documented during the Deepwater Horizon subsea dispersant monitoring activities in 2010. Concentrations below 1 ppm are generally determined to be below the high level of concern threshold of impacts to most species, derived from the USCG-sponsored workshops described earlier. In addition, the level of naturally dispersed oil in the upper ten to 20 meters of the water column is lowered.
- The biodegradation of subsea dispersed oil in deep waters more than 120 miles from shore is expected to result in reduced oil on the surface, reduced oil in sensitive shoreline habitats, and a substantial decrease in the recovery times of the ecosystem (as a whole) .
- Direct injection into the plume at the seabed translates to a considerably higher (order of magnitude) encounter rate than those at the surface, where the oil expression is broadly spread over a surface slick that continuously increases in size as oil is continuously released from the wellhead. Surface dispersant applications are limited to daylight operations only, would have reduced overall encounter rates due to the size of the surface slick, and are expected to be significantly less effective once the oil naturally weathers as a surface slick**. As a result, subsea dispersant injection requires an overall lower DOR for the same level of treatment than a surface dispersant application – significantly less overall application of chemical dispersant would be required to treat the same volume of oil** (Brandvik et al., 2013; Johansen et al., 2013).

Findings Related to Safety

Ongoing research on subsea dispersant injection has demonstrated that an effective subsea dispersant operation will reduce the oil droplet size from the 1 mm range to the 50-200 micron range. Subsea dispersant injection is expected to decrease the surface expression of oil slicks, thereby decreasing VOC and LEL levels in the source control area, which both decreases threats to human health, and increases the productivity of workers who can operate and communicate unrestrained without the use of respirators.

Findings Related to Environmental Protection

Specific findings related to protection of RAR, and particularly threatened or endangered species should be presented here. These findings should be based on the modelled exposure estimates and risk analysis for the modelled scenario or spill event. The findings may include impacts to all applicable environmental resources, cultural resource, and commercial resources. In general:

An effective SSDI program should reduce the amount of oil that reaches environmentally sensitive

shorelines. In addition, reducing the amount of untreated (non-dispersed) oil that surfaces in offshore waters should help protect offshore species, including migratory birds, marine mammals, and sea turtle populations which depend on access to clean surface waters for their survival.

Conclusions

This section summarizes the findings from the expedited NEBA that provide direct support to decisions regarding the use of SSDI. Key findings pertaining to impacts of SSDI on overall risks, including worker safety should be presented. **Consideration of overall impacts on risks, combined with the findings of previous NEBAs performed in the GOM should be summarized in a statement such as:**

> **"For the reasons cited above, and consideration of the findings of previous NEBAs performed in the GOM, this expedited NEBA suggests that subsea dispersant injection has the potential to offer net environmental benefits, lower ecological risks to sensitive environmental areas, and reduced risk to responder health and safety."**

NEBA References

Aurand, D., L. Walko, R. Pond. (2000). *Developing consensus ecological risk assessments: Environmental protection in oil spill response planning - a guidebook*. Ecosystem Management & Associates, Inc. Report 00-01. Washington, DC: U.S. Coast Guard: 147p. Retrieved from http://www.fws.gov/contaminants/fws_oscp_05/fwscontingencyappendices/N-Manuals-Response-Assessment/CG-EcolRiskatOilSpills.pdf.

Brandvik, P.J., Johansen, Ø., Leirvik, F., Farooq, U., and Daling, P.S. (2013). Droplet breakup in sub-surface oil releases – Part 1: Experimental study of droplet breakup and effectiveness of dispersant injection. *Marine Pollution Bulletin, 73*(1), 319-326. doi:10.1016/j.marpolbul.2013.05.020.

Brakstad, O., P. Daling, L. Faksness, I. Almås, S. Vang, S. Syslak, and F. Leirvik. (2014). Depletion and biodegradation of the Macondo 252 oil in dispersions and emulsions generated in an oil-on-seawater mesocosm flume basin. *Mar. Poll. Bull.* 84, 125-134.

Hazen, T. C., E. A. Dubinsky, T. Z. DeSantis, G. L. Andersen, Y. M. Piceno, N. Singh, J. R. Jansson, A. Probst, S. E. Borglin, J. L. Fortney, W. T. Stringfellow, M. Bill, M. S. Conrad, L. M. Tom, K. L. Chavarria, T. R. Alusi, R. Lamendella, D. C. Joyner, C. Spier, M. Auer, M. L. Zemla, R. Chakraborty, E. L. Sonnenthal, P. D'haeseleer, H.-Y. N. Holman, S. Osman, Z. Lu, J. D. Van Nostrand, Y. Deng, J. Zhou, and O. U. Mason. (2010). Deep-sea oil plume enriches psychrophilic oil-degrading bacteria. *Science*, 330:204-208.

Johansen Ø, Brandvik, P. J., & Farooq, U. (2013). Droplet breakup in subsea oil releases – Part 2: Predictions of droplet size distributions with and without injection of chemical dispersants. *Marine Pollution Bulletin, 73*(1), 327-335. doi:10.1016/j.marpolbul.2013.04.012.

Lee, K., Nedwed, T., Prince, R. C., and D. Palandro. (2013). Lab tests on the biodegradation of chemically dispersed oil should consider the rapid dilution that occurs at sea. *Marine Pollution Bulletin, 73*(1), 314-318. doi:10.1016/j.marpolbul.2013.06.005.

Lewis, A. and D. Aurand. (1997). Putting dispersants to work: Overcoming obstacles. Washington, DC, American Petroleum Institute.

McFarlin, K.M., R.C. Prince, R. Perkins, and M.B. Leigh. (2014). Biodegradation of Dispersed Oil in Arctic Seawater at -1°C. *PLoS one* 9, e84297.

Prince, R. C., K. M. McFarlin, J. D. Butler, E. J. Febbo, F. Wang, and T. J. Nedwed. (2013). The primary biodegradation of dispersed crude oil in the sea. *Chemosphere*, 90, 521–526.

Venosa, A.D. and E.L. Holder. (2007). Biodegradability of dispersed crude oil at two different temperatures. *Marine Pollution Bull.*, 54:545-553.

Attachment 2 Timeline for Utilizing Subsea Dispersant Injection

Attachment 3 Dispersant Injection Rate Table

API OSRP Guidance document review

OGC added the disclaimer: "This document does not necessarily reflect the opinions of the regulatory community, has not been approved by the regulatory community, and does not constitute an endorsement of this RP by the regulatory community"

- API response: "**Disagree.** At EPA's request, we deleted all references to EPA being part of the work group but considered all comments they provided even though only work group members were allowed to submit comments. Additionally, USCG and BSEE did not take exception to being listed as members of the work group but in consideration of EPA's request that no federal agencies be mentioned, BSEE and USCG felt just referring to participation by the "regulatory community" would at least partially satisfy EPA's request. **Since this statement is EPA's position and not that of USCG or BSEE, it will not be included in the final RP.**"

API document state: The recommendations developed by the Workgroup in Section 3 include a number of features and concepts that were incorporated into the design of this RP."

- EPA requested that "…by the Workgroup…" be changed to "…in coordination with the Workgroup…".
- API response: "**Disagree – The recommendations were developed by the workgroup** not in coordination with another unnamed entity."

API document state: "The content recommended by this RP was, however, benchmarked against BSEE's regulations (30 CFR Part 254 and associated guidance in NTL 2012-N06) and found to be in general compliance but will depend on the specific information plan holders include in each section.

- EPA stated that "Compliance determinations are made by regulatory agencies and are specific, not general." And requested that the statement be changed to "…API believes them to be found to be in general compliance…."
- API's response: "**Disagree. The workgroup found them to be in general compliance and not API.**"
- Caplis email [August 4, 2016]: "I agree with your thoughts about compliance."

AIP OSRP document includes a section on Net Environmental Benefit Analysis (NEBA) [Section 6.3.2] and cites references that haven't been published and don't appear to be currently available: Response Strategy Development Using SIMA, API 2016 and Guidelines on Implementing Spill Impact Mitigation Assessment, SIMA, API/IPIECA/IOGP 2016.

Although the document states refers to applicable regulatory authorities in establishing specific worst-case discharge criteria, Annex B instructs the plan holder to "**Describe how and why the worst-case discharge scenarios were selected, referring to the oil spill risk and impact analyses conducted by the plan holder.**" In response to a previous comments on WCD planning scenario, API noted that the sentence "**Planning Scenario selection should also consider those with unique circumstances, such as relatively close proximity to shore or sensitive resources**, or resource requirements such as sour or Group V oils as well as **those that represent a variety of potential environmental impacts**" was added to address a BSEE comment that special consideration be given to facilities that are close to shore or possess unique characteristics in addition to the facility with the WCD. API section on Oil Spill Impact/Consequence Analysis [Section B.3] contains similar factors cited in API NEBA documents. March - May 2016 - API Industry Guidelines on Requesting Regulatory Concurrence for Subsea Dispersant Use - API BULLETIN 4719 - Draft

Reincarnation of the RRT VI Industry Liaison Committee efforts that were of concern last year. We took issue with some of their statements.

Sections include:

Introduction
Scope
Terms, Definitions, and Abbreviations

- Overview

Summary of Core Information Submitted to Regional Response Teams
Evaluating the Use of Subsea Dispersant Injection
Use of Modelling to Support Response Decision-making
Use of Subsea Monitoring to Support Response Decision-Making
Importance of Effective Data Management Techniques

- **Use of NEBA to Support Response Decision-Making**
- Methods traditionally used for evaluating the potential net environmental impacts of various response technologies include Net Environmental Benefit Analysis (NEBA), and Consensus Ecological Risk Assessment (CERA). Such analyses are typically conducted in support of planning activities, but the principles and some of the methods employed can also be used during response actions, or response simulations and drills. Such analyses are typically referred to as "expedited or qualitative NEBAs" or "Environmental Trade Off Analyses". During drills or exercises, unless a NEBA has been conducted through applicable planning activities that take the release scenario into account, an "Expedited NEBA" should be conducted and included as part of the RRT concurrence package.

Regional Response Team Concurrence Request Process
Incident Command System Positions with Significant SSDI Roles
Annex A - Recommended Submittal Elements for SSDI Approval Request
Annex B - Summary of Primary Response Options
Annex C - Example Timeline for Utilizing Subsea Dispersant Injection
Annex D - Subsea Dispersant initial Injection Rate Calculation
Bibliography

Even though this is supposed to be Industry Guidelines, the document directly references to RRT VI, stating that its offering a "clarification on how RRT VI has interpreted requirements of 40 CFR Section 300.910 as applied specifically to subsea dispersant use…" It also characterizes other parts of the NCP, as well as roles and responsibilities under the Incident Command Structure / Unified Command.

API characterized the guidelines as describing the RRT concurrence request process, proposed information submission recommendations that are specific to subsea dispersant injection and the use of Net Environmental Benefit Analysis (NEBA) and other forms of tradeoff analyses as decision support tools.

PREP 4C Guidelines

BSEE Incident Management Team Exercises - Objectives

BSEE ORIGINAL: **Demonstrate the ability to apply and coordinate the use of multiple countermeasures based on an informal, incident-specific net environmental benefit analysis** and the response Concept of Operations as outlined in the OSRP.

FINAL: Ability to select and propose the use of an optimal mix of response countermeasures to the FOSC, **based on an assessment of the operational feasibility, expected effectiveness, and projected environmental tradeoffs associated with using each countermeasure.**

EPA questions for BSEE (Nov. 4 2015)

What is the process to conduct a "NEBA"?
What is the specific process that is used to conduct a NEBA? We are aware of USCG's "Developing Consensus Ecological Risk Assessments", where an Ecological Risk Assessment (ERA) is defined as "a process through which to evaluate the possible ecological consequences of human activities and natural catastrophes. An ERA emphasizes the comparison of exposure to a stressor or stressors (i.e., oil and/or the response options) with an ecological effect (e.g., population disruption, changes in ecological community structure or function, toxicological effects). As much as possible, this comparison is made quantitatively, including an estimation of the probability that the predicted consequences will occur and of the associated severity and magnitude of the effects. "In addition, the ERA recognizes its uncertainties and explains the limits of the analysis. However, it is unclear if the reference to NEBA in the 4C guidelines is intended to reflect a similar type of analysis. We are suggesting edits because of concerns that NEBA appears to be used as a general justification solely for protection of the shoreline without considering all of the potential ecological effects.

What is the scope of a NEBA?
The only place that NEBA is referenced in the 4C guidance is in this BSEE/IMT section. What information (including site specific) is required to be considered in a NEBA? BSEE is requiring the plan holder to develop an "informal, incident specific NEBA". What does this owner/operator ecological risk assessment addresses? Do they include relevant information contained environmental impact analysis regulations that is required per 30 CFR 550, for EPs and DPPs?

What is an "informal, incident-specific NEBA"?
How does this process differ from a "formal" NEBA? The preamble does not have any comments or discussion on including a NEBA as part of IMT exercises. So it is unclear what led to this language being inserted.

NEBA relative to chemical countermeasures.
We understand that the reference to NEBA in this document is to assessing "the use of multiple counter measures" (which would include mechanical). However, it is our understanding that at least some regulated industry believe that NEBA is used solely in support of the use of chemical countermeasures, particularly dispersants. The concern is that the NEBA process should not be conducted absent similar considerations for other response options and/or for the optimal combination of response options. To the extent that NEBA does include chemical countermeasures, then specifics of what both the analysis and the use decision-making process entails needs to be clearly established.

Who is conducting the NEBA?
For the internal exercises, the 4C guidelines establish that the owner/operator would be conducting exercises based on a NEBA that presumably the owner/operator would develop. While we understand a NEBA can serve to inform planning/exercise/use decisions, the decision to use dispersants, or any other chemical countermeasure is ultimately a government decision, and must be done in accordance with the Subpart J of the NCP. To reflect this, to the extent that the owner/operator relies on any NEBA type of environmental tradeoffs assessment, it should be clear that it is to "inform" planning, not to make "use decisions" by the owner/operator. Any

owner/operator environmental tradeoff assessment should also be referring back to those prepared by the Area Committees for the Area Contingency Plans.

Reference: https://www.bsee.gov/sites/bsee_prod.opengov.ibmcloud.com/files/final_2016_prep_guidelines.pdf

6.2	FE: Incident Management Team Exercise – Offshore Facilities
Applicability:	IMT.
Frequency:	Annually.
Initiating Authority:	Owner or operator.
Participating Elements:	IMT and plan holder company officials as established in the spill response plan.
Scope:	Exercise the IMT's organization, communication, and decision - making in managing a response.
Objectives:	Exercise a select combination of the Core Components as outlined within Appendix A of the PREP Guidelines. During each triennial cycle, all of the applicable Core Components in Appendix A need to be exercised at least once. In addition, effective demonstration of any of the following components may be included in the scenario for the exercise: A. Ability to detect, assess, project, track and monitor the spill, properly map the spill information necessary to respond, direct response resources appropriately, and share that information with others as indicated in the response plan. B. Knowledge of OSRP, any referenced OSRO Inventories, tactics manuals, and well containment plans. C. Ability to access information in the appropriate Regional Contingency Plans (RCPs) and ACPs for the location of sensitive areas, protective best management practices, resources available within the area, unique conditions of area, recommended response strategies, etc. D. For any chemical or biological countermeasures or *in - situ* burning cited in the OSRP, the ability to prepare and submit a request and usage plan to the FOSC. The preparation of a usage and monitoring plan/request for each such countermeasure listed in the plan must be exercised during the triennial cycle. 1. Ability to select and propose the use of an optimal mix of response countermeasures to the FOSC, based on an assessment of the operational feasibility, expected effectiveness, and **projected environmental tradeoffs associated with using each countermeasure**. 2. In the case of a request for aerial/vessel applied dispersants, API Technical Report 1148 ("Aerial and Vessel Dispersant Preparedness and Operations Guide") contains an example of a Daily Aerial/Vessel Dispersant Application Plan that may be appropriate for use in this situation. 3. For OSRPs that also list SSDI as a response capability, the IMT should complete an application request and usage and monitoring plan for SSDI, as well as a management plan for coordinating the allocation of dispersant stockpiles between surface - application and SSDI operations, as appropriate. 4. Ability to implement and coordinate the use of multiple response countermeasures, as approved by the FOSC, in accordance with the offshore response Concept of Operations outlined in the OSRP. E. Demonstrate the effective and coordinated integration of source control and subsea containment operations with other incident management activities, including oil spill response operations. F. Identification of corrections necessary to address any noncompliance or preparedness issues encountered while conducting the exercise and the incorporation of these corrections into the OSRP.
Certification:	Self - certification.
Verification:	Verification by BSEE; records must be available upon request.

http://www.bsee.gov/uploadedFiles/BSEE/About_BSEE/Divisions/OSPD/Final%202016%20PREP%20Guidelines.pdf

RRT VI Dispersant Exercises - At least 4 RRT VI Incident Specific Activation Reports on epaosc.org website for Subsea dispersant use and 1 for Surface dispersant use

May 2016 - HWCG-LLOG 2016 Gulf of Mexico Exercise

On May 10-11, 2016, HWCG-LLOG conducted their annual industry-led Preparedness for Response Exercise Program (PREP) exercise. As part of the exercise, they requested RRT concurrence to use subsea dispersants, specifically COREXIT EC9527A, FINASOL OSR 52, and ACCELL Clean DWD, as an effective means to minimize environmental impact.

Exercise Scenario is located in the **Mississippi Canyon 300, Well #2** block approximately 59-miles south of the mouth of the Mississippi River, and was based on their oil spill response plan's worst-case discharge. HWCG-LLOG requested RRT-6 approval for the use of subsea dispersants to reduce volatile organic compounds (VOCs) exposure to responders, and reduce the potential for oil impacts to the shoreline and resources at risk.

On April 29, 2016, HWCG-LLOG's exercise planners provided their subsea dispersant package to RRT-6 (i.e., **Summary Slide Deck, Resources at Risk, Critical Review of Toxicity, Monitoring Plan, Logistics, Schedule, RRT Incident Data Sheet, Scenario, and Mass Data comparisons**). On May 10, 2016, at 1400 CT, the Incident-Specific RRT (ISRRT) teleconference commenced; call adjourned at 1500.

RRT members were provided a read-ahead package prior to the call. This helped facilitate a meaningful discussion and allowed more productive feedback to HWCG-LLOG personnel. Despite the many unknowns with this exercise, RRT members unanimously agreed that injecting subsea dispersants at the source of the spill was the best and preferred method, thus minimizing oil from reaching the surface and shoreline.

- **NOAA acknowledged that using subsea dispersants at the source is generally the best option to keep the oil out of critical habitats; however, as the lead trustee for numerous "at risk" species in the subsea, surface, near-shore and on-shore environment, they have a more difficult challenge when weighing the tradeoffs between response techniques.** Another variable in the decision process is what time of year the incident occurs (e.g., Sea Turtle nesting).
- DOI recommended that responders should do everything possible to keep the oil out of the wetlands and minimize impact to bird rookeries and fish nurseries. To do this effectively in the open ocean environment, subsea dispersant use at the wellhead would be the best option. Also, in-situ burning and mechanical recovery would not be effective in rough water, allowing the oil to remain on the surface for longer periods of time, resulting in weathering of the oil, which in turn makes it even harder to disperse, cleanup and remove.

Outcome

Mr. Ronnie Crossland: Approved, with the understanding that in an actual incident, there could be several calls leading up to an actual approval. RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback / progress on the subsea application and monitoring process.

Mr. Greg Pollock - State of Texas (TGLO): Approved. Although spill is located in federal waters, **TGLO recognizes that if "no action" (i.e., subsea dispersants) is taken, the oil could eventually impact state waters.** They are also in favor of fighting the spill as far offshore as possible.

Mr. Brian Wynne -State of Louisiana (LOSCO): Approved. **Although spill is located in federal waters, LOSCO recognizes that if "no action" (i.e., subsea dispersants) is taken, the oil could eventually impact state waters.**

RRT Incident Specific Activation Summary: https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20-%20HWCG-LLOG%20--%205-10-2016.pdf

August 2015 - Chevron USA Inc. - Chevron USA Inc. conducted their annual industry led PREP exercise (requested RRT concurrence to use subsea dispersants as part of the exercise).

Nine days prior to a one hour RRT VI Incident Specific teleconference that the USCG RRT-6 Co-Chair convened at the request of the Exercise FOSC, Chevron's exercise planners provided their subsea dispersant package to RRT-6 that included:

- **Summary Slide Deck,**
- **Resources at Risk,**
- **Critical Review of Toxicity,**
- **Monitoring Plan, Logistics, Schedule,**
- **RRT Incident Data Sheet,**
- **Scenario, and Incident Map**

The purpose of the call was to review, discuss and potentially approve Chevron's request to apply subsea dispersants to mitigate the discharge.

Exercise Scenario is located in **Keathley Canyon 785** approximately 210-miles south of Morgan City, LA, and was based on their oil spill response plan's **242K worst case discharge**. Chevron requested RRT-6 approval for the use of subsea dispersants to reduce VOCs to promote responder safety, and to reduce impacts to the shoreline and resources at risk. Despite the many unknowns with this exercise, RRT members unanimously agreed that injecting subsea dispersants at the source of the spill was the best and preferred method, thus minimizing oil from reaching the surface and shoreline.

The following are key takeaways that were discussed during the call:

- In the event that subsea dispersants are actually requested, the UC must provide the RRT with a Monitoring Plan that is both aggressive and adaptive. The plan should include the following factors for measuring the efficiency of subsea dispersants:
    - Have the ability to measure and evaluate the effectiveness of both contact time and mixing efficiency while injecting dispersants.
    - Ability to measure the distribution of droplets, and ensuring the smaller droplets are less than the 200 micron range.
- During a spill where dispersants are to be applied, it is a good idea to work in close coordination with the academic community (e.g., National Science Foundation, State Universities, etc.) to promote transparency and facilitate the sharing of monitoring data, so that everyone is working towards a common goal.
- NOAA acknowledged that using subsea dispersants at the source is generally the best option to keep the oil out of critical habitats; however, as the lead trustee for numerous "at risk" species in the subsea, surface, near-shore and on-shore environment, they have a more difficult challenge when weighing the tradeoffs between response techniques. Another variable in the decision process is what time of year the incident occurs (e.g., Sea Turtle nesting).
- DOI recommended that responders should do everything possible to keep the oil out of the wetlands and minimize impact to bird rookeries and fish nurseries. To do this effectively in the open ocean environment, subsea dispersant use at the wellhead would be the best option. **Also, in-situ burning and mechanical recovery would not be effective in rough water, allowing the oil to remain on the surface for longer periods of time, resulting in weathering of the oil, which in turn makes it even harder to disperse.**

Outcome

Charlie Henry (NOAA natural resource trustee) and Stephen Spencer (DOI natural resource trustee): Agreed that subsea dispersant use was the best option in this case; monitoring plan needs to be in place.

Brandi Todd (EPA): Approved, with the understanding that in an actual incident, there could be several calls leading up to an actual approval. RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback / progress on the subsea application and monitoring process.

RRT Incident Specific Activation Summary: https://www.epaosc.org/sites/5083/files/Activation%20Call--EXERCISE%20-%20Chevron-%208-19-2015.pdf

November 2014 - BP Hopkins - BP conducted their annual industry-led PREP (requested RRT concurrence to use subsea dispersants as part of the exercise).

The exercise planners provided subsea dispersant package to RRT-6

- **Incident Data Sheet,**
- **Proposed High Level Subsea Dispersant Operations Plan,**
- **Proposed Subsea Dispersant Injection Monitoring Plan,**
- **Expedited Net Environmental Benefit Analysis (NEBA) of Subsea Dispersant Injection, and**
- **Oil Spill Trajectory and Fate Modeling Summary**

One hour and ten minute RRT-6 ISRRT teleconference to review, discuss and potentially approve BP's request to apply subsea dispersants to mitigate the discharge ongoing from **Green Canyon 327**.

The Environmental Unit (EU) presented overview of NEBA that led to the request for subsea dispersant approval. Key benefits outlined during the call:

- Responder Safety – reduce volatile organic compounds (VOCs) and exposure limits.
- Reduce large surface slicks – that could potentially migrate over large surface areas and impact the following:
    - Wildlife – reduce the potential exposure to sensitive areas of concern, such as the upper layer of the water column, where marine mammals and turtles are found.
    - Critical Habitats – modeling software predicted impact to the Flower Garden Banks if subsea dispersants were not used.
    - Shoreline – reduce potential of oil impacting and stranding on shorelines.
    - Economic – reduce economic impacts (commercial, sport, and recreational)
- Weather – high winds and large waves expected to make conventional recovery methods impossible.

Outcome

Charlie Henry (NOAA) – Recognized that this is an exercise and that the information that is discussed and agreed on during this incident will not be the same for every incident. It is important to note that every incident is unique and will have to be assessed individually on a case-by-case basis.

Ronnie Crossland (EPA) - Approved, with the stipulation that in an actual incident, RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback/progress on the subsea application and monitoring process. Also, the RRT would most likely require daily reports/follow-up calls to review efficacy of the subsea dispersants, and to make course corrections as needed.

RRT Incident Specific Activation Summary: https://www.epaosc.org/site/doc_list.aspx?site_id=5083

https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20--%20Incident%20Specific%20Activation%20Report%20BP%20Hopkins%20--%2011-05-2014.pdf

April/May 2014 - HWCG-Freeport-McMoRan Oil & Gas (HWCG-FMOG) Gulf of Mexico - HWCG-FMOG conducted their annual industry led PREP exercise (requested RRT concurrence to use subsea dispersants as part of the exercise)

Exercise Scenario is located in the **Green Canyon 393** block in a water depth of 3,800-feet;

Nineteen days prior to a one hour and five minute RRT VI Incident Specific teleconference that the USCG RRT-6 Co-Chair convened at the request of the Exercise FOSC, the exercise planners provided their subsea dispersant package to RRT-6 that included (as examples):

- **Facility Incident Report,**
- **Proposed Subsea Dispersant Operations Plan,**
- **Subsea Dispersant,**
- **Subsea Dispersant Monitoring Plan,**
- **Incident Action Plan,**
- **Application Monitoring Materials and Equipment List**

The USCG RRT-6 Co-Chair convened a second 17 minute call the next day at the request of the Exercise FOSC

DOC and DOI trustee representatives provided consultation and outlined the following action items in advance of RRT-6 concurrence, which EPA, Texas, and Louisiana representatives agreed.

- Explain the **positive net benefit of using subsea dispersants as opposed to not using them.**
- **Work with Resource Trustees to determine the trade-offs of using versus not using subsea dispersants**, and how will it affect the following:
    - Sport fishing
    - Habitat Fisheries
    - Long-term effects in marsh versus deepwater
- Provide RRT-6 with **the benefits/tradeoffs of each of the following cleanup techniques:**
    - **Subsea dispersants**
    - **Surface dispersants**
    - No Action – what would be the trade off if no action is taken?
- Consult with the NOAA SSC to help with the modeling, fate of oil, and to help determine resources at risk.
    - What is the trajectory if we do not disperse?
    - Long-term monitoring for ESA, (e.g., Sea Turtles, Marine Mammals, and dolphins)
- **Work with BSEE to get 30-day trajectory predictions from the RP's Oil Spill Response Plan (OSRP).**

Outcome

Charlie Henry (NOAA natural resource trustee) and Stephen Spencer (DOI natural resource trustee): Agreed with the request. No further comments

Steve Mason on behalf David "Wes" McQuiddy (EPA): Agreed with the request. No further comments

RRT Incident Specific Activation Summary: https://www.epaosc.org/site/doc_list.aspx?site_id=5083
https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20--%20Freeport%20McMoran%20--%2004-30-2014.pdf

November 2013 - Chevron USA Inc. - Chevron USA Inc. conducted their annual industry led PREP exercise (requested RRT concurrence to use subsea dispersants as part of the exercise).

Over a three-day period (19-21 November 2013), Chevron conducted their Full-Scale Exercise in accordance with the Preparedness for Response Exercise Program (PREP) guidelines. As part of the exercise, the Coast Guard FOSC pursued RRT concurrence to use dispersants and in-situ burning to minimize environmental impact.

Prior to the exercise, Chevron planners provided several key read ahead documents to RRT-6, (e.g., Exercise Briefing, Dispersant checklist, and the In-situ Burning Checklist).

On 20 November 2013, at 1000, the RRT-6 Incident Specific Activation call commenced; call adjourned at

1037.

RRT Incident Specific Activation Summary: https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20--%20Chevron%20Oil%20Spill%20--%2011-21-2013.pdf

ConocoPhillips 2013 – Presentation to RRT VI. Exercise Scenario located in **Walker Ridge 460** in 6,915 ft of water. No Activation Summary on the EPAOSC.org website.

RRT VI presentation: https://www.epaosc.org/sites/11040/files/05-29%201530%20ConocoPhillips%20Exercise.pdf **NEBA Concerns/Questions**

- Evaluate trade-offs associated with dispersant use, in part through use or review of NEBAs conducted for past oil spills
    - What were the NEBA protocols used (e.g., USCG CERA, ASTM)?
    - What is the scope (e.g., environmental, socioeconomic) and methodology of the trade-off analysis?
        - Qualitative vs quantitative
        - NEBA-type analyses are often characterize as determining the "best" option, ensure "maximum" or "greatest" environmental protection, "lowest" overall negative impact on the environment/socioeconomic, promotes the "quickest" overall ecosystem recovery
    - What factors are used when comparing response options?
- Are factors such as logistical, availability, efficiency considered? If so, how does this impact the analysis? Does response method inefficiency or inadequate availability drive the analysis to a suboptimal outcome?
- How are assumptions supported prior to and validated during a response?
- When is the analysis conducted (planning phase vs expedited)?
- Who conducted the analysis (e.g., responsible party, government, third party)?
    - Certain stakeholders may weigh factors differently
    - If multiple stakeholders involved, who selects the participants? What criteria are used to select the participants?
- How are uncertainties/unknowns addressed?

To: Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Wilson, Gregory
Sent: Wed 9/14/2016 7:13:38 PM
Subject: RRT 6 Activation Summaries - Exercises
Activation Call -- EXERCISE -- Chevron Oil Spill -- 11-21-2013.pdf
Activation Call -- EXERCISE -- Freeport McMoran -- 04-30-2014.pdf
Activation Call -- EXERCISE - HWCG-LLOG -- 5-10-2016.pdf
Activation Call -- EXERCISE -- Incident Specific Activation Report BP Hopkins -- 11-05-2014.pdf
Activation Call--EXERCISE - Chevron- 8-19-2015.pdf

Exercise
Exercise
Exercise

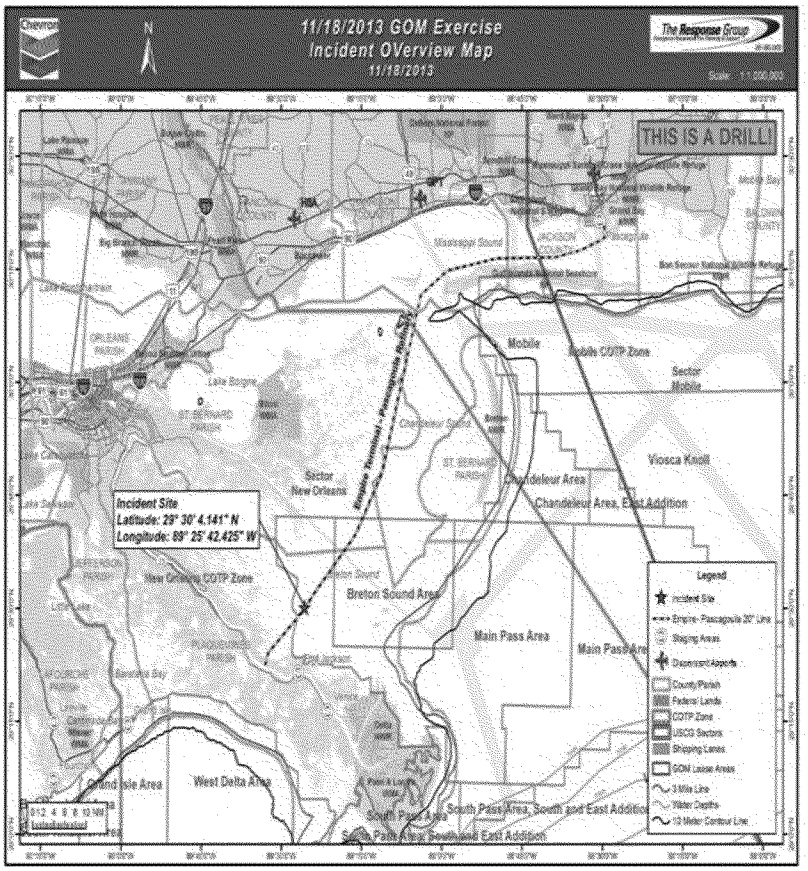
Exercise
Exercise
Exercise

Incident Specific Activation Report

Chevron 2013 Gulf of Mexico Full-Scale Exercise

Simulated Medium Oil Spill – Coastal Zone

U.S. Coast Guard, Sector New Orleans, LA



Regional Response Team 6

http://www.rrt6.org/

Nov 20, 2013

(RRT-6 Activation Date)

Brief Timeline of Events:

Over a three-day period (19-21 November 2013), Chevron conducted their Full-Scale Exercise in accordance with the Preparedness for Response Exercise Program (PREP) guidelines. As part of the exercise, the Coast Guard FOSC pursued RRT concurrence to use dispersants and in-situ burning to minimize environmental impact.

Exercise **Exercise** **Exercise**

ED_001324_00007409-00001

Incident Specific Activation Report

Chevron 2013 Gulf of Mexico Full-Scale Exercise

Prior to the exercise, Chevron planners provided several key read ahead documents to RRT-6, (e.g., Exercise Briefing, Dispersant checklist, and the In-situ Burning Checklist).

On 20 November 2013, at 1000, the RRT-6 Incident Specific Activation call commenced; call adjourned at 1037.

Exercise Scenario:

Chevron simulated a rupture and subsequent discharge of approximately 10K-12K bbls of crude oil in Louisiana state waters from one of their 20" pipelines. The pipeline runs from Empire Terminal (Empire, LA) to Pascagoula Refinery (Pascagoula, MS), a total of 104 miles, with no isolation valves and a total capacity of 198,000 bbls.

Key Factors:

FOSC dispersant preauthorization does not apply at the source (due to water depth); however, since the simulated spill was forecasted to move into deeper water there was the opportunity for the FOSC to exercise his dispersant preauthorization authority to reduce the potential for the oil to impact the Gulf Island Seashore and shoreline in Mississippi and Alabama. The RRT telcon served three primary purposes: (1) as an expanded audience for the required emergency consultation with the Services (40 CFR 300.135(j)(k); (2) as a mechanism to discuss & obtain concurrence from the EPA & the State of Louisiana for use of alternative response technology; and (3) allow Chevron personnel the opportunity to participate in a RRT telcon (gain awareness & knowledge of the process, expectations, etc).

DISPERSANTS:

Although acknowledging that dispersant preauthorization exists within RRT-6, Sector New Orleans advised of their intention to engage the RRT in advance of actual dispersant application to ensure that concurrence is obtained.

The RRT recommended an aggressive public affairs outreach be initiated as soon as possible once alternative technology determination is made.

In the event of a Fisheries closure, the UC should have close coordination with state fisheries personnel (in addition to DOC/NMFS).

The USCG Gulf Strike Team (GST) to provide Tier 1 SMART Monitoring.

UC consulted with National Marine Fisheries and Fish and Wildlife services for "Best Management Practices" with dealing with Wildlife and Endangered Species in the area.

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RRT-6 Emergency Consultation (Dispersants):

Consultation:			
Support Plan & Tactics (Yes/No)	Agency	POC	Comments
Yes	DOI	Dr. Stephen Spencer	Fish and Wildlife will represent DOI with issues regarding endangered species Monitor very closely for beach impacts Parks Service should be consulted due to the potential impacts to the Gulf Islands National Seashore.
Yes	DOC NOAA	Mr. Charlie Henry	Ensure aerial observers (spotters) are in place prior to applying dispersants. They should document all Sea Turtles and/or Sea Mammals in the affected area.

RRT-6 Concurrence (Dispersants):

Concurrence:			
Yes/NO	Agency	POC	Comments
Yes	State of Louisiana	Colonel Brian Wynne	Colonel Brian Wynne provided Concurrence
Yes	EPA R6	Not able to participate on telcon.	Although not able to participate on telcon, follow-up discussion resulted in EPA providing their notional concurrence with the initial application of an aerial dispersant and use of in-situ burning as per existing RRT guidelines.

Historical Dispersant Application Discussion: The ***2-Mile Rule*** originated from the Deepwater Horizon (DWH) incident. The 'rule' limits the application of dispersants within a 2-mile radius of a manned platform. Although this 'rule' was an identified best management practice during the DWH incident, it is NOT mandated within existing RRT-6 dispersant guidelines. Within RRT-6, dispersant application can be conducted less than 2 miles from structures in the Gulf of Mexico on a case-by-case basis with FOSC/UC concurrence -- they just can't spray closer than 500 ft. per FAA rules. During DWH, the FOSC/UC received complaints & feedback about the perception of planes "coming too close". As such, the UC pushed the spray ops back to 2 miles for manned assets (platforms, boats) and 3 miles for marine mammals. After this change, allegations of "being too close" subsided dramatically. Marine Spill Response Corporation (MSRC) revised their SOPs to account for DWH lessons learned, but acknowledge their ability to apply dispersant closer than 2 miles if all are in agreement. The objective is to conduct all operations safely. It is imperative to ensure FOSC/UC knowledge/approval; proactively broadcast a security message; set a safety zone/temporary flight restriction (TFR); and advise workers on platforms/vessels that a plane will be passing "close by".

IN-SITU BURNS:

Just like dispersants, the FOSC has preauthorization, in certain areas, to initiate in-situ burns within RRT-6; however, the position of Sector New Orleans is to engage the RRT for concurrence prior to initiation of any in-situ burns.

FOSC requested permission to conduct in-situ burns near the pipeline break. Since the break was located in state waters, NOAA recommended the UC work closely with state partners and stakeholders.

RRT-6 Emergency Consultation (In-Situ Burn):

Consultation:			
Support Plan & Tactics (Yes/No)	Agency	POC	Comments
Yes	DOI	Dr. Stephen Spencer	No issues, and since DOI is part of the UC, they will monitor results and adjust accordingly. If burn starts to cause issues onshore, responders can release the boom and the fire will go out rather quickly.
Yes	DOC-NOAA	Mr. Charlie Henry	Recommended that the EPA's TAGA Bus should be requested to provide air monitoring and to give the community assurance that the smoke plumes are not toxic, and to document results if liability issues arise.

RRT-6 Concurrence (In-Situ Burn):

Concurrence:			
Yes/NO	Agency	POC	Comments
Yes	State of Louisiana	Colonel Brian Wynne	NSTR
Yes	EPA R6	Not able to participate on telcon.	Although not able to participate on telcon, follow-up discussion resulted in EPA providing their notional concurrence with the initial application of an aerial dispersant and use of in-situ burning as per existing RRT guidelines.

Incident Specific Activation Report

Chevron 2013 Gulf of Mexico Full-Scale Exercise

Exercise
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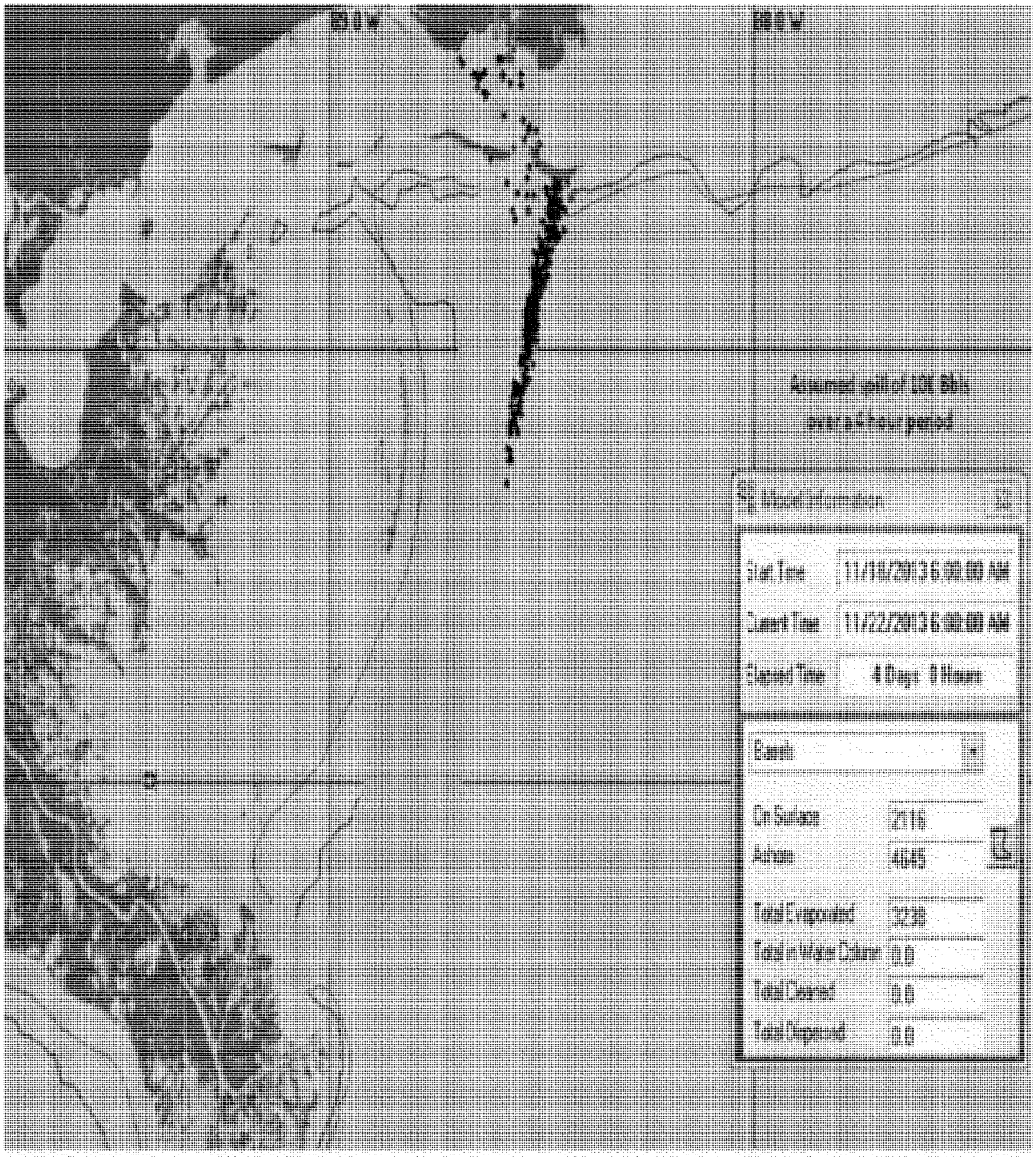

96 Hour Trajectory Showing Predicted Location
@ 0600Hrs 11-22-2013

Exercise
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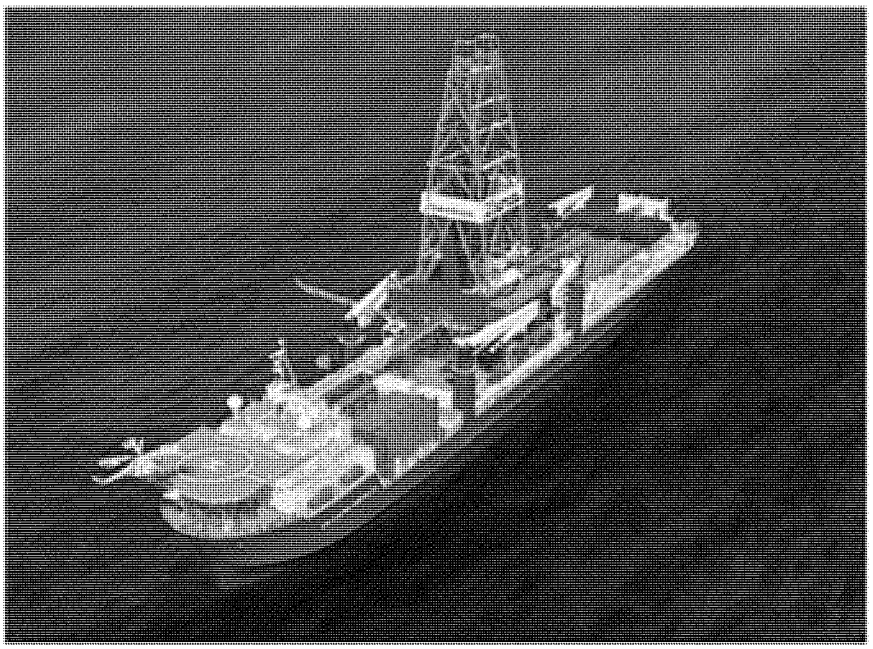
Incident Specific Activation Report

Exercise
Exercise
Exercise

HWCG-Freeport-McMoRan Oil & Gas
(HWCG-FMOG) Gulf of Mexico 2014 Exercise

Simulated Major Oil Spill – Coastal Zone
U.S. Coast Guard, Marine Safety Unit Morgan City, LA



Regional Response Team 6

http://www.rrt6.org/

April 30 & May 1, 2014

(RRT-6 Activation Dates)

Brief Timeline of Events:

HWCG-FMOG conducted their annual industry led Preparedness for Response Exercise Program (PREP) exercise on 30 Apr and 1 May 2014. As part of the exercise, they requested RRT concurrence to use subsea dispersants, specifically COREXIT 9500, as an effective means to minimize environmental impact.

On 11 April 2014, the exercise planners provided several key read ahead documents to RRT-6, (e.g., Facility Incident Report, Proposed Subsea Dispersant Operations Plan, Subsea Dispersant, Subsea Dispersant Monitoring Plan, Incident Action Plan, Application Monitoring Materials and Equipment List).

(HWCG-FMOG) Gulf of Mexico 2014 Exercise

On 30 April 2014, at 1400 CT, the RRT-6 Incident Specific Activation call commenced; call adjourned at 1505.

On 1 May 2014, at 1000, the RRT-6 convened a follow-up call; call adjourned at 1017.

Exercise Scenario: While in the process of tripping out of a hole in the Green Canyon 393 block, the Drill Ship DEEPWATER CHAMPION reported a fire in their engine room. Operation occurred in a water depth of 3,800-feet; drill depth: 23,975-feet.

The fire caused the vessel to lose power and drift off site. When this occurred, the drill string cleared the Blow out Preventer (BOP), and the lower marine riser successfully disconnected; however, the subsea pod did not properly actuate the blind and sheer rams and resulted in an uncontrolled hydrocarbon discharge.

Summary / Conclusion: USCG RRT-6 Co-Chair convened two Incident Specific RRT conference calls at the request of the Exercise FOSC. DOC and DOI trustee representatives provided consultation and outlined the following action items in advance of RRT-6 concurrence. EPA and state reps from TX & LA agreed.

- Explain the positive net benefit of using subsea dispersants as opposed to not using them.
- Work with Resource Trustees to determine the trade-offs of using versus not using subsea dispersants, and how will it affect the following:
    - Sport fishing
    - Habitat Fisheries
    - Long-term effects in marsh versus deepwater
- Provide RRT-6 with the benefits/tradeoffs of each of the following cleanup techniques:
    - Subsea dispersants
    - Surface dispersants
    - No Action – what would be the trade off if no action is taken?
- Consult with the NOAA SSC to help with the modeling, fate of oil, and to help determine resources at risk.
    - What is the trajectory if we do not disperse?
    - Long-term monitoring for ESA, (e.g., Sea Turtles, Marine Mammals, and dolphins)
- Work with BSEE to get 30-day trajectory predictions from the RP's Oil Spill Response Plan (OSRP).

Exercise **Exercise** **Exercise**

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RRT-6 Consultation:

Consultation:			
Support Plan & Tactics (Yes/No)	Agency	POC	Comments
Yes	DOI	Dr. Stephen Spencer	
Yes	DOC-NOAA	Mr. Charlie Henry	

RRT-6 Concurrence:

Concurrence:			
Yes/No	Agency	POC	Comments
Yes	EPA R6	Steve Mason on behalf David "Wes" McQuiddy	
Yes	State of Louisiana	Brian Wynne	
Yes	State of Texas	Greg Pollock	

Useful links:

- Dispersant Application Observer Job Aid (NOAA)
- EPA Response to BP Spill in the Gulf of Mexico
- API JITF Subsea Dispersant Injection Newsletter

Exercise **Exercise** **Exercise**

Exercise
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Exercise

Incident-Specific Activation Report

Exercise
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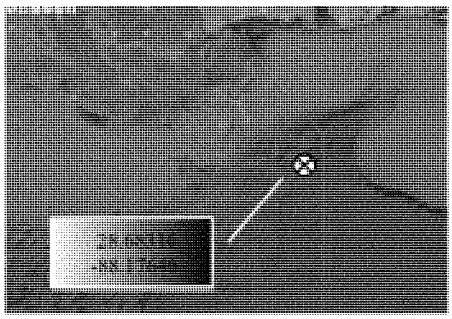
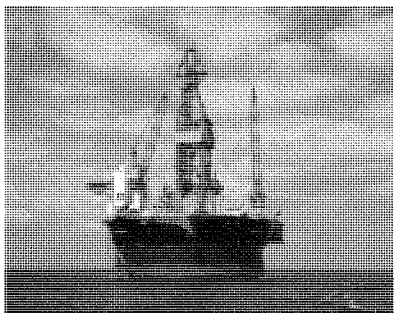
Exercise

HWCG-LLOG 2016
Gulf of Mexico Exercise

Simulated Major Oil Spill – Coastal Zone
U.S. Coast Guard, Marine Safety Unit Morgan City, LA





Regional Response Team (RRT) 6

Link

May 10, 2016

(RRT-6 Activation Date)

Brief Timeline of Events:

1. On May 10-11, 2016, HWCG-LLOG conducted their annual industry-led Preparedness for Response Exercise Program (PREP) exercise. As part of the exercise, they requested RRT concurrence to use subsea dispersants, specifically COREXIT EC9527A, FINASOL OSR 52, and ACCELL Clean DWD, as an effective means to minimize environmental impact.

2. On April 29, 2016, HWCG-LLOG's exercise planners provided their subsea dispersant package to RRT-6 (i.e., Summary Slide Deck, Resources at Risk, Critical Review of Toxicity, Monitoring Plan, Logistics, Schedule, RRT Incident Data Sheet, Scenario, and Mass Data comparisons).

3. On May 10, 2016, at 1400 CT, the Incident-Specific RRT (ISRRT) teleconference commenced; call adjourned at 1500.

Exercise Scenario: At 0545 CT 07 May 2016 the drilling rig SEVAN LOUISIANA was completing drilling operations on Mississippi Canyon 300, Well #2. The well was past all the objective sands and the rig was drilling the rat hole at 21,020' Measured Depth (MD) with the drill bit on bottom. The Offshore Supply Vessel (OSV) BO-TRUC 41 was alongside the rig in Dynamic Positioning (DP) mode offloading the production liner casing. There was a strong thunderstorm in the area producing winds of 60 knots with 3-5ft seas and low visibility. OSV

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BO-TRUC 41 had a drive off at full power and rammed into the SEVAN LOUISIANA's starboard / aft section. The impact shook the rig and created a large hole in the aft section. The jarring impact caused a load being transported on a forklift to shift and strike the Abandon Vessel Shutdown (AVS) button located at lifeboat station #4. This activated the AVS sequence, blacking out the rig, and sending the SEVAN LOUISIANA adrift. The crew assessed the situation; however, the rig was well into the "red zone" at a substantial offset prior to activating the emergency disconnect system (EDS). The EDS worked and the riser and Lower Marine Riser Package (LMRP) disconnected from the Blowout Preventer (BOP) stack.
After 60-minutes the rig was able to restore power and deploy the Remotely Operated Vehicle (ROV).

- The ROV inspected the riser and associated subsea equipment and the results were:
  - The LMRP was still attached to the riser.
  - The wellhead was bent at an angle greater than 2° (max bulls eye angle is 2°); and mud was flowing out of the top of the BOP at an undermined rate.
  - Approximately 350 - 425 feet of drill pipe was sticking out of the BOP with the drill pipe against the inside diameter of the BOP mandrel. The pipe was bent with the end of the pipe on the seafloor.
  - The drill pipe string was lying on the seabed, and there was no observed flow from the end of the pipe.

Summary / Conclusion: USCG RRT-6 Co-Chair (Mike Sams) convened an ISRRT conference call at the request of the Exercise FOSC. The purpose of the call was to review, discuss and potentially approve HWCG-LLOG's request to apply subsea dispersants to mitigate the discharge.

Situation Status: HWCG-LLOG provided a brief overview of their exercise and reiterated that the read-ahead package contained the comprehensive situation status. The location of the incident was simulated in Mississippi Canyon Block 300, approximately 59-miles south of the mouth of the Mississippi River, and was based on their oil spill response plan's worst-case discharge. HWCG-LLOG requested RRT-6 approval for the use of subsea dispersants to reduce volatile organic compounds (VOCs) exposure to responders, and reduce the potential for oil impacts to the shoreline and resources at risk.

RRT-6 Member Discussions: RRT members were provided a read-ahead package prior to the call. This helped facilitate a meaningful discussion and allowed more productive feedback to HWCG-LLOG personnel. Despite the many unknowns with this exercise, RRT members unanimously agreed that injecting subsea dispersants at the source of the spill was the best and preferred method, thus minimizing oil from reaching the surface and shoreline. Members acknowledged that during a real incident, HWCG-LLOG would simultaneously be deploying assets to control the spill (capping stack, cap and flow and/or top hat), and deploying mechanical means (skimmers). The following are key takeaways that were discussed during the call:

- In the event that subsea dispersants are actually requested, the UC must provide the RRT with a Monitoring Plan that is both **aggressive and adaptive**.
- NOAA acknowledged that using subsea dispersants at the source is generally the best option to keep the oil out of critical habitats; however, as the lead trustee for numerous

Exercise **Exercise** **Exercise**

"at risk" species in the subsea, surface, near-shore and on-shore environment, they have a more difficult challenge when weighing the tradeoffs between response techniques. Another variable in the decision process is what time of year the incident occurs (e.g., Sea Turtle nesting).

- DOI recommended that responders should do everything possible to keep the oil out of the wetlands and minimize impact to bird rookeries and fish nurseries. To do this effectively in the open ocean environment, subsea dispersant use at the wellhead would be the best option. Also, in-situ burning and mechanical recovery would not be effective in rough water, allowing the oil to remain on the surface for longer periods of time, resulting in weathering of the oil, which in turn makes it even harder to disperse, cleanup and remove.
- The RRT members discussed and **approved** the request to use two additional dispersants in addition to COREXIT EC9627A; (specifically, FINASOL OSR 52 and ACCELL Clean DWD). Key factors that contributed to the approval for use of three dispersants were: (1) the stockpile of COREXIT; and (2) recommended products are listed on the EPA's Product Schedule. This is the first time RRT-6 has approved (notionally, for exercise purposes) the use of a dispersant other than COREXIT.
- Another unique (and key component) of this exercise was the utilization of dispersants being flown in from international locations. Oil Spill Response Limited (OSRL) has a global dispersant stockpile (GDS) of approximately 1.1 million gallons that is available (and was simulated during this exercise) if the incident response becomes prolonged.

RRT-6 Consultation:

Consultation:			
Support Plan & Tactics (Yes/No)	Agency	POC	Comments
Yes	DOC-NOAA	Mr. Charlie Henry	Agreed that subsea dispersant use was the best option in this case; monitoring plan must be in place.
Yes	DOI	Dr. Stephen Spencer	Agreed that subsea dispersant use was the best option in this case.

Exercise **Exercise** **Exercise**

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RRT-6 Concurrence:

Concurrence:			
Yes/No	Agency	POC	Comments
Yes	EPA R6	Mr. Ronnie Crossland	Approved, with the understanding that in an actual incident, there could be several calls leading up to an actual approval. RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback / progress on the subsea application and monitoring process.
Yes	State of Texas (TGLO)	Mr. Greg Pollock	Approved. Although spill is located in federal waters, TGLO recognizes that if "no action" (i.e., subsea dispersants) is taken, the oil could eventually impact state waters. They are also in favor of fighting the spill as far offshore as possible.
Yes	State of Louisiana (LOSCO)	Mr. Brian Wynne	Approved. Although spill is located in federal waters, LOSCO recognizes that if "no action" (i.e., subsea dispersants) is taken, the oil could eventually impact state waters.

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Incident Specific Activation Report

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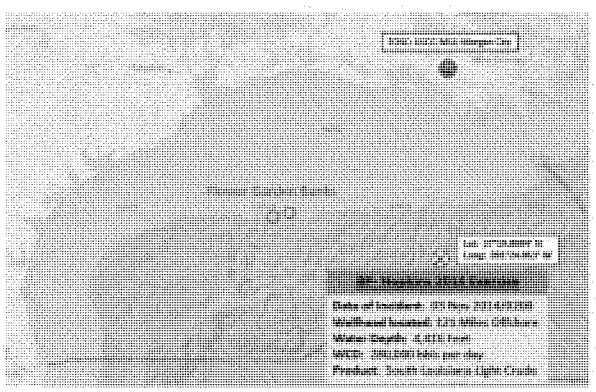
Exercise

BP Hopkins 2014
Gulf of Mexico Exercise

Simulated Major Oil Spill – Coastal Zone
U.S. Coast Guard, Marine Safety Unit Morgan City, LA



Regional Response Team 6

http://www.rrt6.org/

November 5, 2014

(RRT-6 Activation Date)

Brief Timeline of Events:

BP conducted their annual industry-led Preparedness for Response Exercise Program (PREP) exercise on 5 November 2014. As part of the exercise, they requested RRT concurrence to use subsea dispersants, specifically COREXIT EC9500A, as an effective means to minimize environmental impact.

On 27 October 2014, the exercise planners provided several documents for situational awareness (i.e., In-Situ Burn Checklist, Proposed In-Situ Burn Operations Plan, Surface Dispersant Pre-Authorization Checklist, and Proposed Surface Dispersant Operations Plan). These were not discussed during the Incident Specific Regional Response Team (ISRRT) teleconference.

On 29 October 2014, the exercise planners provided subsea dispersant package to RRT-6 (i.e., Incident Data Sheet, Proposed High Level Subsea Dispersant Operations Plan, Proposed Subsea Dispersant Injection Monitoring Plan, Expedited Net Environmental Benefit Analysis (NEBA) of Subsea Dispersant Injection, and Oil Spill Trajectory and Fate Modeling Summary).

On 5 November 2014, at 1000 CT, the RRT-6 ISRRT teleconference commenced; call adjourned at 1110.

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BP Hopkins 2014
Gulf of Mexico Exercise

Exercise Scenario: Simulated collision between a container ship and the WEST SIRIUS Mobile Offshore Drilling Unit (MODU). The MODU was drilling in the Hopkins Field when the collision occurred. As a precautionary measure the MODU tried to avoid collision by engaging their Emergency Disconnect System (EDS); however, it was unsuccessful. The MODU sustained some damage, but maintained water integrity and moved off station. A Remotely Operated Vehicle (ROV) was deployed to the sea bottom to assess the damages. Video feed revealed a plume of dark fluid emitting from the well head and objects (2 containers) resting against the Blowout Preventer (BOP).

Summary / Conclusion: USCG RRT-6 Co-Chair convened an Incident Specific RRT conference call at the request of the Exercise FOSC. The purpose of the call was to review, discuss and potentially approve BP's request to apply subsea dispersants to mitigate the discharge ongoing from Green Canyon 327.

Situation Status: The Environmental Unit (EU) presented overview of NEBA that led to the request for subsea dispersant approval. Key benefits outlined during the call:

- *Responder Safety* – reduce volatile organic compounds (VOCs) and exposure limits.
- *Reduce large surface slicks* – that could potentially migrate over large surface areas and impact the following:
  - *Wildlife* – reduce the potential exposure to sensitive areas of concern, such as the upper layer of the water column, where marine mammals and turtles are found.
  - *Critical Habitats* – modeling software predicted impact to the Flower Garden Banks if subsea dispersants were not used.
  - *Shoreline* – reduce potential of oil impacting and stranding on shorelines.
  - *Economic* – reduce economic impacts (commercial, sport, and recreational)
- Weather – high winds and large waves expected to make conventional recovery methods impossible.

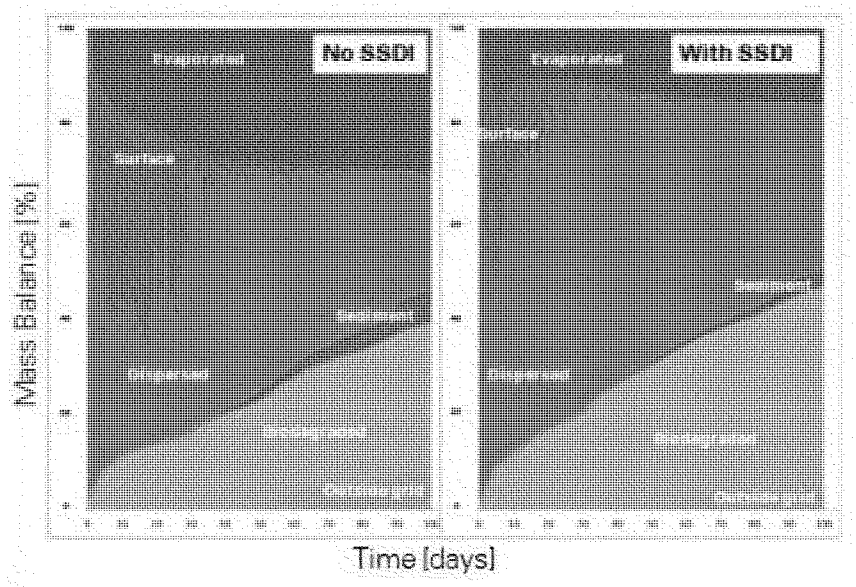

Table 1

Exercise **Exercise** **Exercise**

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RRT-6 Member Discussions:

- NOAA explained how the Relative Mass Balance presented by the EU is a cumulative balance, and over time the benefits get more and more blurred. There are a lot of variables that are not taken into the model. For instance, the fate of the oil in each of the compartments (see Table 1) over time will undergo their own specific changes. So, it can be assumed that the use of subsea dispersants would have more of a benefit than actually depicted in the table. Bottom line is every incident would be looked at on a case-by-basis, and we should ask the following questions:
    - What was spilled?
    - Where is it going?
    - What is at risk?
    - How it can hurt?
    - What can be done?

- NOAA provided a specific analysis of what could be expected near the well site and areas that under certain conditions could be affected by the oil.
- In the Gulf of Mexico, most of the biological action occurs to the north, or near the shelf, however, there are some deepwater high-value resources at risk as well. The following are all of the resources potentially at risk:
    - *Blue Fin Tuna*: spawning times are from mid-April to mid-June. The juvenile fish are generally around 5-months old, and in a motile state. They are not in the free floating platonic stage, making them a lower risk.
    - *Blue Crabs*: similar to Blue Fin Tuna; low risk.
    - *Brown Shrimp*: spawning times September to November; low risk.
    - *Sea Birds/Migratory Birds*: low probability near well head unless there is rafting seaweed (sargassum) they can land on.
    - *Marine Mammals*:
        - *Sperm Whales*- likely to encounter at or near the well site.
        - *Spotted Dolphins*- likely to encounter at or near the well site.
        - *Bottlenose Dolphins*- not likely to encounter at or near the well site.
    - *Sea Turtles*: low probability, however, if there is sargassum in the area, you may find juvenile turtles.
    - *Deepwater corals*: there have been reports of deepwater corals near the Flower Garden Banks.

- Monitoring Plan: NOAA recommend that during a real incident, it would be advisable to have a monitoring plan that is adaptive. For example, in this situation it would be advisable to have fence line monitoring at the Flower Garden Banks, which has the highest aggregate of resources in the area.
- Weather: NOAA mentioned that with the increased weather and waves we can expect more natural dispersion. It can also be expected that there will be more tar balls and tar ball fields forming, making it impossible to track where they will come ashore.
- Offshore response will be hindered by limited daylight combined with the long transit times to reach the spill location.

RRT-6 Consultation:

Consultation:			
Support Plan & Tactics (Yes/No)	Agency	POC	Comments
Yes	DOI	Dr. Stephen Spencer	With the low probability of oil reaching the shore, DOI deferred to DOC-NOAA/NMFS. DOI also stated that using subsea dispersants would be the best tool for this scenario.
Yes	DOC-NOAA	Mr. Charlie Henry	Recognized that this is an exercise and that the information that is discussed and agreed on during this incident will not be the same for every incident. It is important to note that every incident is unique and will have to be assessed individually on a case-by-case basis.

RRT-6 Concurrence:

Concurrence:			
Yes/No	Agency	POC	Comments
Yes	EPA R6	Mr. Ronnie Crossland	Approved, with the stipulation that in an actual incident, RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback/progress on the subsea application and monitoring process. Also, the RRT would most likely require daily reports/follow-up calls to review efficacy of the subsea dispersants, and to make course corrections as needed.
Yes	State of Texas	Mr. Greg Pollock	Approved, with the understating that as we move forward, we (RRT/UC) continue to work together to improve/refine the subsea dispersant process.
N/A	State of Louisiana	Mr. Brian Wynne	Not present on call.

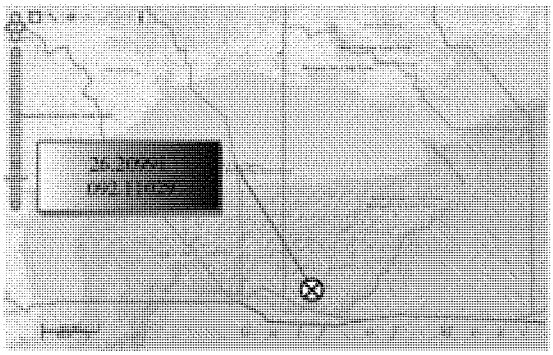
Useful links:

- Dispersant Application Observer Job Aid (NOAA)
- EPA Response to BP Spill in the Gulf of Mexico
- API JITF Subsea Dispersant Injection Newsletter

Incident Specific Activation Report

Chevron USA Inc. 2015
Gulf of Mexico Exercise

Simulated Major Oil Spill – Coastal Zone
U.S. Coast Guard, Marine Safety Unit Morgan City, LA



Regional Response Team (RRT) 6

August 19, 2015

(RRT-6 Activation Date)

Brief Timeline of Events:

On May 13-15, 2015, Chevron USA Inc. conducted their annual industry-led Preparedness for Response Exercise Program (PREP) exercise. As part of the exercise, they requested RRT concurrence to use subsea dispersants, specifically COREXIT EC9500A, as an effective means to minimize environmental impact. The RRT was not able to coordinate the call during the actual exercise dates; however, agreed to hold it at a later date.

On August 10, 2015, Chevron's exercise planners provided their subsea dispersant package to RRT-6 (i.e., Summary Slide Deck, Resources at Risk, Critical Review of Toxicity, Monitoring Plan, Logistics, Schedule, RRT Incident Data Sheet, Scenario, and Incident Map).

On August 19, 2015, at 1000 CT, the Incident Specific RRT (ISRRT) teleconference commenced; call adjourned at 1100.

Exercise Scenario: While operating in Keathley Canyon 785, the drillship PACIFIC SHARAV was blown off station by a microburst which resulted in the sheering of the riser. All emergency disconnect procedures were followed; however, they were not able to activate a well shut-in and stop the flow of oil. The worst case discharge is 242K barrels a day. A remotely operated vehicle (ROV) was deployed to inspect the riser.

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Summary / Conclusion: USCG RRT-6 Co-Chair convened an Incident Specific RRT conference call at the request of the Exercise FOSC. The purpose of the call was to review, discuss and potentially approve Chevron's request to apply subsea dispersants to mitigate the discharge.

Situation Status: Chevron provided a brief overview of their exercise and reiterated that the read-ahead package contained the comprehensive situation status. The location of the incident was simulated in Keathley Canyon approximately 210-miles south of Morgan City, LA, and was based on their oil spill response plan's worst case discharge. Chevron requested RRT-6 approval for the use of subsea dispersants to reduce VOCs to promote responder safety, and to reduce impacts to the shoreline and resources at risk. The monitoring plan was written to include built-in trigger points to facilitate discussion and to reassess the efficacy of the dispersant use.

RRT-6 Member Discussions: RRT members were provided a read-ahead package prior to the call. This helped facilitate a meaningful discussion and allowed more productive feedback to Chevron personnel. Despite the many unknowns with this exercise, RRT members unanimously agreed that injecting subsea dispersants at the source of the spill was the best and preferred method, thus minimizing oil from reaching the surface and shoreline. Members acknowledged that during a real incident, Chevron would simultaneously be deploying assets to control the spill (capping stack, cap and flow, and/or top hat). The following are key takeaways that were discussed during the call:

- In the event that subsea dispersants are actually requested, the UC must provide the RRT with a Monitoring Plan that is both **aggressive and adaptive**. The plan should include the following factors for measuring the efficiency of subsea dispersants:
    - Have the ability to measure and evaluate the effectiveness of both contact time and mixing efficiency while injecting dispersants.
    - Ability to measure the distribution of droplets, and ensuring the smaller droplets are less than the 200 micron range.
- During a spill where dispersants are to be applied, it is a good idea to work in close coordination with the academic community (e.g., National Science Foundation, State Universities, etc.) to promote transparency and facilitate the sharing of monitoring data, so that everyone is working towards a common goal.
- NOAA acknowledged that using subsea dispersants at the source is generally the best option to keep the oil out of critical habitats; however, as the lead trustee for numerous "at risk" species in the subsea, surface, near-shore and on-shore environment, they have a more difficult challenge when weighing the tradeoffs between response techniques. Another variable in the decision process is what time of year the incident occurs (e.g., Sea Turtle nesting).
- DOI recommended that responders should do everything possible to keep the oil out of the wetlands and minimize impact to bird rookeries and fish nurseries. To do this effectively in the open ocean environment, subsea dispersant use at the wellhead would be the best option. Also, in-situ burning and mechanical recovery would not be effective in rough water, allowing the oil to remain on the surface for longer periods of time, resulting in weathering of the oil, which in turn makes it even harder to disperse.

Exercise **Exercise** **Exercise**

RRT-6 Consultation:

Consultation:			
Support Plan & Tactics (Yes/No)	Agency	POC	Comments
Yes	DOC-NOAA	Mr. Charlie Henry	Agreed that subsea dispersant use was the best option in this case; monitoring plan needs to be in place.
Yes	DOI	Dr. Stephen Spencer	Agreed that subsea dispersant use was the best option in this case; monitoring plan needs to be in place.

RRT-6 Concurrence:

Concurrence:			
Yes/No	Agency	POC	Comments
Yes	EPA R6	Ms. Brandi Todd	Approved, with the understanding that in an actual incident, there could be several calls leading up to an actual approval. RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback / progress on the subsea application and monitoring process.
Yes	State of Texas	Mr. Greg Pollock	Approved. Although spill is located in federal waters, RRT recognizes that if "no action" (i.e., subsea dispersants) is taken, the oil could eventually impact state waters.
Yes	State of Louisiana	Mr. Brian Wynne	Approved. Although spill is located in federal waters, RRT recognizes that if "no action" (i.e., subsea dispersants) is taken, the oil could eventually impact state waters.

Exercise Exercise Exercise

API SIMA Workshop Overview

Background

In recent years the oil and gas industry has placed significantly greater emphasis on the use of the net environmental benefit analysis (NEBA) methodology in the development of oil spill response strategies for at least the more significant incidents. While the general NEBA concept was well understood and many companies had developed their own NEBA methodologies, it was recognized there was not a common approach on how NEBAs should be conducted. Industry also recognized the NEBA term did not accurately represent the intent of the analysis in addition to it now addresses socio-economic and cultural impacts in addition to environmental. Consequently, IPIECA, IOGP and API collaborated on a project to develop a basic methodology for conducting NEBAs and have adopted the more descriptive term of spill impact mitigation assessment (SIMA).

SIMA Overview

The new SIMA guidelines can be summarized in the following four stages:

1. **Compile and evaluate data** for relevant oil spill scenarios.
2. **Predict outcomes/impacts** for the "No Intervention" option as well as the relative mitigation potential of other feasible response options for each scenario.
3. **Balance trade-offs** by weighing and comparing the range of benefits and drawbacks of each response option, including No Intervention, for each scenario.
4. **Select the best response option(s)** to form the strategy for each scenario that will minimize ecological, socio-economic and cultural impacts and promote rapid recovery.

The four stage process was adopted from the IPIECA/IOGP NEBA Good Practice Guide published in 2015 and the methodology was informed by the Consensus Ecological Risk Assessment (Aurand et al, 2000) as well as other NEBA/SIMA related documents and tools. The new methodology is a qualitative approach that is recommended for use in the planning phase with the outcomes modified during the response phase as necessary to account for incident specific conditions and circumstances. It can also be used independently in the response phase or in a more quantitative form for either phase if it is expected to materially change the outcomes and not time constrained.

It is important to note that this new SIMA methodology is not intended to be an industry standard applied to all oil spills but rather a methodology that can be utilized in the absence of other methods and particularly for more significant spills.

Workshop Objective

To better ensure the new SIMA method will be a viable approach in mitigating oil spill impacts and to promote broader acceptance within the spill response community, this workshop was organized to review the SIMA method and apply it to selected oil spill scenarios (i.e., stress test). It will involve key regulatory and industry representatives from the US. Another workshop involving international regulators and industry representatives will likely be organized as well.

The primary objectives of the workshops are to:

- identify potential significant gaps/flaws in the approach and obtain input on how best to address them, and
- obtain feedback on the suitability of the SIMA method for mitigating oil spill impacts and any potential application limitations

Gina Coelho email 3-2-2016: "**The American Petroleum Institute and IPIECA have undertaken several projects to help industry improve understanding and consistent application of the "Net Environmental Benefit Analysis (NEBA)" process for spill response decision making.** One effort (in which I am involved) involves taking the IPIECA GPG and tweaking it to make it more relevant to U.S. stakeholders. **Industry recognizes the importance of involving Federal and state agencies in this process, and suggested that I seek your input. I have developed a short survey to help inform that effort. If you agree to participate, I will schedule a 30 minute phone interview during which you may verbally share your thoughts and ideas.**

The information you share with me will be kept confidential and will not be publicly distributed; it will be used to help my team (comprised of myself, David Fritz, and Jim Staves) tailor the IPIECA GPG to the US spill response framework. I understand that you may not have the same experience as other individuals within your agency, and would ask you to share information based on your own personal understanding of NEBA concepts as they apply to oil spill planning and response in the US."

- Gina Coelho is an industry consultant and was a BP contractor for DWH, Dave Fritz was a BP employee during DWH, and Jim Staves worked for EPA Region 6 during DWH, but now retired from EPA and works as an industry consultant.
- OGC raised potential ethics concerns with responding to the survey. RID sent out an email to EPA personnel (including region 6) noting OGC's concerns.
- R6 referenced the IPIECA guidance in their two page NEBA justification for subsea dispersant use as part of the 2014 Green Canyon Exercise (see attached email). At that time we raised concerns with DOI's statement (attached email train) that indicated that if "subsea dispersant application is contemplated for an actual incident, this is what the justification will likely look like as it is put forward by the offshore exploration and production industry." We have significant concerns with the lack of detailed documentation and with the conclusions of the analysis that was offered as part of that exercise.
- The IPIECA guidance was also referenced in the RRT VI Subsea Dispersant Use Guidelines (draft version in the attached RRT Subsea Guidance Email) that were developed by the ILC (those were not finalized as an RRT document, but API has hinted to developing that document into an API recommended Practice).

CWA and NCP Requirements

Area Contingency Planning - 40 CFR 210(c):

- The ACP shall include the following…A description of the area covered by the plan, including the areas of special economic or environmental importance that might be damaged by a discharge;

Fish and Wildlife and Sensitive Environments Plan (FWSEP)

- All ACPs incorporate detailed annex containing FWSEP
- Consistent with the RCP and NCP
- Prepared in consultation with the USFWS and NOAA and other interested natural resource management agencies/parties.
- Among other requirements, the annex is to:
    - identify and establish priorities for fish and wildlife resources and their habitats and other important sensitive areas requiring protection from any direct or indirect effects from discharges,
    - provide a mechanism to be used during a spill response for timely identification of protection priorities of those fish and wildlife resources and habitats and sensitive environmental areas that may be threatened or injured by a discharge, and
    - identify potential environmental effects on fish and wildlife, their habitat, and other sensitive environments resulting from removal actions or countermeasures, including the option of no removal
    - Based on the evaluation of potential environmental effects, the annex should establish priorities for application of countermeasure and removal actions to habitats within the geographic region of the ACP

Reference: http://www.ecfr.gov/cgi-bin/text-idx?SID=f9a9c0ef0be4091830b5282ad7c0d670&mc=true&node=pt40.30.300&rgn=div5

- 33 USC 1321 (d)(2)(G) – Prepare a schedule, in cooperation with the States, identifying—
  (i) dispersants, other chemicals, and other spill mitigating devices and substances, if any, that may be used in carrying out the Plan,
  (ii) the waters in which such dispersants, other chemicals, and other spill mitigating devices and substances may be used, and
  (iii) the quantities of such dispersant, other chemicals, or other spill mitigating device or substance which can be used safely in such waters,

  which schedule shall provide in the case of any dispersant, chemical, spill mitigating device or substance, or waters not specifically identified in such schedule that the President, or his delegate, may, on a case-by-case basis, identify the dispersants, other chemicals, and other spill mitigating devices and substances which may be used, the waters in which they may be used, and the quantities which can be used safely in such waters

- EO 12777 delegates 33 USC 1321(d)(2)(G) to the EPA Administrator
- Implemented under Subpart J of the NCP

Authorization of Use (40 CFR 300.910)

- Mechanical recovery is NOT subject to authorization of use under Subpart J
- No specific "NEBA" requirement under Subpart J; rather response strategies are developed under the ACs
- RRTs and ACs address the desirability of using appropriate dispersants, other products listed on the NCP Product Schedule, and burning agents
- RCPs and ACPs shall, as appropriate, include applicable preauthorization plans and address the specific contexts in which such products should and should not be used

- The RRT representatives from EPA and the states with jurisdiction over the waters of the area to which a preauthorization plan applies and the DOC and DOI natural resource trustees shall review and either approve, disapprove, or approve with modification **the preauthorization plans developed by Area Committees**, as appropriate.
- Pre-authorization plans require approval of:
    - EPA RRT representative
    - States with jurisdiction over the waters of the area to which a preauthorization plan applies and;
    - DOC and DOI natural resource trustees
- Authorization of use for spill situations that are not addressed by the preauthorization plans requires:
    - Concurrence of the EPA representative to the RRT
    - As appropriate, concurrence of the RRT representatives from the states with jurisdiction over the navigable waters threatened by the release or discharge
    - Consultation with the DOC and DOI natural resource trustees

- Exception only to prevent or substantially reduce threat to human life
    - Insufficient time to obtain the needed concurrences/consultations
    - OSC must inform the EPA RRT representative and, as appropriate, the RRT representatives from the affected states and, when practicable, the DOC/DOI natural resources trustees as soon as possible
    - Not intended to circumvent preauthorization or case-by-case use authorizations
        - NCP addresses worker health and safety under 40 CFR 300.150

BSEE OSRP Regulations (30 CRR 254) required:

- An appropriate trajectory analysis specific to the area in which the facility is located, which must identify onshore and offshore areas that a discharge potentially could affect. The trajectory analysis chosen must reflect the maximum distance from the facility that oil could move in a time period that it reasonably could be expected to persist in the environment,
- **A list of the resources of special economic or environmental importance that potentially could be impacted in the areas identified by the trajectory analysis and the strategies used for their protection**. At a minimum, this list must include those resources of special economic and environmental importance, if any, specified in the appropriate Area Contingency Plan(s),
- A description of the response equipment that will be used to contain and recover the discharge to the maximum extent practicable and how to cope with the initial spill volume upon arrival at the scene and then support operations for a blowout lasting 30 days. This description must include the types, location(s) and owner, quantity, and capabilities of the equipment,
- A description of the personnel, materials, and support vessels that would be necessary to ensure that the identified response equipment is deployed and operated promptly and effectively, and
- Must ensure that the response equipment, materials, support vessels, and strategies listed are suitable, within the limits of current technology, for the range of environmental conditions anticipated at the facility

http://www.ecfr.gov/cgi-bin/text-idx?SID=ae9d48e87e273e549942f003d6bc7f29&mc=true&node=se30.2.254_126&rgn=div8

Note: BOEM incorporates the same BSEE requirements into Exploration/Production Plans requirements at 30 CFR 550.219 (Exploration Plans), and 30 CFR 550.250 (for Development and Production Plans (DPP) and Development Operations Coordination Documents (DOCD))
http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title30/30cfr550_main_02.tpl

USCG DWH ISPR

- Overall, the team found these ACPs to be inadequate for this incident, and possibly for smaller, more localized incidents. (pg 5)

In the Gulf of Mexico or anywhere offshore oil production occurs, there must be direct linkage between the Oil Spill Response Plan (OSRP) and local ACPs.

- The ISPR Team found that not including worst case discharge (WCD) scenarios from offshore oil

exploration, development, and production activities in ACPs for areas in which such activities are occurring was unacceptable.

- The NCP directs Area Committees to address ESAs and include booming and protection strategies to address a WCD.
    - In some planning areas, the ESAs were simply not identified in any plan. In some plans where the areas were listed, they were not prioritized.
    - In few instances, ESAs did have protection strategies for the areas that were most heavily impacted.
    - The equipment, trained personnel, and other response resources needed to implement the protection strategies were not included in many plans.
    - While many responders stated that impact to wildlife and habitat could have been much worse in the Deepwater Horizon incident, there is a consensus among team members that, had ESAs been given appropriate attention during the planning process, the adverse impacts could have been much less. ESAs have been given uneven, and in some cases, inadequate attention in the ACP development process throughout the Gulf of Mexico. There must be a comprehensive national planning process that identifies ESAs and assures that there are trained personnel, equipment, and strategies adequate to protect these resources. The Coast Guard needs to work with Federal, State, local, tribal, and natural resource trustee stakeholders to select an exemplar among those ACPs that adequately addresses ESAs and make that a benchmark for future planning efforts.

The use of two alternative response technologies, **dispersants and in situ burning (ISB), proved critical to prevent wholesale impacts to ESAs** because the characteristics of the spill were favorable to the use of both technologies. However, **important concerns and questions remain about their impacts on the environment, and more research is necessary before bringing them into the mainstream of spill response options**.

- Although pre-authorization of dispersant use was approved by the Regional Response Team (RRT) and implemented by the Federal On-Scene Coordinator (FOSC), significant public concern was expressed over the volume being used and toxicity of the dispersants, causing EPA to develop protocols for dispersant application and monitoring.
    - While the FOSC always has the authority to approve use of dispersants to protect human life, in this case, to control volatile organic compounds in the source area, EPA intervened to address the volume and toxicity issues, as well as subsea application at the source. **This resulted in a temporary suspension of dispersant application, which may have resulted in more oil reaching the coastline.**
    - While the issue of subsea application may not have been reasonably foreseen, **other issues such as toxicity and volumetric limitations should have been foreseen as part of the National Oceanic and Atmospheric Administration/Environmental Protection Agency preparedness programs, and should have been researched and addressed well before this event.**
- The use of dispersants in the Deepwater Horizon incident identified a need for a thorough review of this response option, its efficacy in minimizing environmental impacts, its overall effect on the environment, and conditions under which they are most effective. Dispersant protocols and authorization procedures should be established and articulated in ACPs, and the degree to which dispersants may be used in ESAs should be addressed.

Reference: https://www.uscg.mil/foia/docs/dwh/bpdwh.pdf

EPA Subpart J Proposed Rule

The EPA representative to the RRT, the Department of Commerce and the
Department of the Interior natural resource trustees and, as appropriate the RRT representative from the state(s) with jurisdiction over waters and adjoining shorelines within the preauthorization plan area shall review and either approve, approve with modification, or disapprove **the preauthorization plans developed by the RRT and/or the Area Committees.**

Reference: https://www.epa.gov/emergency-response/revisions-national-oil-and-hazardous-substances-pollution-contingency-plan

API Comments on Subpart J

API General Comments
(pg 1-2) To this end, woven into every operational endeavor are release prevention measures, preparedness methods and plans for rapid, effective response should an incident resulting in a release occur. Developed alongside regulatory agencies, operators submit to and follow a distinct set of response principles which protect shared values. The framework by which these principles are employed and tradeoffs are made in order to protect these shared values is called Net Environmental Benefit Analysis (NEBA). NEBA is a process used by the response community for making the best choices to minimize impacts of oil releases on people and the environment. NEBA aids in protecting people and the environment, and is the matrix through which every decision is made in a response event. In the offshore context, oil dispersing agents are a primary tool in the NEBA process and the response toolkit, as they are a principal tool used for protecting human health and defending environmentally sensitive areas. When a release occurs, judgment and response speed are critical. In an offshore setting, dispersants are essential in creating a safe environment and are a key ingredient in marshaling an effective, swift response.

(pg 4-7) *A Net Environmental Benefit Analysis Process Ensures Response Choices that Minimize the Impacts of Oil Spills on People and the Environment*
Any changes to the rule must take into account the Net Environmental Benefit Analysis (NEBA)[2] process. When a spill occurs, the OSC must make time-critical choices about which response options to implement immediately and effectively to manage the potential impacts of the spill. The NEBA process helps the OSC select choices that minimize the impacts of the spill on people and the environment. **NEBA is a consensus-based planning tool** that is used to bring natural resource trustees, regulators and stakeholders together to address resource-management decision-making needs for an oil spill response. It provides a structured, scientific method to evaluate the likely net reduction, or possible increase, **in environmental and socio-economic impacts** resulting from the implementation candidate response options as compared to the natural recovery or "do nothing" alternative. An assessment of the trade-offs associated with each option is then conducted taking into consideration the potential impacts to sensitive environmental resources and local community values. The NEBA process determines which response option or combination of options can best reduce the overall impact of spilled oil to common values and promote the fastest overall ecosystem recovery. **Of particular note, the NEBA process considers the potential effects to a wide range of concerns, ranging from likely environmental effects (i.e., deep marine to terrestrial, etc.) to possible economic consequences**. When initially considering the potential outcomes, no individual area receives a greater priority over another. Instead, all are weighed from an equal footing and only after evaluating all the likely effects is a determination made regarding the response option that offers that greatest environmental benefit. In so doing, **decision-makers ensure that an unbiased process is used, with input from relevant stakeholders,** to determine the best course of action. This process has been adopted all over the world to identify response methods that will yield the greatest benefit with the least impact.[3]

The NEBA process can be used in both oil spill preparedness planning and response. In the United States, **a formal NEBA process is conducted during the planning phase at the Area Committee and Regional Response Team (RRT) levels with input from state and Federal participants to determine the benefits and**

limitations from using each response technology within their individual areas of responsibility. In most offshore regions of the U.S., this is accomplished in the form of the Consensus-Based Ecological Risk Assessments (CERA) process (NEBA equivalent) used by the U.S. Coast Guard (USCG)[4] and supported by the National Oceanic and Atmospheric Administration (NOAA), EPA, other Federal and state agencies, and academia. More than twenty workshops were held in various locations around the continental U.S., Caribbean, and Alaska from 1995 to 2011 to compare the benefits and risks of various response options when considering resource trade-off decisions. All of the workshops resulted in final publications (available from USCG) that were delivered to the Area Committees and RRTs to assist with response planning. One example of how this CERA/NEBA process was used to inform dispersant use decision-making is summarized in several papers authored by regulators in the state of California.[5] The applicability of the CERA/NEBA process as a tool for facilitating dispersant decision-making during spill response and planning was also evaluated by NOAA and published in a 2008 paper.[6]

In 2014, the practice of incorporating a NEBA review during Source Control drills in the Gulf of Mexico was implemented by RRT VI during several large scale spill response exercises,[7] which has fostered good cooperation between the agencies to focus on the goal of minimizing shoreline community and ecosystem impacts by selecting response options that can maximize the effective treatment of oil offshore. NEBA discussions during both of these recent spill drills resulted in the concurrence of the RRT to authorize dispersants (both aerially and subsea) to treat the offshore oil slick.

Government decision-makers and/or the Responsible Party can conduct a rapid NEBA during actual spill responses to compare and rank the strengths and weaknesses of different response options for the incident-specific conditions. Lessons learned following a spill are incorporated into future policies and plans. Ecological recovery studies of the 1996 *Sea Empress* spill in the UK demonstrate the benefit of dispersant application along the coastline to prevent persistent oil from stranding in shoreline habits.[8] A more recent publication examined the recovery rates for a tropical ecosystem during a controlled study of dispersed versus untreated shoreline oil slicks and concluded that better recovery occurred in the areas where dispersant was used.[9]

Regrettably, the Proposed Rule lacks a NEBA perspective. It incorrectly focuses on intrinsic, hazard-based criteria for substance listing and ignores the more appropriate risk-based trade-off decision process responders must consider during an oil spill response. It does not recognize that dispersants are only applied when regulators and response decision-makers deem them necessary to prevent more significant and harmful consequences. The Proposed Rule favors protecting pelagic and benthic species while putting **critical habitats, such as the ocean's surface and near-surface zones,** as well as sensitive shorelines, at greater risk to environmental damage. **Modeling results** presented at the 2005 International Oil Spill Conference concluded that:

> *"...the **results of the modeling** support the contention that there are more opportunities to save wildlife, shorelines, and sensitive habitats along the shore with dispersant use than there are risks of impacting water column biota. If the areas that would be impacted by surface oil are those where wildlife are concentrated, as they typically are near shore, and the water column impacts resulting from dispersant use would be offshore where water column biota are lower in abundance, the trade-off is much more heavily weighted toward dispersant use before oil comes near the shoreline. In fact, for medium or smaller spills, or even larger spills where sensitive species and life stages are not present, the impact of dispersant use on water column biota could be negligible."*[10]

For oil spills where dispersant use is contemplated, a typical NEBA will predict the potential impacts to aquatic organisms from an increased exposure to dispersed oil droplets. Dispersant use is typically restricted to water depths greater than 10 to 20 meters so that dilution will minimize exposure or impacts to the benthic community. Studies have shown the dispersed oil concentrations are rapidly diluted within the large volume of receiving water from a high of a few hundred parts per million to a few parts per million within a few hours. Consequently, exposure to the toxic effects of the dispersed oil will be of short duration and limited to those aquatic organisms that inhabit near surface waters. The NEBA will also estimate the reduction of impacts to waterfowl, shoreline ecosystems and coastal communities resulting from the reduction in, or elimination of, the quantity of floating oil. The trade-offs of a short term increase in exposure of selected aquatic organisms to

dispersed oil versus an increase in oil impacting coastal environments and communities must be evaluated and take into account local community values to determine if dispersant use is warranted.

Given the challenges of implementing other response options, a decision not to have dispersants available to responders could result in oil stranding on shorelines where it may persist for an extended time. Effectively dispersed oil will biodegrade rapidly so that the majority of the oil will persist for a much shorter period of time. Reducing the persistence of the oil in the environment is critical to reducing the overall impacts.[11] This is not to say that water column organisms are less intrinsically important than surface or shoreline species but using NEBA can and does provide a critical framework for deciding what is best for the overall ecosystem. Important considerations to understand in assessing this tradeoff include:[12]

- The impacts to the water column are mitigated by dilution – that is the potentially toxic levels of dispersed oil are limited in duration and physical coverage/extent and effected populations (e.g., plankton) tend to be ones that recover quickly.
- Oil effectively dispersed in the water column will generally biodegrade after a few days or weeks while oil stranded in near shore and shoreline areas can persist for years.
- Near shore and shoreline areas are the nursery grounds for many species, even those that live offshore as adults, so protecting the near shore areas also protects organism that live as adults offshore.
- The bio density of near shore areas (swamps and marshes) is far greater than the bio density in pelagic waters offshore.
- Dispersants also protect surface dwelling organisms offshore, i.e., marine mammals, birds, and turtles, through removal of floating oil.
- Slicks on the water surface are far more likely to impact fish eggs and larva that tend to float at or near the water surface than quickly removing oil from the surface with dispersants.
- In certain geographies, slicks can impact mangroves and other shoreline vegetation that can subsequently die off and result in shoreline erosion that increases sediments in the near shore water column and potentially affects corals and other species.

The Agency should consider the NEBA process and how and why dispersants are used before making changes to the Subpart J Regulations.

[2] NEBA is similar to the Consensus Ecological Risk Assessment (CERA) process developed by the U.S. Coast Guard in the mid-1990s.

[3] See, Incident management system for the oil and gas industry: good practice guidelines for incident management and emergency response personnel, IPIECA, August 2014, http://www.ipieca.org/publication/incident-management-system-oil-and-gas-industry-good-practice-guidelines-incident-manage.

[4] Aurand, D., Walko, L., & Pond, R. (2000). Developing consensus ecological risk assessments: Environmental protection in oil spill response planning. Washington, D.C.: U.S. Coast Guard.

[5] Addassi, Y. N., & Faurot-Daniels, E. (2005). California oil spill dispersant plan-Achievement through cooperation. Proceedings of the 2005 International Oil Spill Conference, 2005(1), 433-437. doi:10.7901/2169-3358-2005-1-433; Addassi, Y. N., Sowby, Parker-Hall, H., & Robberson, B. (2005). Establishment of dispersant use zones in the state of California: A consensus approach for marine waters 3–200 nautical miles from shore. Proceedings of the 2005 International Oil Spill Conference, 2005(1), 187-191. doi:10.7901/2169-3358-2005-1-187.

[6] Mearns, A., & Evans, M. (2008). Evaluating the consensus ecological risk assessment workshop as a tool for facilitating decision-making during spill response and planning. *Proceedings of the 2008 International Oil Spill Conference Proceedings, 2008*(1), 739-741. doi:10.7901/2169-3358-2008-1-739

[7] **Freeport McMoran Source Control drill (April 30-May 1, 2014) and BP Source Control drill (Nov 5-6, 2014)**

[8] Lunel, T., Rusin, J., Bailey, N., Halliwell, C., & Davies, L. (1997). The net environmental benefit of a successful dispersant operation at the Sea Empress incident. *Proceedings of the 1997 International Oil Spill Conference, 1997*(1), 185-194. doi:10.7901/2169-3358-1997-1-185

[9] Baca, B., Rosch, E., DeMicco, E. D., & Schuler, P. A. (2014). TROPICS: 30-year follow-up and analysis of mangroves, invertebrates, and hydrocarbons. *Proceedings of the 2014 International Oil Spill Conference,*

2014(1), 1734-1748. doi:10.7901/2169-3358-2014.1.1734
[10] **French McCay, et al., Modeling Fates and Impacts of Hypothetical Oil Spills in Delaware, Florida, Texas, California, and Alaska Waters, Varying Response Options Including Use of Dispersants.** International Oil Spill Conference Proceedings: May 2005, Vol. 2005, No. 1 pp. 735-740. Also available at http://ioscproceedings.org/doi/pdf/10.7901/2169-3358-2005-1-735.
[11] Hazen, et al., Deep-Sea Oil Plume Enriches Indigenous Oil-Degrading Bacteria, Science, 330 (2010), pp. 204-208.
[12] (a) French McCay, D., and Graham, E. Quantifying Tradeoffs – Net Environmental Benefits of Dispersant Use.
International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 762-775.
(b) McManus, M.A., Woodson, C.B. Plankton Distribution and Ocean Dispersal. The Journal of Experimental Biology, 215
(2012), pp. 1008-1016.
(c) DeMicco et al., Net Environmental Benefit Analysis (NEBA) of Dispersed Oil on Nearshore Tropical Ecosystems:
TROPICS – The 25th Year Research Visit, International Oil Spill Conference Proceedings, May 2011, Vol. 2011-282.
(d) Varela et al., The Effect of the "Prestige" Oil Spill on the Plankton of the N-NW Spanish Coast. Marine Pollution Bulletin 53 (2006), pp. 272-296.
(e) Addassi, et al., Establishment of Dispersant Use Zones in the State of California: A Consensus Approach for Marine Waters 3-200 Nautical Miles from Shore. International Oil Spill Conference Proceedings: May 2005, Vol. 2015, No. 1, pp. 187-191.

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Dispersant Toxicity Tests do not Accurately Simulate Real World Exposures.
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(pg 9) In the context of NEBA (and its forebear, the Consensus Ecological Risk Assessment, or CERA), scientists understand and accept that marine organisms may experience localized, transient toxic effects from exposure to dispersed oil, but these local effects are offset by the benefit of dispersant use in preventing or minimizing oil drifting ashore and causing severe and long-term harm to more sensitive coastal resources and communities. **While knowledge of the potential for toxic effects to marine organisms is useful for conducting a NEBA, it cannot be the sole indicator that dictates the use of dispersants.** All resources-at-risk as well as coastal communities must be considered in the response option decision-making process, with the emphasis on coordinating a response that will result in the least overall impacts while promoting the most rapid overall recovery of the affected ecosystem.

Section § 300.910 Authorization for Agent Use
The Unified Command (UC) determines the best use of response assets on a daily basis.
(pg 14) EPA should not establish a policy or rule that mechanical recovery is always the priority choice of countermeasures to use in a response. In the preamble for this section (column 1, 80 Fed. Reg. 3387), the Agency makes the following statement:

> *"During the DWH response, a priority countermeasures scheme was established to first use mechanical recovery via skimming/booming or in-situ burning followed by subsea dispersant and lastly surface dispersant use."*

This may have been the conceptual prioritization from the perspective of EPA, but in reality dispersants played a much larger role and it was the responsibility of the UC to determine the best use of response assets on a daily basis to account for weather conditions, VOC suppression, oil slick locations, response equipment availability, etc. Every spill is different and specific references to a single spill event can indirectly and inappropriately be perceived as a recommended practice and should be avoided. In any spill scenario, all response tools must be

used to their maximum effect. The Agency's unprecedented use of "Directives" during the DWH incident severely limited the use of dispersants and **circumvented the NEBA decision-making process allowing significantly more oil reaching the water's surface and, subsequently, the shoreline.** This resulted in additional environmental impacts with no documented benefits to the marine ecosystem.

The Agency should reconsider this statement and prioritization as it puts unneeded complexity into the response decision-making process and inappropriately prioritizes mechanical recovery over other response options. The effectiveness of mechanical recovery can be limited in large, offshore spills as a result of typical environmental conditions, such as wave action/height or wind conditions as well as the extensive surface area that must be covered. **Further, the Agency's artificial prioritization of this technique over other viable response options is contrary to the NEBA concept to determine the best blend of response options (with no pre-determined or pre-existing bias) to achieve the best overall protection and recovery for the ecosystem.**

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Proposed changes involving preauthorization planning will increase the workload of all Regional Response Teams (RRTs) and Area Committees (AC) and restrict their flexibility.

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(pg 16) The Agency must provide specific examples to show how this rule assists responders, particularly in relation to the OSC duties of making timely operational decisions, **especially those decisions based on using the concept of NEBA to guide a response.**

Section § 300.910(a) Use of Agents Identified on the Schedule on Oil Discharges Addressed by a Preauthorization Plan

Area Committees should identify shoreline habitats that can benefit from the appropriate use of dispersants.

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(pg 17) API and NOIA support the requirement that Area Committees should identify shoreline habitats that can benefit from the appropriate use of dispersants or other response methods. **This will advance the use of the NEBA concept.** Note that many of these resources are already identified in Area Contingency Plans.

Section § 300.910(a)(1) Preauthorization Plan Development

Dispersant use should not be limited by the preauthorization plan.

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(pg 19) If the Agency wants to determine whether and how to limit dispersant use, we propose a joint EPA/industry study of existing research results to provide scientific credibility to any limitations that are established. Without scientific justification, artificially-set limitations on dispersant use would threaten the intent of using NEBA to support response decision-making and would limit the OSC's ability to make the best overall decision concerning the actual scenario and the environment.

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We suggest that the Agency confer with other Federal agencies involved in oil spill planning and response and revise the language in the Proposed Rule to specify that preauthorization should rely on the concepts of CERA/NEBA as the foundation for plans and response decisions, not on artificially set limits on dispersant volumes. The USCG has conducted more than a dozen CERAs to help inform the decision-making process, but **the Proposed Rule appears to contradict the CERA/NEBA tenets that were previously used to define preauthorization zones.**

Section § 300.910(b) Use of Agents Identified on the Schedule on Oil Discharges Not Addressed by a Preauthorization Plan

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(pg 23) ***Early dispersant use decision-making should focus on documenting that a NEBA justification exists to support dispersant application.***

The Proposed Rule would unnecessarily establish new requirements for an OSC to document the parameters used to authorize dispersants. This is discussed in the same section (column 2, 80 Fed. Reg. 3423), as follows:

> *"...the OSC must consider and document the parameters for the use of agents including the quantities to be used, the duration of use, the depth of water, the distance to shoreline and proximity to populated areas, and should address factors such as environmentally sensitive resources or restricted areas that might be impacted, agent inventory and storage locations, agent manufacturing capability, availability of equipment needed for agent use, availability of adequately trained operators and appropriate means to monitor agent use in the environment."*

Because dispersants have a limited window of opportunity to be used on spills, it is important to decide quickly on their use. Decisions by the OSC should not be delayed to complete information that is not needed.

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As such, we believe that the immediate actions by the OSC should include a review of the pre-authorization plan(s) and **a rapid, incident-specific NEBA to support the selection of response options that may include dispersant application as a means to lessen or eliminate impacts to sensitive shoreline resources or to protect worker health and safety.**

Section § 300.910(g) Supplemental Testing, Monitoring, and Information

(pg 28) *API believes the standard efficacy and toxicity tests already required are more than adequate for regional use.*

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Regional data are unlikely to fundamentally change overall NEBA considerations for dispersant use.

Section § 300.910(h) Recovery of Agents from the Environment

The OSC has the authority to use the NEBA process to make decisions on recovery of agents from the environment.

(pg 29-30) In the preamble to this section, the Agency is requesting comments on new language that would require the Responsible Party, under OSC oversight, to remove specified products/agents from the environment after use. While the Proposed Rule hints at NEBA, it does not reference it specifically when suggesting that some situations (e.g., safety of personnel or greater harm to the environment) might preclude the removal of these agents. That would seem to contradict the main change in this section (h) while not providing any framework (e.g., NEBA) in which to make a determination for precluding the removal. The language is also potentially redundant as the OSC is already obligated to consider safety and additional adverse environmental impacts (i.e., via NEBA) as part of the normal decision-making process. Essentially, it is already an underlying tenet of the response process. Additionally, in some cases recovering 100 percent of these agents after application is not practical or even feasible regardless of the diligence of the Responsible Party

We suggest revising the proposed language to make it clear that the OSC has the authority to use the NEBA process to make these decisions:

> *(h) Recovery of Agents from the Environment. Depending on factors such as the safety of response personnel and harm to the environment (including consideration of Net Environmental Benefit Analysis [NEBA]), and as directed by the OSC, the Responsible Party shall, following application, endeavor to adequately contain, collect, store and dispose of the agents that are intended to be recovered from the environment.*

Section § 300.913 Monitoring the Use of Dispersants

The appropriate use of spill mitigating products will reduce the overall impact of the spill and protect the health and safety of response personnel.

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(pg 30-31) The main threat to response personnel, communities, and the ecosystem comes from the oil, not from the spill mitigating products. The concept of CERA/NEBA accepts that some effects might be caused by the response (including the use of spill mitigating products), but also recognizes the greater benefit of reducing the overall impact of the spill that can be achieved by using them. The Agency needs to acknowledge the importance of NEBA in justifying the use of dispersants.

We believe that the focus on the potential for negative environmental impacts that could be caused by a dispersant ignores the essential point that dispersants are used to mitigate (minimize) the negative human health and environmental impacts that could be caused by the oil. The main threat to the ecosystem comes from the oil itself, not from the dispersant. The wording of the preamble to a final rule needs to:

- reflect the ultimate aim of dispersant use;
- clarify that the toxicity of dispersed oil comes from the oil (not the dispersant); and
- acknowledge and emphasize the importance of using a NEBA process in dispersant use decision-making.

We request that the Agency consider including the following two paragraphs (or equivalent language) in the preamble to the final rule to briefly explain dispersant use and the importance of NEBA in making dispersant use decisions.

> *"Dispersant Use and Net Environmental Benefit Analysis (NEBA)*
> *The aim of dispersant use is to protect response personnel from VOC exposure and to prevent oil from drifting ashore and potentially causing severe and long-term damage to coastal resources and communities, by dispersing the oil into the water column where it will be diluted rapidly to very low concentrations and the majority of the oil will subsequently be biodegraded. This common aim of dispersant use is the same, whether it is applied to oil on the sea surface or directly at the outflow source in the case of a subsea release. The potential risk of dispersant use is that, by dispersing the oil into the water column, there is an increased potential for toxic effects to be caused to marine organisms. The severity of the toxic effects that could be caused is related to the exposure of the marine organisms to the dispersed oil (or the partly water-soluble oil compounds) and exposure is a function of concentration of the oil in the water and the duration for which such exposure persists.*
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> *The issue of the environmental trade-offs caused by dispersant use is addressed by Net Environmental Benefit Analysis (NEBA). NEBA is a process used to make choices about oil spill response techniques to be used to minimize the potential impacts of the oil on people and the environment. NEBA takes into account the likely effectiveness and feasibility of conducting alternative response techniques under the prevailing conditions. The main principle of NEBA is that an oil spill response technique (or combination of techniques) that is used should be that which minimizes potential impacts of the oil on the environment to the greatest extent and promotes the most rapid recovery and restoration of the affected area. In many cases of dispersant use, the potential risks to the offshore marine ecosystem are very low because dispersed oil concentrations are low and persist only briefly. There is benefit in using dispersants in offshore environments to prevent damage to coastal communities and sensitive near-shore resources where persistent stranded oil can cause longer-term environmental problems."*

The Proposed Rule also appears to focus more on the environmental effects during the response rather than the health and safety of response personnel. The Agency should make it clear that one of the primary objectives of characterizing the efficacy and understanding transport is to protect the health and safety of response personnel. That critical aspect is not mentioned in this section.

Section § 300.913(a) Documenting and Monitoring the Oil Discharged and Dispersants Used Requirements
The Responsible Party should not be required to document information at the beginning of a response that has already been determined in planning and preparedness activities.

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(pg 35) Given current dispersant stockpiles in the U.S. and in the Global Dispersant Stockpile, it should be assumed that sufficient dispersants will be available if their use is warranted by NEBA.

Section § 300.913(d) Ecological Receptor Characterization
Monitoring required to determine possible environmental effects is too time consuming to support dispersant operations decisions.

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(pg 40) Rather than requiring the Responsible Party to make this real-time assessment [species sensitivity distributions (SSD)], a CERA/NEBA process (conducted as part of contingency planning) should serve as the basis to make operational decisions on whether dispersants and/or other agents should be used during a response. A CERA/NEBA is the only mechanism that allows a full environmental trade-offs analysis of all response options to be conducted.

Section § 300.913(e)(1) Daily Sampling and Data Analyses Reporting
The Agency should not develop requirements for daily authorizations of dispersant quantities.

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(pg 40) Furthermore, it [placing daily limits on volumes of dispersants] circumvents the NEBA process that evaluates the best response options that protect the environment as a whole.

Section § 300.913(e)(2) Immediate Reporting of Ecological Receptors
Real-time ecological receptor analysis is unrealistic and should be part of a CERA/NEBA process.

(pg 41) The requirement in this section for real-time ecological receptor analysis is unrealistic. Such efforts need time and broad stakeholder participation to be meaningful. This information should be part of a NEBA process to document the resources at risk of the potentially affected ecosystem. Only through this detailed NEBA process can an adequate understating of overall ecosystem recovery be developed and assessed. Further, the process of overall environmental trade-offs is independent of individual species impacts and should be based at the ecosystem level.

Section § 300.915(b)(2) Dispersant Toxicity tests and listing criteria

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Testing of dispersants using the developmental assay for the purple sea urchin is not relevant.
(pg 47) The relevance of this test [EPA test protocol involving sea urchin embryos], which was developed for the assessment of wastewater effluents, to dispersant use is highly questionable. Again, trying to estimate potential real world consequences to dispersed oil exposure should be part of a NEBA decision-based process. The environmental trade-offs of using dispersants in offshore environments to protect sensitive shoreline habitats from oil exposure is being circumvented.

Dispersant testing should only be used for screening individual dispersant products.

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(pg 48) In summary, the Agency's suggested toxicity testing changes in the Proposed Rule do not take into account the essential role of NEBA in considering the potential benefits and risks of dispersant use as a response option for an offshore oil release. The Product Schedule should focus on the basic testing to compare the efficacy and toxicity of the dispersants against each other with the sole purpose of screening good products that should be listed. The Proposed Rule should not attempt to translate any laboratory data into possible real-world implications. This process should instead be defined by full stakeholder NEBA discussions specific to a given spill scenario.

Conclusions
(pg 51) The Proposed Rule does not recognize that response option decisions must be based on NEBA and that dispersing oil in offshore environments, where it may dilute and biodegrade, is often preferred over the long-term environmental damages that will occur when untreated oil strands and persists in shoreline environments;

BSEE Well Control and Arctic Rules

Arctic Rule (6-27-2016 version)

Previous draft BSEE preamble stated: "Oil discharged into the environment will always result in the potential for some level of toxic effects to organisms and their habitat. Spill response countermeasures have the potential to reduce or mitigate these toxic effects. **Conducting net environmental benefit analyses is the best way to plan for and make operational decisions regarding which spill response countermeasures will result in the most effective reduction of the harmful effects of spilled oil.**" (pg 178).

- EPA commented that the preamble "Should be clearly highlighted here that the analysis "to plan for and make operational decisions regarding which spill response countermeasures" to use is conducted as part of the ACP/RCP process as described elsewhere in this preamble."
- BSEE's response: deleted text at issue – not necessary to response. (the entire text cited above)

Previous draft BSEE preamble stated: BSEE also supports the use of a process to compare the environmental outcomes associated with using various response techniques and countermeasures in order to assess and select the most appropriate response technologies for use during an event. However, the selection and use of response technologies during a spill event is governed by EPA regulations contained within the NCP, and by the FOSC, which is a pre-designated senior USCG official. BSEE is not dictating the selection or use of any particular strategies for responding to any specific spill situation through its regulations or the OSRP process. **BSEE does have a separate regulatory rulemaking study underway that is considering a requirement for all OSRPs to include the use of an assessment process that would evaluate the environmental tradeoffs of various response countermeasures in their planning for a response.** (pg 258-259)

- EPA commented: How is this not relevant to the RCP/ACP effort, as opposed to the OSRP, which have the "…focus and purpose is to address how the operator will supply, manage, and sustain the necessary response resources for implementing the strategies and tactics." as stated in BSEE's response below?
- BSEE response: Revised – deleted language (in the bold text)

"One commenter recommended that strategies and tactics listed in the OSRP, including use of dispersants and burning, should be based on the latest regional-specific research, historical oil spill data, field tests conducted by the operator or its Oil Spill Response Organization (OSRO), and exercises, and environmental analysis.

While BSEE agrees that response strategies and tactics should be informed by all the methods recommended by the commenter, **BSEE disagrees with their assertion that plan holders are responsible for gathering this information, or that plan holders are responsible for field testing or validating these strategies and tactics as part of the process of developing and submitting their OSRPs. Rather, response strategies and tactics are developed and approved for use geographically and temporally, and should be exercised and validated by the Regional Response Teams and Area Committees, and should be contained in the appropriate RCPs and ACPs.** As such, Regional Response Teams and Area Committees would be the appropriate entities to review ongoing trends, new research or testing information, and to adjust the response strategies in the RCPs and ACPs accordingly. While OSRPs must be consistent with the strategies and tactics identified for use in the relevant RCPs and ACPs, their focus and purpose is to address how the operator will supply, manage, and sustain the necessary response resources for implementing the strategies and tactics."

"Two commenters recommend that the requirements in § 254.80 should contain specific protection and response strategies and maps for environmentally sensitive areas and subsistence resources. One of the commenters further suggests that plan holders should have response personnel and equipment pre-staged near those sensitive sites, and that the strategies and equipment should be tested through a plan holder's exercise program, prior to being included in an OSRP.

While BSEE agrees protection and response strategies for sensitive resources are a critical part of oil spill response, **BSEE disagrees that these strategies should be developed by industry plan holders, nor does BSEE believe it is feasible for a plan holder to pre-stage personnel and equipment throughout the Arctic wherever sensitive resources might be located. The correct place for the development of protection and response strategies for sensitive areas and resources, in accordance with guidance in the NCP, is in the**

ACP. In this case, the appropriate place would be within the North Slope SubArea Contingency Plan. Existing regulations do, however, require that operators address strategies for protecting environmentally sensitive areas in their OSRPs. See, e.g., §§ 254.23(i)(3)-(4); 254.26(c). BSEE does not believe that further treatment of this issue is necessary in § 254.80. The Alaska Regional Response Team and the North Slope SubArea Committee are responsible for testing and validating these strategies. **It is not the responsibility of an industry plan holder to develop these geographical response strategies, nor is it a requirement for a plan holder to test any strategies listed in an ACP prior to referencing them in their OSRP."**

RRT 6 Industry Liaison Committee

RRT VI Subsea Dispersant Use - Guidelines for Industry on Requesting Concurrence with Subsea Dispersant Injection (SSDI) Decisions

- Prepared by: RRT VI Industry Liaison Committee (ILC) and API D3 Subsea Dispersants Joint Industry Task Force (JITF) - March 2015

To clarify what type of information would be required by RRT VI to support subsea dispersant use decisions, the RRT VI Industry Liaison Committee (ILC) volunteered to assist in developing draft guidelines for industry on recommended procedures for seeking concurrence with subsea dispersant use requests. The ILC is a committee of RRT VI, which is composed of volunteer members from industry who serve on an ad hoc basis.

The purpose of this document is to provide guidelines, forms and checklists recommended for use by industry. **The guidelines describe the concurrence request process, proposed information submission recommendations that are specific to subsea dispersant injection and the role of Net Environmental Benefit Analysis (NEBA) as a decision support tool.**

Sections include:

Overview
Roles and Responsibilities of National Response System Components in Subsea Dispersant Use Authorization
RRT VI SSDI Concurrence Decision Information Requirements and Checklist

Section 3.7 Analysis of Potential Net Environmental Benefits and NEBA Associated with SSDI

Methods traditionally used for evaluating the potential net environmental impacts of various response technologies have traditionally included "Net Environmental Benefit Analysis" (NEBA), and "Consensus Ecological Risk Assessment" (CERA). Such analyses are typically conducted in support of planning activities, but principles and some of the methods employed can also be used during response actions, or response simulations and drills. Such analyses are typically referred to as "Expedited or Qualitative NEBAs" or Environmental Trade Off Analyses. Unless a NEBA has been conducted through applicable planning activities that take the release scenario into account, an "Expedited NEBA" should be conducted and included as part of the RRT concurrence package.

The objective of using NEBA as an SSDI decision support tool is to evaluate the potential net environmental benefits of using SSDI within the context of the overall response strategy. It is not intended to make specific recommendations but to help inform decisions. While the time frame for conducting an "expedited" NEBA during a response action is compressed, the factors that must be considered are largely the same as for "pre-event" NEBAs.

An example of a generic expedited NEBA is included in Attachment 1 for illustrative purposes. The expedited NEBA should address the following:

- Aquatic RAR: What are the specific aquatic resources deemed to be at risk from the non-chemically dispersed spilled product?
- Terrestrial RAR: What are the specific terrestrial resources deemed to be at risk from the shoreline impact of the non-chemically dispersed spilled product?
- Time to RAR Impact: What is the estimated time of impact to the resources identified in 1 & 2 above? (The NOAA SSC should be contacted for trajectory and environmental fate analysis.)

- Leading Edge Location: What is the estimated location of the leading edge of the spill at the proposed time of initiation of SSDI? (Using model results, lat/long, proximity to shore, coordinate with the NOAA SSC, the RP, or other information sources to estimate the location of the leading edge of the spill at the proposed time of the first application of dispersants).
- Environmental Benefit /Trade Offs: Does it appear that dispersants can be applied at this location in a manner that will likely achieve the desired environmental benefit for the identified RARs? Are there any specifically known resources in the area targeted for dispersant use that might be negatively impacted by application of chemical dispersants? If so, what are the known resources, and is the negative impact to these resources anticipated to be great enough to offset the benefit to the identified resources?
- Are there ways to avoid or minimize adverse affects to known resources (e.g., observers watching for marine wildlife).

Decision Process for Employing SSDI
RRT Concurrence Request Process
IMT Positions with Significant SSDI Roles
References

Attachment 1 Analysis of Potential Net Environmental Benefits and Risk Associated with SSDI

The objective using NEBA as a Subsea Dispersant Injection (SSDI) decision support tool is to evaluate the potential net environmental benefits of using SSDI within the context of the overall response strategy. It is not intended to make specific recommendations but to help inform decisions. While the time frame for conducting an "expedited" NEBA during a response action is compressed, the factors that must be considered are largely the same as for "pre-event" NEBAs. As part of the NEBA evaluation, the consequences of using SSDI to maintain the oil within the water column is evaluated against the impacts of oil remaining on, or rising to, the water surface and potentially stranding on shorelines.

SSDI increases the amount of oil that dissipates into the water column, and reduces the amount of oil remaining on the surface. Dispersant use, therefore, reduces the potential for floating oil and associated volatile hydrocarbons to threaten worker health and safety, and reach ecologically and economically sensitive surface water and shoreline environments. The oil that disperses into the water column may pose temporary elevated exposures to organisms in the immediate area, but research and experience has shown that those exposures are rapidly mitigated by the effects of dilution and microbial degradation of the dispersed oil.

Background

The use of SSDI offers several advantages over other response techniques, such as

- SSDI can be utilized continuously, and is not limited by darkness or most weather conditions that adversely affect, or even preclude other response techniques.
- Dispersants are injected directly into the oil release, so the "encounter rate" is much higher than for surface dispersant use or mechanical recovery techniques.
- SSDI reduces the formation of surface slicks which are harmful to sensitive ecological and public health receptors.
- Reduction of surface slicks produces a concomitant reduction in airborne VOCs which reduces threats to worker health and safety.

The decision making process for employing SSDI as a response method is not significantly different from that used for surface dispersant application. Surface dispersant application has been used more commonly, and

technologies, methods, regulatory frameworks, toxicity, and potential net environmental benefits are well understood. While mechanical recovery remains a preferred response option, past experience in responding to open water oil spills has demonstrated that mechanical recovery alone has traditionally yielded limited rates of recovery for large spills. There are additional limitations posed by greater transit distances for boats supporting the response, and adverse weather conditions that can hamper safe operations and transits to and from port. For these reasons, the appropriate use of dispersants, applied either at the ocean's surface or subsea, may provide the only means of removing significant quantities of oil from the surface quickly, and therefore efficiently reducing overall environmental impacts from the spill to the water surface and near shore, shallow water environments.

The U.S. Coast Guard, with support from a variety of other federal and state agencies including NOAA, US Fish and Wildlife Service, and the Texas General Land Office, has sponsored several Ecological Risk Assessment workshops in the Gulf of Mexico and Caribbean that considered the impacts and ecosystem recovery rates from various oil spill response options at hypothetical open water spills near Galveston Bay, Gulf of Mexico region near the US/Mexico border, Puerto Rico, US Virgin Islands, and Florida Keys. In each of these workshops, participants evaluated dispersant use along with other oil spill response strategies and found that dispersants were effective in protecting many near shore and shoreline resources, and also offered some benefit to animals that utilize open ocean surface waters (such as birds and marine mammals) because of the ability of dispersants to quickly remove oil from the surface of the water. Similar conclusions are expected for subsea dispersant use since most undispersed oil will reach the water's surface over a large area making it difficult to recover and creating environmental impact scenarios consistent with or exceeding those of surface spills.

NEBA Approach

The objective of a NEBA, when applied to oil spills, is to conduct an evaluation that will allow spill responders and stakeholders to choose the response options that will result in the lowest overall negative impact on the environment. This process is addressed in detail in the IPIECA (2000) publication "Choosing Spill Response Options to Minimize Damage: Net Environmental Benefit Analysis". A practical approach to conducting the environmental analysis is provided in the USCG guidance document "Developing Consensus Ecological Risk Assessments: Environmental Protection in Oil Spill Response Planning: A Guidebook" (Aurand et al., 2000).

Several mesocosm and open ocean field trial experiments have demonstrated that the rates of mixing and dilution in open waters that are 3 nautical miles or more offshore and are 10 meters in depth or greater are sufficient to minimize the potential toxic effects of oil dispersed at the surface. At these depths and distances from shore, net environmental benefit analysis demonstrates that transient aquatic toxicological impacts in the water column are much less than the risks to birds, mammals, and coastal and shoreline communities by allowing oil slicks to persist on the water surface and eventually become stranded on the shoreline (Lewis and Aurand, 1997). The net environmental benefits of SSDI could be more pronounced since the depths and distance from shore are likely to be greater.

During an expedited NEBA analysis, factors that should be considered include:

- Concentrations of dispersed oil which may be expected above the subsea injection point, and the dilution potential in that specific body of water.
- Toxicity of the likely concentrations of dispersed oil to local flora and fauna.
- Distribution and fate of the dispersed oil in water, sediments and organisms.
- Distribution, fate, and biological effects of the oil if it is not treated with dispersant—for example, whether it will harm shore habitats or wildlife.
- Expected ability of affected ecosystem populations to recover from any potential toxic impacts.

When conducting an expedited NEBA, the following priorities should be considered in evaluating the potential benefits of SSDI:

- Human health and safety
- Environmental protection priorities
- Minimize wildlife exposure
- Minimize habitat contamination
- Minimize oil stranding on sensitive shorelines
- Maximize ecological recovery potential

Other protection priorities that should be considered include:

- Amenity beaches
- Marinas, commercial activities
- Shoreline property values
- Subsistence and cultural values
- Archeological and historical preservation areas

The same justifications that have been previously demonstrated for aerial dispersant pre-approval remain valid for SSDI, as follows:

- Removing oil from the surface of the water minimizes impacts to critical surface and shoreline habitats as this oil will eventually strand in sensitive near-shore estuaries and habitats.
- The concentrations of dispersed oil in the water column from subsea dispersant injection are expected to rapidly dilute both vertically and laterally through the water column, which will result in lower concentrations within a few kilometers of the well head (Lee, 2013). Concentrations below 1 ppm are generally determined to be below the high level of concern threshold of impacts to most species, derived from the USCG-sponsored workshops described earlier.
- Observations from the Deepwater Horizon (DWH) event demonstrated that an effective subsea dispersant operation will reduce surface volatiles, which will enhance worker health and safety, as well as reduce the oil droplet sizes.
- Bacterial biodegradation studies summarized by Hazen et al. (2010) have indicated that the shift to a smaller dispersed oil droplet size due to subsea dispersant injection will increase biodegradation rates which will further reduce the persistence of high concentrations of subsea oil "plumes" over the course of several days.
- The biodegradation of subsea dispersed oil in deep waters more than 120 miles from shore will translate to reduced oil on the surface, reduced oil in sensitive shoreline habitats, and a substantial increase in the recovery times of the ecosystem as a whole.
- In addition to protection of near-shore and shoreline habitats, preventing untreated (non-dispersed) oil from surfacing in offshore waters will help protect offshore species, including migratory birds, marine mammals, and sea turtle populations which depend on access to clean surface waters for their survival.

NEBA Scope

The geographic scope of an expedited NEBA is determined by the release location, flow rate or volume, duration, and the influences of currents, weather, dispersion, dissolution, and ultimately biodegradation. These factors are used in 3D modelling to produce potential trajectories, accounting for uncertainty, which ultimately

determine this geographic scope of an expedited NEBA. Since flow rate is subject to high levels of uncertainty, initial modelling is often based on a Worst Case Discharge (WCD) scenario. This information should be included in the Incident Data Sheet, and modelling results should be included in the authorization request to the RRT.

Response Options

The six response options appropriate for consideration in an expedited NEBA in the GOM are summarized below. For an expedited NEBA, performed in support of an exercise or release event, time constraints require that they be evaluated qualitatively rather than quantitatively. While this may be accomplished by an exercise planning team in preparation for a drill, it should be performed in the Environmental Unit during an actual release, and should involve all emergency consultation with all appropriate trustees. A brief description of each method, and their potential uses and limitations should be provided. It is assumed that all response methods may be used, where appropriate, during a response that involves SSDI.

Natural Recovery

Natural recovery is defined as no human intervention to influence the fate of the spilled oil. It represents the baseline against which all response options are compared. With natural recovery, the spilled oil will drift with the winds and currents, and then gradually weather until it evaporates, dissolves, and disperses into the water column, or strands on the shoreline. Once stranded, weathering will continue and the oil will gradually biodegrade or be incorporated into the sediments. Portions of the relatively fresh oil may be released from the shoreline and redistributed several times until it finally degrades, is consumed by organisms, or is deposited permanently.

Natural recovery is considered an appropriate option for spills at sea which do not threaten shoreline or protected habitats. It is also appropriate for some sensitive shoreline habitats where intrusion by people and equipment may cause more environmental damage than allowing the oil to degrade naturally, or where recovery and cleanup are not feasible.

Logistics: Monitoring at sea and on affected shoreline is required; shoreline recovery may take weeks or up to months or years, depending on the ambient energy level.

Limitations: Does not meet public expectation that an attempt will be made to remove spilled oil from the environment. Since this is a passive response, it will not protect high value shoreline habitats. In the case of natural recovery the floating oil will weather on the sea surface. If on-shore winds drive this weathering oil into intertidal and coastal areas, in some cases (e.g., marshes and mangroves) any cleanup effort could potentially do more ecological harm.

On-water Mechanical Recovery

On-water mechanical recovery is defined as the removal of oil from water for disposal and possible reuse to prevent or minimize impacts to sensitive nearshore and offshore habitats. Open water mechanical recovery uses skimmers and booms to redirect and remove oil from the surface of the water. The success rate of oil removal by means of mechanical recovery is dependent upon factors such as wind, waves, and daylight.

Logistics: The equipment needed to carry out mechanical recovery will involve a large number of skimming vessels, support vessels, storage barges, spotter aircraft, and significant quantities of collection boom. The equipment will need to be transported to the spill site, which in this instance is approximately 120 miles offshore. Collected oil will need to be stored and ultimately returned to shore for proper disposal. Given the size

of the continuing release, this will be a formidable challenge.

Limitations: There will be a lag time from the time of the spill to the time of conducting mechanical recovery; making the window of opportunity to conduct mechanical recovery smaller. The longer the oil is present, the more it disperses and is more difficult to recover, with the oil thinning out as it spreads. Even beyond the encounter rate, weather conditions and day length would be critical in this area. Open water boom begins to fail in sea states with waves over approximately six feet.

On Water In-situ Burning

On-water in-situ burning (ISB) involves the collection of oil in booms (as in on-water recovery), but then removes the oil from the water surface by burning, minimizing storage and disposal problems. ISB has the same weather and day length conditions as on-water mechanical recovery and realistically needs even lower wave heights, plenty of daylight available to monitor and track the burn, and minimal wind that allow the burn to be ignited and controlled.

Logistics: Equipment needs for vessels and boom are similar to on-water mechanical recovery, with the addition of fire boom, enhanced monitoring aircraft, ignition capability, and smoke-plume modeling.

Limitations: Limitations of weather and day length are similar to on-water mechanical recovery. The availability of fire boom, which becomes unusable over time, would be a factor in a spill of this duration.

Aerial Dispersant Application

Dispersants may be applied to surface slicks from airplanes, helicopters, or vessels. The volume of dispersant applied is a fraction of the volume of oil treated, with a typical dispersant to oil ratio (DOR) of 1:20. Surface dispersant application is pre-authorized by the Region VI RRT for most areas where SSDI could be considered for a subsea oil release. It is anticipated that both vessel and aerial applications will be used, in addition to SSDI, as appropriate. When the oil is treated with dispersants, it initially disperses within the upper 10 meters (30 feet) of the water column due to natural mixing processes. If these dispersed oil droplets are small enough (generally less than 0.01-0.02 mm diameter) the droplets will remain dispersed in the water column. The dispersed oil will be rapidly diluted due to spreading both horizontally and vertically by tides and currents (Lee, 2013). Historically, dispersed oil concentrations of 20 to 50 parts per million (ppm) have been reported in the upper 10 meters of the water column directly under the slick. These concentrations dilute rapidly as the oil moves through time and space in the water column.

Logistics: In the scenario analyzed here application from large, fixed wing aircraft is the most logical mode of application for surface slicks. It is likely that vessel based application will occur near the release point to reduce airborne VOCs.

Limitations: Dispersant operations require a 300-meter minimum cloud ceiling, three-mile forward visibility, daylight, wind speeds less than 35 knots, and wave heights of 0.15 to 3 meters. Effective application rates (DOR) are approximately 3-5 times higher than for SSDI. Aerial application is limited to daylight hours and as a result can only be operational for half of the amount of time compared to SSDI.

Shoreline Protection and Recovery

The shoreline acts as a natural containment barrier for oil spilled on water. Protective booming is seen as an important tool when oil cannot be effectively treated on-water. While protective booming can be valuable, it brings about a certain degree of risk of collateral damage due to physical disturbance by work crews installing,

maintaining, and dismantling the boom. Additionally, there are impacts of disturbance and scarring from anchoring the materials to soils, sediments, or plants, along with increased erosion of shoreline and sediments while the boom jostles in place.

Examination of the benefits and tradeoffs of shoreline protection and recovery are different than examining the benefits and tradeoffs of on-water response. Given the option, on-water cleanup will almost always be environmentally preferable to on-shore recovery.

Logistics: Both shoreline protection and recovery tend to be labor intensive and involve large numbers of responders who must be trained, transported, housed, and managed in a potentially hostile environment. In addition, worker personal protective equipment, hand tools, washing equipment, protective and containment boom, and any appropriate mechanical equipment must be provided, stored, transported, and maintained.

Limitations: The use of protective boom is highly dependent on weather, type of shoreline, topography, and hydrographic conditions. For shoreline recovery, heavy machinery on beaches and intrusion by humans on foot can have adverse impacts on some shoreline habitats. Adverse public reaction, restricted commercial and recreational use or access during cleanup, high cost, and difficulty in gaining access to impacted shorelines (due to logistic or topographical obstacles) can make shoreline protection and recovery difficult operationally.

In shoreline habitats, such as marshes and mangroves, the activity associated with the cleanup can often be more damaging than the oil itself; the cleanup operations can drive the contaminants below the surface and make them available to the root systems of plants and organisms that burrow into the sediments. It is common in these environments for oil to be allowed to remain on the surface of the sediments with sorbents placed at the edge of the water line in an effort to passively collect any oil that re-floats.

Subsea Dispersant Injection

SSDI has only been conducted during the DWH spill in 2010, where dispersants were applied at the well head opening at the sea floor. The same general chemical dispersion principles apply that are discussed in Aerial Dispersant Application, with a few key distinctions. First, with subsea injection, the encounter rate is extremely high because the dispersant is being applied directly to the oil source as it is released into the water, before the oil begins to rise and spread horizontally and vertically within the water column. Because of the high encounter rate, DORs of 1:50 to 1:100 should be sufficient to effectively disperse the oil. The higher DOR means that less dispersant is required for subsea dispersant injection versus aerial dispersant application. Because the injection is occurring at the sea floor, the dispersed oil will dilute vertically over a much greater volume of water, and transfer at depth will be driven by buoyancy of the dispersed oil droplets (vertically) as well as by deep ocean currents (horizontally). This rapid dilution equates to lower concentrations of dispersed oil than those typically measured after a surface application (where the dispersed oil is typically limited to 10 meters of vertical dilution) (Lee, 2013).

Logistics: Subsea dispersant injection takes more time to initially deploy than aerial application. Dispersant and ROV operation vessels must be deployed to the well location, a dispersant manifold needs to be positioned on the dispersant supply vessel, and coiled tubing is then deployed to the seafloor via ROVs. A minimum of two ROVs are needed for this operation. One will control the dispersant injection wand into the oil release point, and the second will supply lighting and videography. If a Cap and Containment system is installed on the well head, it may be possible to connect the dispersant supply hose directly to an injection port on the capping stack. Given the substantial distance from shore, it is anticipated that the specialized equipment would take approximately four days to be mobilized and set up at the Source Control location. Once deployed and connected, the system is designed to operate continuously via remote monitoring.

Limitations: Unlike most other response options, which are limited to daylight hours for aviation and boat safety reasons, subsea dispersant injection can virtually be maintained 24-hours per day, seven days per week, provided that dispersant stockpile is available and on-site. A disruption to the dispersant stockpile would likely only occur during extreme sea states when dispersant tote transfers could not be conducted. Mobilization times for SSDI are longer (roughly four days) compared to aerial dispersant that could be mobilized in roughly one day. However, once the SSDI system is assembled and operational, it can run non-stop.

Implications for NEBA

This section should focus on the potential for exposures to resources of concern, based on the results of the trajectory modelling studies. Emphasis should be placed on identifying the potential for exposures to resources at risk, within potentially affected categories, such as S*horelines, Surface Layer, Shallow Layer, Water Column,* and *Benthos.* Refer to figures used to illustrate the results of trajectory modelling.

Risk Analysis

The impact of SSDI on risk to each of the resources at risk should be described. Typically, SSDI would be expected to reduce the exposures to hydrocarbons at the water surface, and increase exposures in the water column. Water column exposures should be highest near the release point where the subsea dispersant treatment occurs, and rapidly decrease with distance from the treatment location. a concomitant reduction in atmospheric VOC exposure would be expected, without a major increase in risk to water column resources.

Given that the injection occurs at the wellhead, the exposures to dispersed oil in the deeper water column do increase, but the areas exceeding the evaluation thresholds should be rarely exceeded, and sensitve resources should be uncommon. The effects of SSDI use on risks should be as follows:

- The risks to marine mammals and birds in the surface micro-layer and shallow surface waters should be reduced based on the reduction in floating oil.
- The risk to sea turtles in the surface micro-layer and shallow surface waters should be reduced for the same reasons.
- Effects on habitats, such as *Sargassum spp*. Should be reduced due to a reduction in floating oil.
- The risk to fish (eggs and larvae) and invertebrates in the shallow water column should be reduced due to the reduction in naturally dispersed oil that may occur near the surface.
- The risk to coral should be reduced since dispersed oil plumes are expected to be very deep, or near the surface.

Key Findings

Previous NEBAs conducted for scenarios in US waters have favored the use of surface dispersant application during larger spills in offshore waters over mechanical recovery. However, mechanical recovery is still the primary response option and SSDI is being requested to enhance the response thereby further reducing ecological and economic impacts. Key findings of the expedited NEBA, based on the modelled scenario should be presented here.

In general, the same justifications that have been previously demonstrated for aerial dispersant pre-approval should remain valid for subsea dispersant injection, as follows:

Overall

When oil droplet sizes are reduced through dispersant applications, biodegradation rates of components in

dispersed oil are expected to increase. Smaller droplets generate larger oil-water interface areas for oil degrading bacteria to attach to, and dissolution of water-soluble compounds is therefore expected to increase. Volatile oil compounds will rapidly dissolve during subsurface spills and thereby become subject to rapid biodegradation. In contrast, volatiles will largely evaporate after surfacing of the oil. Several laboratory studies have shown that dispersant treatment of dispersible oils increase oil compound biodegradation (Siron et al., 1995; Venosa and Holder, 2007; Hazen et al., 2010; Prince et al., 2013; McFarlin et al., 2014; Brakstad et al., 2014).

Subsea Dispersant Injection

- Natural dispersion and evaporation limit the thickness and geographic extent of floating oil, and when subsea injection of dispersants is used less oil remains on the surface.
- Subsea dispersant injection is the only response method that can be conducted at night, and during relatively high sea states. Subsea dispersant application would be a continuous response activity employed to mitigate a continuous and uncontrolled release from the well. Until the well can be mechanically capped, subsea dispersants are expected to provide the best short-term option to reduce oil reaching the ocean surface and lessen overall environmental impacts.
- Subsurface dispersant injection increases hydrocarbon concentrations in the deep oil plume, but the areas should be relatively small and do not represent a significant risk to sensitive biological resources. The subsea dispersed oil concentrations are expected to rapidly dilute both vertically and laterally through a very well mixed water column, which will result in concentrations well below 1 ppm within a few kilometers of the well head. This was documented during the Deepwater Horizon subsea dispersant monitoring activities in 2010. Concentrations below 1 ppm are generally determined to be below the high level of concern threshold of impacts to most species, derived from the USCG-sponsored workshops described earlier. In addition, the level of naturally dispersed oil in the upper ten to 20 meters of the water column is lowered.
- The biodegradation of subsea dispersed oil in deep waters more than 120 miles from shore is expected to result in reduced oil on the surface, reduced oil in sensitive shoreline habitats, and a substantial decrease in the recovery times of the ecosystem (as a whole) .
- Direct injection into the plume at the seabed translates to a considerably higher (order of magnitude) encounter rate than those at the surface, where the oil expression is broadly spread over a surface slick that continuously increases in size as oil is continuously released from the wellhead. Surface dispersant applications are limited to daylight operations only, would have reduced overall encounter rates due to the size of the surface slick, and are expected to be significantly less effective once the oil naturally weathers as a surface slick**. As a result, subsea dispersant injection requires an overall lower DOR for the same level of treatment than a surface dispersant application – significantly less overall application of chemical dispersant would be required to treat the same volume of oil** (Brandvik et al., 2013; Johansen et al., 2013).

Findings Related to Safety

Ongoing research on subsea dispersant injection has demonstrated that an effective subsea dispersant operation will reduce the oil droplet size from the 1 mm range to the 50-200 micron range. Subsea dispersant injection is expected to decrease the surface expression of oil slicks, thereby decreasing VOC and LEL levels in the source control area, which both decreases threats to human health, and increases the productivity of workers who can operate and communicate unrestrained without the use of respirators.

Findings Related to Environmental Protection

Specific findings related to protection of RAR, and particularly threatened or endangered species should be presented here. These findings should be based on the modelled exposure estimates and risk analysis for the modelled scenario or spill event. The findings may include impacts to all applicable environmental resources, cultural resource, and commercial resources. In general:

An effective SSDI program should reduce the amount of oil that reaches environmentally sensitive shorelines. In addition, reducing the amount of untreated (non-dispersed) oil that surfaces in offshore waters should help protect offshore species, including migratory birds, marine mammals, and sea turtle populations which depend on access to clean surface waters for their survival.

Conclusions

This section summarizes the findings from the expedited NEBA that provide direct support to decisions regarding the use of SSDI. Key findings pertaining to impacts of SSDI on overall risks, including worker safety should be presented. **Consideration of overall impacts on risks, combined with the findings of previous NEBAs performed in the GOM should be summarized in a statement such as:**

> **"For the reasons cited above, and consideration of the findings of previous NEBAs performed in the GOM, this expedited NEBA suggests that subsea dispersant injection has the potential to offer net environmental benefits, lower ecological risks to sensitive environmental areas, and reduced risk to responder health and safety."**

NEBA References

Aurand, D., L. Walko, R. Pond. (2000). *Developing consensus ecological risk assessments: Environmental protection in oil spill response planning - a guidebook*. Ecosystem Management & Associates, Inc. Report 00-01. Washington, DC: U.S. Coast Guard: 147p. Retrieved from http://www.fws.gov/contaminants/fws_oscp_05/fwscontingencyappendices/N-Manuals-Response-Assessment/CG-EcolRiskatOilSpills.pdf.

Brandvik, P.J., Johansen, Ø., Leirvik, F., Farooq, U., and Daling, P.S. (2013). Droplet breakup in sub-surface oil releases – Part 1: Experimental study of droplet breakup and effectiveness of dispersant injection. *Marine Pollution Bulletin, 73*(1), 319-326. doi:10.1016/j.marpolbul.2013.05.020.

Brakstad, O., P. Daling, L. Faksness, I. Almås, S. Vang, S. Syslak, and F. Leirvik. (2014). Depletion and biodegradation of the Macondo 252 oil in dispersions and emulsions generated in an oil-on-seawater mesocosm flume basin. *Mar. Poll. Bull.* 84, 125-134.

Hazen, T. C., E. A. Dubinsky, T. Z. DeSantis, G. L. Andersen, Y. M. Piceno, N. Singh, J. R. Jansson, A. Probst, S. E. Borglin, J. L. Fortney, W. T. Stringfellow, M. Bill, M. S. Conrad, L. M. Tom, K. L. Chavarria, T. R. Alusi, R. Lamendella, D. C. Joyner, C. Spier, M. Auer, M. L. Zemla, R. Chakraborty, E. L. Sonnenthal, P. D'haeseleer, H.-Y. N. Holman, S. Osman, Z. Lu, J. D. Van Nostrand, Y. Deng, J. Zhou, and O. U. Mason. (2010). Deep-sea oil plume enriches psychrophilic oil-degrading bacteria. *Science*, 330:204-208.

Johansen Ø, Brandvik, P. J., & Farooq, U. (2013). Droplet breakup in subsea oil releases – Part 2: Predictions of droplet size distributions with and without injection of chemical dispersants. *Marine Pollution Bulletin, 73*(1), 327-335. doi:10.1016/j.marpolbul.2013.04.012.

Lee, K., Nedwed, T., Prince, R. C., and D. Palandro. (2013). Lab tests on the biodegradation of chemically dispersed oil should consider the rapid dilution that occurs at sea. *Marine Pollution Bulletin, 73*(1), 314-318. doi:10.1016/j.marpolbul.2013.06.005.

Lewis, A. and D. Aurand. (1997). Putting dispersants to work: Overcoming obstacles. Washington, DC, American Petroleum Institute.

McFarlin, K.M., R.C. Prince, R. Perkins, and M.B. Leigh. (2014). Biodegradation of Dispersed Oil in Arctic

Seawater at -1°C. *PLoS one* 9, e84297.

Prince, R. C., K. M. McFarlin, J. D. Butler, E. J. Febbo, F. Wang, and T. J. Nedwed. (2013). The primary biodegradation of dispersed crude oil in the sea. *Chemosphere*, 90, 521–526.

Venosa, A.D. and E.L. Holder. (2007). Biodegradability of dispersed crude oil at two different temperatures. *Marine Pollution Bull.*, 54:545-553.

Attachment 2 Timeline for Utilizing Subsea Dispersant Injection

Attachment 3 Dispersant Injection Rate Table

API OSRP Guidance document review

OGC added the disclaimer: "This document does not necessarily reflect the opinions of the regulatory community, has not been approved by the regulatory community, and does not constitute an endorsement of this RP by the regulatory community"

- API response: "**Disagree.** At EPA's request, we deleted all references to EPA being part of the work group but considered all comments they provided even though only work group members were allowed to submit comments. Additionally, USCG and BSEE did not take exception to being listed as members of the work group but in consideration of EPA's request that no federal agencies be mentioned, BSEE and USCG felt just referring to participation by the "regulatory community" would at least partially satisfy EPA's request. **Since this statement is EPA's position and not that of USCG or BSEE, it will not be included in the final RP**."

API document state: The recommendations developed by the Workgroup in Section 3 include a number of features and concepts that were incorporated into the design of this RP."

- EPA requested that "…by the Workgroup…" be changed to "…in coordination with the Workgroup…".
- API response: "**Disagree – The recommendations were developed by the workgroup** not in coordination with another unnamed entity."

API document state: "The content recommended by this RP was, however, benchmarked against BSEE's regulations (30 CFR Part 254 and associated guidance in NTL 2012-N06) and found to be in general compliance but will depend on the specific information plan holders include in each section.

- EPA stated that "Compliance determinations are made by regulatory agencies and are specific, not general." And requested that the statement be changed to "…API believes them to be found to be in general compliance…."
- API's response: "**Disagree. The workgroup found them to be in general compliance and not API.**"
- Caplis email [August 4, 2016]: "I agree with your thoughts about compliance."

AIP OSRP document includes a section on Net Environmental Benefit Analysis (NEBA) [Section 6.3.2] and cites references that haven't been published and don't appear to be currently available: Response Strategy Development Using SIMA, API 2016 and Guidelines on Implementing Spill Impact Mitigation Assessment, SIMA, API/IPIECA/IOGP 2016.

Although the document states refers to applicable regulatory authorities in establishing specific worst-case discharge criteria, Annex B instructs the plan holder to "**Describe how and why the worst-case discharge scenarios were selected, referring to the oil spill risk and impact analyses conducted by the plan holder**." In response to a previous comments on WCD planning scenario, API noted that the sentence "**Planning Scenario selection should also consider those with unique circumstances, such as relatively close proximity to shore or sensitive resources**, or resource requirements such as sour or Group V oils as well as **those that represent a variety of potential environmental impacts**" was added to address a BSEE comment that special consideration be given to facilities that are close to shore or possess unique characteristics in addition to the facility with the WCD. API section on Oil Spill Impact/Consequence Analysis [Section B.3] contains similar factors cited in API NEBA documents.

March - May 2016 - API Industry Guidelines on Requesting Regulatory Concurrence for Subsea Dispersant Use - API BULLETIN 4719 - Draft

Reincarnation of the RRT VI Industry Liaison Committee efforts that were of concern last year. We took issue with some of their statements.

Even though this is supposed to be Industry Guidelines, the document directly references to RRT VI, stating that its offering a "clarification on how RRT VI has interpreted requirements of 40 CFR Section 300.910 as applied specifically to subsea dispersant use…" It also characterizes other parts of the NCP, as well as roles and responsibilities under the Incident Command Structure / Unified Command.

API characterized the guidelines as describing the RRT concurrence request process, proposed information submission recommendations that are specific to subsea dispersant injection and the use of Net Environmental Benefit Analysis (NEBA) and other forms of tradeoff analyses as decision support tools.

Sections include:

Introduction
Scope
Terms, Definitions, and Abbreviations
- Overview

Summary of Core Information Submitted to Regional Response Teams
Evaluating the Use of Subsea Dispersant Injection
Use of Modelling to Support Response Decision-making
Use of Subsea Monitoring to Support Response Decision-Making
Importance of Effective Data Management Techniques
Use of NEBA to Support Response Decision-Making
- Methods traditionally used for evaluating the potential net environmental impacts of various response technologies include Net Environmental Benefit Analysis (NEBA), and Consensus Ecological Risk Assessment (CERA). Such analyses are typically conducted in support of planning activities, but the principles and some of the methods employed can also be used during response actions, or response simulations and drills. Such analyses are typically referred to as "expedited or qualitative NEBAs" or "Environmental Trade Off Analyses". During drills or exercises, unless a NEBA has been conducted through applicable planning activities that take the release scenario into account, an "Expedited NEBA" should be conducted and included as part of the RRT concurrence package.

Regional Response Team Concurrence Request Process
Incident Command System Positions with Significant SSDI Roles

Annex A - Recommended Submittal Elements for SSDI Approval Request
A.10 Analysis of Potential Benefits and Trade-offs Associated with Subsurface Dispersant Injection
NOTE: We are still awaiting some clear decisions on the term that will be adopted to describe "operational NEBA" – this section will be updated once we have that decision from the OSPER SC.

An example of how NEBA is applied during an operational response is included in Figure 9.1 for illustrative purposes which addresses the following critical elements:. As shown in Figure 9.1, the following questions could be address the following:

a) Safety: Do high VOC or LEL levels from subsea well hydrocarbons at surface exceed safe work conditions?

b) Aquatic/shoreline RAR: What are the specific aquatic/shoreline resources, organisms and habitat are at risk from the non-chemically and chemically dispersed spilled product?

c) Birds: What are the specific birds based on ESI maps would be at risk from the shoreline impact of the non-

chemically dispersed spilled product?

d) Time to RAR Impact: What is the estimated time of impact to the resources identified in Items a) and b) above? (The NOAA SSC can be contacted for trajectory and environmental fate analysis.)

e) Spill Trajectory: What is the estimated location of the leading edge of the spill trajectory at the proposed time of initiation of SSDI? (Using model results, lat/long, proximity to shore, coordinate with the NOAA SSC, the RP, or other information sources to estimate the location of the leading edge of the spill at the proposed time of the first application of dispersants).

f) Environmental Benefit/Trade Offs Impacts from Dispersed Oil: Does it appear that dispersants can be applied at this location in a manner that will likely achieve the desired environmental benefit for the identified RARs? Are there any specifically known resources in the area targeted for dispersant use that might be negatively impacted by application of chemical dispersants? If so, what are the known resources, and is the negative impact to these resources anticipated to be great enough to offset the benefit to the identified resources?

g) Are there ways to avoid or minimize adverse effects to known resources (e.g., observers watching for marine wildlife).

The scenario depicted below in Figure 9.1 illustrates how SSDI can reduce the overall consequences of a release and thereby achieve net environmental benefits.

Note: this example is provided for illustrative purposes only. A NEBA performed for a specific scenario must take into account the characteristics of the release, the local environmental resources, their ecological, commercial and cultural value and their seasonality.

During an actual event, it is unlikely that a formal NEBA document would be prepared, but the environmental unit, with participation from environmental trustees such as DOC, DOI, and applicable State agencies would utilize the same analytical concepts in identifying potential environmental benefits, and risks, associated with the available response technologies.

Annex B - Summary of Primary Response Options
Annex C - Example Timeline for Utilizing Subsea Dispersant Injection
Annex D - Subsea Dispersant initial Injection Rate Calculation
Bibliography

PREP 4C Guidelines - BSEE Incident Management Team Exercises - Objectives

BSEE ORIGINAL: **Demonstrate the ability to apply and coordinate the use of multiple countermeasures based on an informal, incident-specific net environmental benefit analysis** and the response Concept of Operations as outlined in the OSRP.

FINAL: Ability to select and propose the use of an optimal mix of response countermeasures to the FOSC, **based on an assessment of the operational feasibility, expected effectiveness, and projected environmental tradeoffs associated with using each countermeasure.**

EPA questions for BSEE (Nov. 4, 2015)

What is the process to conduct a "NEBA"?

What is the specific process that is used to conduct a NEBA? We are aware of USCG's "Developing Consensus Ecological Risk Assessments", where an Ecological Risk Assessment (ERA) is defined as "a process through which to evaluate the possible ecological consequences of human activities and natural catastrophes. An ERA emphasizes the comparison of exposure to a stressor or stressors (i.e., oil and/or the response options) with an ecological effect (e.g., population disruption, changes in ecological community structure or function, toxicological effects). As much as possible, this comparison is made quantitatively, including an estimation of the probability that the predicted consequences will occur and of the associated severity and magnitude of the effects. "In addition, the ERA recognizes its uncertainties and explains the limits of the analysis. However, it is unclear if the reference to NEBA in the 4C guidelines is intended to reflect a similar type of analysis. We are suggesting edits because of concerns that NEBA appears to be used as a general justification solely for protection of the shoreline without considering all of the potential ecological effects.

What is the scope of a NEBA?

The only place that NEBA is referenced in the 4C guidance is in this BSEE/IMT section. What information (including site specific) is required to be considered in a NEBA? BSEE is requiring the plan holder to develop an "informal, incident specific NEBA". What does this owner/operator ecological risk assessment addresses? Do they include relevant information contained environmental impact analysis regulations that is required per 30 CFR 550, for EPs and DPPs?

What is an "informal, incident-specific NEBA"?

How does this process differ from a "formal" NEBA? The preamble does not have any comments or discussion on including a NEBA as part of IMT exercises. So it is unclear what led to this language being inserted.

NEBA relative to chemical countermeasures.

We understand that the reference to NEBA in this document is to assessing "the use of multiple counter measures" (which would include mechanical). However, it is our understanding that at least some regulated industry believe that NEBA is used solely in support of the use of chemical countermeasures, particularly dispersants. The concern is that the NEBA process should not be conducted absent similar considerations for other response options and/or for the optimal combination of response options. To the extent that NEBA does include chemical countermeasures, then specifics of what both the analysis and the use decision-making process entails needs to be clearly established.

Who is conducting the NEBA?

For the internal exercises, the 4C guidelines establish that the owner/operator would be conducting exercises based on a NEBA that presumably the owner/operator would develop. While we understand a NEBA can serve to inform planning/exercise/use decisions, the decision to use dispersants, or any other chemical countermeasure is ultimately a government decision, and must be done in accordance with the Subpart J of the NCP. To reflect this, to the extent that the owner/operator relies on any NEBA type of environmental tradeoffs assessment, it should be clear that it is to "inform" planning, not to make "use decisions" by the owner/operator. Any owner/operator environmental tradeoff assessment should also be referring back to those prepared by the Area Committees for the Area Contingency Plans.

6.2	FE: Incident Management Team Exercise – Offshore Facilities
Applicability:	IMT.
Frequency:	Annually.
Initiating Authority:	Owner or operator.
Participating Elements:	IMT and plan holder company officials as established in the spill response plan.
Scope:	Exercise the IMT's organization, communication, and decision - making in managing a response.
Objectives:	Exercise a select combination of the Core Components as outlined within Appendix A of the PREP Guidelines. During each triennial cycle, all of the applicable Core Components in Appendix A need to be exercised at least once. In addition, effective demonstration of any of the following components may be included in the scenario for the exercise: A. Ability to detect, assess, project, track and monitor the spill, properly map the spill information necessary to respond, direct response resources appropriately, and share that information with others as indicated in the response plan. B. Knowledge of OSRP, any referenced OSRO Inventories, tactics manuals, and well containment plans. C. Ability to access information in the appropriate Regional Contingency Plans (RCPs) and ACPs for the location of sensitive areas, protective best management practices, resources available within the area, unique conditions of area, recommended response strategies, etc. D. For any chemical or biological countermeasures or *in - situ* burning cited in the OSRP, the ability to prepare and submit a request and usage plan to the FOSC. The preparation of a usage and monitoring plan/request for each such countermeasure listed in the plan must be exercised during the triennial cycle. 1. Ability to select and propose the use of an optimal mix of response countermeasures to the FOSC, based on an assessment of the operational feasibility, expected effectiveness, and **projected environmental tradeoffs associated with using each countermeasure.** 2. In the case of a request for aerial/vessel applied dispersants, API Technical Report 1148 ("Aerial and Vessel Dispersant Preparedness and Operations Guide") contains an example of a Daily Aerial/Vessel Dispersant Application Plan that may be appropriate for use in this situation. 3. For OSRPs that also list SSDI as a response capability, the IMT should complete an application request and usage and monitoring plan for SSDI, as well as a management plan for coordinating the allocation of dispersant stockpiles between surface - application and SSDI operations, as appropriate. 4. Ability to implement and coordinate the use of multiple response countermeasures, as approved by the FOSC, in accordance with the offshore response Concept of Operations outlined in the OSRP. E. Demonstrate the effective and coordinated integration of source control and subsea containment operations with other incident management activities, including oil spill response operations. F. Identification of corrections necessary to address any noncompliance or preparedness issues encountered while conducting the exercise and the incorporation of these corrections into the OSRP.
Certification:	Self - certification.
Verification:	Verification by BSEE; records must be available upon request.

https://www.bsee.gov/sites/bsee_prod.opengov.ibmcloud.com/files/final_2016_prep_guidelines.pdf

RRT VI Dispersant Exercises - At least 4 RRT VI Incident Specific Activation Reports on epaosc.org website for Subsea dispersant use and 1 for Surface dispersant use

May 2016 - HWCG-LLOG 2016 Gulf of Mexico Exercise

On May 10-11, 2016, HWCG-LLOG conducted their annual industry-led Preparedness for Response Exercise Program (PREP) exercise. As part of the exercise, they requested RRT concurrence to use subsea dispersants, specifically COREXIT EC9527A, FINASOL OSR 52, and ACCELL Clean DWD, as an effective means to minimize environmental impact.

Exercise Scenario is located in the **Mississippi Canyon 300, Well #2** block approximately 59-miles south of the mouth of the Mississippi River, and was based on their oil spill response plan's worst-case discharge. HWCG-LLOG requested RRT-6 approval for the use of subsea dispersants to reduce volatile organic compounds (VOCs) exposure to responders, and reduce the potential for oil impacts to the shoreline and resources at risk.

On April 29, 2016, HWCG-LLOG's exercise planners provided their subsea dispersant package to RRT-6 (i.e., **Summary Slide Deck, Resources at Risk, Critical Review of Toxicity, Monitoring Plan, Logistics, Schedule, RRT Incident Data Sheet, Scenario, and Mass Data comparisons**). On May 10, 2016, at 1400 CT, the Incident-Specific RRT (ISRRT) teleconference commenced; call adjourned at 1500.

RRT members were provided a read-ahead package prior to the call. This helped facilitate a meaningful discussion and allowed more productive feedback to HWCG-LLOG personnel. Despite the many unknowns with this exercise, RRT members unanimously agreed that injecting subsea dispersants at the source of the spill was the best and preferred method, thus minimizing oil from reaching the surface and shoreline.

- **NOAA acknowledged that using subsea dispersants at the source is generally the best option to keep the oil out of critical habitats; however, as the lead trustee for numerous "at risk" species in the subsea, surface, near-shore and on-shore environment, they have a more difficult challenge when weighing the tradeoffs between response techniques**. Another variable in the decision process is what time of year the incident occurs (e.g., Sea Turtle nesting).
- DOI recommended that responders should do everything possible to keep the oil out of the wetlands and minimize impact to bird rookeries and fish nurseries. To do this effectively in the open ocean environment, subsea dispersant use at the wellhead would be the best option. Also, in-situ burning and mechanical recovery would not be effective in rough water, allowing the oil to remain on the surface for longer periods of time, resulting in weathering of the oil, which in turn makes it even harder to disperse, cleanup and remove.

Outcome

Mr. Ronnie Crossland: Approved, with the understanding that in an actual incident, there could be several calls leading up to an actual approval. RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback / progress on the subsea application and monitoring process.

Mr. Greg Pollock - State of Texas (TGLO): Approved. Although spill is located in federal waters, **TGLO recognizes that if "no action" (i.e., subsea dispersants) is taken, the oil could eventually impact state waters.** They are also in favor of fighting the spill as far offshore as possible.

Mr. Brian Wynne -State of Louisiana (LOSCO): Approved. **Although spill is located in federal waters, LOSCO recognizes that if "no action" (i.e., subsea dispersants) is taken, the oil could eventually impact state waters.**

RRT Incident Specific Activation Summary: https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20-%20HWCG-LLOG%20--%205-10-2016.pdf

August 2015 - Chevron USA Inc. - Chevron USA Inc. conducted their annual industry led PREP exercise (requested RRT concurrence to use subsea dispersants as part of the exercise).

Nine days prior to a one hour RRT VI Incident Specific teleconference that the USCG RRT-6 Co-Chair convened at the request of the Exercise FOSC, Chevron's exercise planners provided their subsea dispersant package to RRT-6 that included:

- **Summary Slide Deck,**
- **Resources at Risk,**
- **Critical Review of Toxicity,**
- **Monitoring Plan, Logistics, Schedule,**
- **RRT Incident Data Sheet,**
- **Scenario, and Incident Map.**

The purpose of the call was to review, discuss and potentially approve Chevron's request to apply subsea dispersants to mitigate the discharge.

Exercise Scenario is located in **Keathley Canyon 785** approximately 210-miles south of Morgan City, LA, and was based on their oil spill response plan's **242K worst case discharge**. Chevron requested RRT-6 approval for the use of subsea dispersants to reduce VOCs to promote responder safety, and to reduce impacts to the shoreline and resources at risk. Despite the many unknowns with this exercise, RRT members unanimously agreed that injecting subsea dispersants at the source of the spill was the best and preferred method, thus minimizing oil from reaching the surface and shoreline.

The following are key takeaways that were discussed during the call:

- In the event that subsea dispersants are actually requested, the UC must provide the RRT with a Monitoring Plan that is both aggressive and adaptive. The plan should include the following factors for measuring the efficiency of subsea dispersants:
    - Have the ability to measure and evaluate the effectiveness of both contact time and mixing efficiency while injecting dispersants.
    - Ability to measure the distribution of droplets, and ensuring the smaller droplets are less than the 200 micron range.
- During a spill where dispersants are to be applied, it is a good idea to work in close coordination with the academic community (e.g., National Science Foundation, State Universities, etc.) to promote transparency and facilitate the sharing of monitoring data, so that everyone is working towards a common goal.
- NOAA acknowledged that using subsea dispersants at the source is generally the best option to keep the oil out of critical habitats; however, as the lead trustee for numerous "at risk" species in the subsea, surface, near-shore and on-shore environment, they have a more difficult challenge when weighing the tradeoffs between response techniques. Another variable in the decision process is what time of year the incident occurs (e.g., Sea Turtle nesting).
- DOI recommended that responders should do everything possible to keep the oil out of the wetlands and minimize impact to bird rookeries and fish nurseries. To do this effectively in the open ocean environment, subsea dispersant use at the wellhead would be the best option. **Also, in-situ burning and mechanical recovery would not be effective in rough water, allowing the oil to remain on the surface for longer periods of time, resulting in weathering of the oil, which in turn makes it even harder to disperse.**

Outcome

Charlie Henry (NOAA natural resource trustee) and Stephen Spencer (DOI natural resource trustee): Agreed that subsea dispersant use was the best option in this case; monitoring plan needs to be in place.

Brandi Todd (EPA): Approved, with the understanding that in an actual incident, there could be several calls leading up to an actual approval. RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback / progress on the subsea application and monitoring process.

RRT Incident Specific Activation Summary: https://www.epaosc.org/sites/5083/files/Activation%20Call--EXERCISE%20-%20Chevron-%208-19-2015.pdf

November 2014 - BP Hopkins - BP conducted their annual industry-led PREP (requested RRT concurrence to use subsea dispersants as part of the exercise).

The exercise planners provided subsea dispersant package to RRT-6

- **Incident Data Sheet,**
- **Proposed High Level Subsea Dispersant Operations Plan,**
- **Proposed Subsea Dispersant Injection Monitoring Plan,**
- **Expedited Net Environmental Benefit Analysis (NEBA) of Subsea Dispersant Injection, and**
- **Oil Spill Trajectory and Fate Modeling Summary**

One hour and ten minute RRT-6 ISRRT teleconference to review, discuss and potentially approve BP's request to apply subsea dispersants to mitigate the discharge ongoing from **Green Canyon 327**.

The Environmental Unit (EU) presented overview of NEBA that led to the request for subsea dispersant approval. Key benefits outlined during the call:

- Responder Safety – reduce volatile organic compounds (VOCs) and exposure limits.
- Reduce large surface slicks – that could potentially migrate over large surface areas and impact the following:
    - Wildlife – reduce the potential exposure to sensitive areas of concern, such as the upper layer of the water column, where marine mammals and turtles are found.
    - Critical Habitats – modeling software predicted impact to the Flower Garden Banks if subsea dispersants were not used.
    - Shoreline – reduce potential of oil impacting and stranding on shorelines.
    - Economic – reduce economic impacts (commercial, sport, and recreational)
- Weather – high winds and large waves expected to make conventional recovery methods impossible.

Outcome

Charlie Henry (NOAA) – Recognized that this is an exercise and that the information that is discussed and agreed on during this incident will not be the same for every incident. It is important to note that every incident is unique and will have to be assessed individually on a case-by-case basis.

Ronnie Crossland (EPA) - Approved, with the stipulation that in an actual incident, RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback/progress on the subsea application and monitoring process. Also, the RRT would most likely require daily reports/follow-up calls to review efficacy of the subsea dispersants, and to make course corrections as needed.

RRT Incident Specific Activation Summary: https://www.epaosc.org/site/doc_list.aspx?site_id=5083

https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20--%20Incident%20Specific%20Activation%20Report%20BP%20Hopkins%20--%2011-05-2014.pdf

April/May 2014 - HWCG-Freeport-McMoRan Oil & Gas (HWCG-FMOG) Gulf of Mexico - HWCG-FMOG conducted their annual industry led PREP exercise (requested RRT concurrence to use subsea dispersants as part of the exercise)

Exercise Scenario is located in the **Green Canyon 393** block in a water depth of 3,800-feet;

Nineteen days prior to a one hour and five minute RRT VI Incident Specific teleconference that the USCG RRT-6 Co-Chair convened at the request of the Exercise FOSC, the exercise planners provided their subsea dispersant package to RRT-6 that included (as examples):

- **Facility Incident Report,**
- **Proposed Subsea Dispersant Operations Plan,**
- **Subsea Dispersant,**
- **Subsea Dispersant Monitoring Plan,**
- **Incident Action Plan,**
- **Application Monitoring Materials and Equipment List.**

The USCG RRT-6 Co-Chair convened a second 17 minute call the next day at the request of the Exercise FOSC

DOC and DOI trustee representatives provided consultation and outlined the following action items in advance of RRT-6 concurrence, which EPA, Texas, and Louisiana representatives agreed.

- Explain the **positive net benefit of using subsea dispersants as opposed to not using them.**
- **Work with Resource Trustees to determine the trade-offs of using versus not using subsea dispersants**, and how will it affect the following:
    - Sport fishing
    - Habitat Fisheries
    - Long-term effects in marsh versus deepwater
- Provide RRT-6 with **the benefits/tradeoffs of each of the following cleanup techniques:**
    - **Subsea dispersants**
    - **Surface dispersants**
    - No Action – what would be the trade off if no action is taken?
- Consult with the NOAA SSC to help with the modeling, fate of oil, and to help determine resources at risk.
    - What is the trajectory if we do not disperse?
    - Long-term monitoring for ESA, (e.g., Sea Turtles, Marine Mammals, and dolphins)
- **Work with BSEE to get 30-day trajectory predictions from the RP's Oil Spill Response Plan (OSRP).**

Outcome

Charlie Henry (NOAA natural resource trustee) and Stephen Spencer (DOI natural resource trustee): Agreed with the request. No further comments

Steve Mason on behalf David "Wes" McQuiddy (EPA): Agreed with the request. No further comments

RRT Incident Specific Activation Summary: https://www.epaosc.org/site/doc_list.aspx?site_id=5083
https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20--%20Freeport%20McMoran%20--%2004-30-2014.pdf

November 2013 - Chevron USA Inc. - Chevron USA Inc. conducted their annual industry led PREP exercise (requested RRT concurrence to use subsea dispersants as part of the exercise).

Over a three-day period (19-21 November 2013), Chevron conducted their Full-Scale Exercise in accordance with the Preparedness for Response Exercise Program (PREP) guidelines. As part of the exercise, the Coast Guard FOSC pursued RRT concurrence to use dispersants and in-situ burning to minimize environmental impact.

Prior to the exercise, Chevron planners provided several key read ahead documents to RRT-6, (e.g., Exercise Briefing, Dispersant checklist, and the In-situ Burning Checklist).

On 20 November 2013, at 1000, the RRT-6 Incident Specific Activation call commenced; call adjourned at

1037.

RRT Incident Specific Activation Summary: https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20--%20Chevron%20Oil%20Spill%20--%2011-21-2013.pdf

ConocoPhillips 2013 – Presentation to RRT VI. Exercise Scenario located in **Walker Ridge 460** in 6,915 ft of water. No Activation Summary on the EPAOSC.org website.

RRT VI presentation: https://www.epaosc.org/sites/11040/files/05-29%201530%20ConocoPhillips%20Exercise.pdf

RRT 6 ART Evaluation Job Aid – Dispersants May 2016 RRT 6 Presentation to the NRT

Question 4: Are other options for product removal considered inadequate?

How is this question evaluated? Do the RRTs consider the information on oil spill response equipment in OSRP and Exploration/Production plans? BSEE OSRP regulations required:

- An appropriate trajectory analysis specific to the area in which the facility is located, which must identify onshore and offshore areas that a discharge potentially could affect. The trajectory analysis chosen must reflect the maximum distance from the facility that oil could move in a time period that it reasonably could be expected to persist in the environment,
- A list of the resources of special economic or environmental importance that potentially could be impacted in the areas identified by the trajectory analysis and **the strategies used for their protection**. At a minimum, this list must include those resources of special economic and environmental importance, if any, specified in the appropriate Area Contingency Plan(s),
- A **description of the response equipment that will be used to contain and recover the discharge to the maximum extent practicable** and how to cope with the initial spill volume upon arrival at the scene and then support operations for a blowout lasting 30 days. This description must include the types, location(s) and owner, quantity, and capabilities of the equipment,
- A description of the personnel, materials, and support vessels that would be necessary to ensure that the identified response equipment is deployed and operated promptly and effectively, and
- Must ensure that the response equipment, materials, support vessels, and strategies listed are suitable, within the limits of current technology, **for the range of environmental conditions anticipated at the facility**

http://www.ecfr.gov/cgi-bin/text-idx?SID=ae9d48e87e273e549942f003d6bc7f29&mc=true&node=se30.2.254_126&rgn=div8

Note: BOEM incorporates the same BSEE requirements into Exploration/Production Plans requirements at 30 CFR 550.219 (Exploration Plans), and 30 CFR 550.250 (for Development and Production Plans (DPP) and Development Operations Coordination Documents (DOCD))

http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title30/30cfr550_main_02.tpl

Is the "inadequacy" evaluation reported back to BOEM and BSEE for their consideration in reviewing OSRPs and exploration/production plans?

Question 5: Will dispersant application achieve the desired environmental benefit for identified RARs?

What information resources are used to "identify" RARs? Is the DWH NRDA considered? Who determines the desired environmental benefit? RRT? RP?

Does the RARs include the BOEM incorporates BSEE requirements into Exploration/Production Plans requirements at 30 CFR 550.219 (Exploration Plans), and 30 CFR 550.250 (for Development and Production

Plans (DPP) and Development Operations Coordination Documents (DOCD))?

http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title30/30cfr550_main_02.tpl

Under the NCP, all ACPs incorporate detailed annex containing FWSEP that are **prepared in consultation with the USFWS and NOAA** and other interested natural resource management agencies/parties and that must be consistent with the RCP and NCP.

Among other requirements, the annex is to:

- **Identify and establish priorities for fish and wildlife resources and their habitats and other important sensitive areas** requiring protection from any direct or indirect effects from discharges,
- Provide a mechanism to be used during a spill response for timely identification of protection priorities of those fish and wildlife resources and habitats and sensitive environmental areas that may be threatened or injured by a discharge, and
- **Identify potential environmental effects on fish and wildlife, their habitat, and other sensitive environments resulting from removal actions or countermeasures**, including the option of no removal
    - Based on the evaluation of potential environmental effects, the annex should establish priorities for application of countermeasure and removal actions to habitats within the geographic region of the ACP

Is FWSEP information in the ACP include deep water species in the identified RAR including deep water?

http://www.ecfr.gov/cgi-bin/text-idx?SID=93dc140ad2dc2edbc2840593023fd636&mc=true&node=se40.28.300_1210&rgn=div8

Question 20: Have ESA, EFH, and NHPA Section 106 consultations been initiated?

Wouldn't the results of ESA and EFH consultations been included in developing or evaluating the response to question 5? If not, then it is unclear how dispersant application can "…achieve the desired environmental benefit for identified RARs."

NEBA Concerns/Questions

- Evaluate trade-offs associated with dispersant use, in part through use or review of NEBAs conducted for past oil spills
    - What were the NEBA protocols used (e.g., USCG CERA, ASTM)?
    - What is the scope (e.g., environmental, socioeconomic) and methodology of the trade-off analysis?
        - Qualitative vs quantitative
        - NEBA-type analyses are often characterize as determining the "best" option, ensure "maximum" or "greatest" environmental protection, "lowest" overall negative impact on the environment/socioeconomic, promotes the "quickest" overall ecosystem recovery
    - What factors are used when comparing response options?
- Are factors such as logistical, availability, efficiency considered? If so, how does this impact the analysis? Does response method inefficiency or inadequate availability drive the analysis to a suboptimal outcome?
- How are assumptions supported prior to and validated during a response?
- When is the analysis conducted (planning phase vs expedited)?
- Who conducted the analysis (e.g., responsible party, government, third party)?
    - Certain stakeholders may weigh factors differently
    - If multiple stakeholders involved, who selects the participants? What criteria are used to select the participants?
- How are uncertainties/unknowns addressed?

API SIMA Workshop Overview

Background

In recent years the oil and gas industry has placed significantly greater emphasis on the use of the net environmental benefit analysis (NEBA) methodology in the development of oil spill response strategies for at least the more significant incidents. While the general NEBA concept was well understood and many companies had developed their own NEBA methodologies, it was recognized there was not a common approach on how NEBAs should be conducted. Industry also recognized the NEBA term did not accurately represent the intent of the analysis in addition to it now addresses socio-economic and cultural impacts in addition to environmental. Consequently, IPIECA, IOGP and API collaborated on a project to develop a basic methodology for conducting NEBAs and have adopted the more descriptive term of spill impact mitigation assessment (SIMA).

SIMA Overview

The new SIMA guidelines can be summarized in the following four stages:

1. **Compile and evaluate data** for relevant oil spill scenarios.
2. **Predict outcomes/impacts** for the "No Intervention" option as well as the relative mitigation potential of other feasible response options for each scenario.
3. **Balance trade-offs** by weighing and comparing the range of benefits and drawbacks of each response option, including No Intervention, for each scenario.
4. **Select the best response option(s)** to form the strategy for each scenario that will minimize ecological, socio-economic and cultural impacts and promote rapid recovery.

The four stage process was adopted from the IPIECA/IOGP NEBA Good Practice Guide published in 2015 and the methodology was informed by the Consensus Ecological Risk Assessment (Aurand et al, 2000) as well as other NEBA/SIMA related documents and tools. The new methodology is a qualitative approach that is recommended for use in the planning phase with the outcomes modified during the response phase as necessary to account for incident specific conditions and circumstances. It can also be used independently in the response phase or in a more quantitative form for either phase if it is expected to materially change the outcomes and not time constrained.

It is important to note that this new SIMA methodology is not intended to be an industry standard applied to all oil spills but rather a methodology that can be utilized in the absence of other methods and particularly for more significant spills.

Workshop Objective

To better ensure the new SIMA method will be a viable approach in mitigating oil spill impacts and to promote broader acceptance within the spill response community, this workshop was organized to review the SIMA method and apply it to selected oil spill scenarios (i.e., stress test). It will involve key regulatory and industry representatives from the US. Another workshop involving international regulators and industry representatives will likely be organized as well.

The primary objectives of the workshops are to:

- identify potential significant gaps/flaws in the approach and obtain input on how best to address them, and
- obtain feedback on the suitability of the SIMA method for mitigating oil spill impacts and any potential application limitations

Gina Coelho email 3-2-2016: "**The American Petroleum Institute and IPIECA have undertaken several projects to help industry improve understanding and consistent application of the "Net Environmental Benefit Analysis (NEBA)" process for spill response decision making.** One effort (in which I am involved) involves taking the IPIECA GPG and tweaking it to make it more relevant to U.S. stakeholders. **Industry recognizes the importance of involving Federal and state agencies in this process, and suggested that I seek your input. I have developed a short survey to help inform that effort. If you agree to participate, I will schedule a 30 minute phone interview during which you may verbally share your thoughts and ideas.**

The information you share with me will be kept confidential and will not be publicly distributed; it will be used to help my team (comprised of myself, David Fritz, and Jim Staves) tailor the IPIECA GPG to the US spill response framework. I understand that you may not have the same experience as other individuals within your agency, and would ask you to share information based on your own personal understanding of NEBA concepts as they apply to oil spill planning and response in the US."

- Gina Coelho is an industry consultant and was a BP contractor for DWH, Dave Fritz was a BP employee during DWH, and Jim Staves worked for EPA Region 6 during DWH, but now retired from EPA and works as an industry consultant.
- OGC raised potential ethics concerns with responding to the survey. RID sent out an email to EPA personnel (including region 6) noting OGC's concerns.
- R6 referenced the IPIECA guidance in their two page NEBA justification for subsea dispersant use as part of the 2014 Green Canyon Exercise (see attached email). At that time we raised concerns with DOI's statement (attached email train) that indicated that if "subsea dispersant application is contemplated for an actual incident, this is what the justification will likely look like as it is put forward by the offshore exploration and production industry." We have significant concerns with the lack of detailed documentation and with the conclusions of the analysis that was offered as part of that exercise.
- The IPIECA guidance was also referenced in the RRT VI Subsea Dispersant Use Guidelines (draft version in the attached RRT Subsea Guidance Email) that were developed by the ILC (those were not finalized as an RRT document, but API has hinted to developing that document into an API recommended Practice).

CWA and NCP Requirements

Area Contingency Planning - 40 CFR 210(c):

- The ACP shall include the following…A description of the area covered by the plan, including the areas of special economic or environmental importance that might be damaged by a discharge;

Fish and Wildlife and Sensitive Environments Plan (FWSEP)

- All ACPs incorporate detailed annex containing FWSEP
- Consistent with the RCP and NCP
- Prepared in consultation with the USFWS and NOAA and other interested natural resource management agencies/parties.
- Among other requirements, the annex is to:
    - identify and establish priorities for fish and wildlife resources and their habitats and other important sensitive areas requiring protection from any direct or indirect effects from discharges,
    - provide a mechanism to be used during a spill response for timely identification of protection priorities of those fish and wildlife resources and habitats and sensitive environmental areas that may be threatened or injured by a discharge, and
    - identify potential environmental effects on fish and wildlife, their habitat, and other sensitive environments resulting from removal actions or countermeasures, including the option of no removal
    - Based on the evaluation of potential environmental effects, the annex should establish priorities for application of countermeasure and removal actions to habitats within the geographic region of the ACP

Reference: http://www.ecfr.gov/cgi-bin/text-idx?SID=f9a9c0ef0be4091830b5282ad7c0d670&mc=true&node=pt40.30.300&rgn=div5

- 33 USC 1321 (d)(2)(G) – Prepare a schedule, in cooperation with the States, identifying—
  (i) dispersants, other chemicals, and other spill mitigating devices and substances, if any, that may be used in carrying out the Plan,
  (ii) the waters in which such dispersants, other chemicals, and other spill mitigating devices and substances may be used, and
  (iii) the quantities of such dispersant, other chemicals, or other spill mitigating device or substance which can be used safely in such waters,

  which schedule shall provide in the case of any dispersant, chemical, spill mitigating device or substance, or waters not specifically identified in such schedule that the President, or his delegate, may, on a case-by-case basis, identify the dispersants, other chemicals, and other spill mitigating devices and substances which may be used, the waters in which they may be used, and the quantities which can be used safely in such waters

- EO 12777 delegates 33 USC 1321(d)(2)(G) to the EPA Administrator
- Implemented under Subpart J of the NCP

Authorization of Use (40 CFR 300.910)

- Mechanical recovery is NOT subject to authorization of use under Subpart J

- No specific "NEBA" requirement under Subpart J; rather response strategies are developed under the ACs
- RRTs and ACs address the desirability of using appropriate dispersants, other products listed on the NCP Product Schedule, and burning agents
- RCPs and ACPs shall, as appropriate, include applicable preauthorization plans and address the specific contexts in which such products should and should not be used
- The RRT representatives from EPA and the states with jurisdiction over the waters of the area to which a preauthorization plan applies and the DOC and DOI natural resource trustees shall review and either approve, disapprove, or approve with modification **the preauthorization plans developed by Area Committees**, as appropriate.
- Pre-authorization plans require approval of:
    - EPA RRT representative
    - States with jurisdiction over the waters of the area to which a preauthorization plan applies and;
    - DOC and DOI natural resource trustees
- Authorization of use for spill situations that are not addressed by the preauthorization plans requires:
    - Concurrence of the EPA representative to the RRT
    - As appropriate, concurrence of the RRT representatives from the states with jurisdiction over the navigable waters threatened by the release or discharge
    - Consultation with the DOC and DOI natural resource trustees

- Exception only to prevent or substantially reduce threat to human life
    - Insufficient time to obtain the needed concurrences/consultations
    - OSC must inform the EPA RRT representative and, as appropriate, the RRT representatives from the affected states and, when practicable, the DOC/DOI natural resources trustees as soon as possible
    - Not intended to circumvent preauthorization or case-by-case use authorizations
        - NCP addresses worker health and safety under 40 CFR 300.150

BSEE OSRP Regulations (30 CRR 254) required:

- An appropriate trajectory analysis specific to the area in which the facility is located, which must identify onshore and offshore areas that a discharge potentially could affect. The trajectory analysis chosen must reflect the maximum distance from the facility that oil could move in a time period that it reasonably could be expected to persist in the environment,
- **A list of the resources of special economic or environmental importance that potentially could be impacted in the areas identified by the trajectory analysis and the strategies used for their protection**. At a minimum, this list must include those resources of special economic and environmental importance, if any, specified in the appropriate Area Contingency Plan(s),
- A description of the response equipment that will be used to contain and recover the discharge to the maximum extent practicable and how to cope with the initial spill volume upon arrival at the scene and then support operations for a blowout lasting 30 days. This description must include the types, location(s) and owner, quantity, and capabilities of the equipment,
- A description of the personnel, materials, and support vessels that would be necessary to ensure that the identified response equipment is deployed and operated promptly and effectively, and
- Must ensure that the response equipment, materials, support vessels, and strategies listed are suitable, within the limits of current technology, for the range of environmental conditions anticipated at the facility

http://www.ecfr.gov/cgi-bin/text-idx?SID=ae9d48e87e273e549942f003d6bc7f29&mc=true&node=se30.2.254_126&rgn=div8

Note: BOEM incorporates the same BSEE requirements into Exploration/Production Plans requirements at 30 CFR 550.219 (Exploration Plans), and 30 CFR 550.250 (for Development and Production Plans (DPP) and Development Operations Coordination Documents (DOCD)) http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title30/30cfr550_main_02.tpl

USCG DWH ISPR

- Overall, the team found these ACPs to be inadequate for this incident, and possibly for smaller, more localized incidents. (pg 5)

In the Gulf of Mexico or anywhere offshore oil production occurs, there must be direct linkage between the Oil Spill Response Plan (OSRP) and local ACPs.

- The ISPR Team found that not including worst case discharge (WCD) scenarios from offshore oil exploration, development, and production activities in ACPs for areas in which such activities are occurring was unacceptable.
- The NCP directs Area Committees to address ESAs and include booming and protection strategies to address a WCD.
    - In some planning areas, the ESAs were simply not identified in any plan. In some plans where the areas were listed, they were not prioritized.
    - In few instances, ESAs did have protection strategies for the areas that were most heavily impacted.
    - The equipment, trained personnel, and other response resources needed to implement the protection strategies were not included in many plans.
    - While many responders stated that impact to wildlife and habitat could have been much worse in the Deepwater Horizon incident, there is a consensus among team members that, had ESAs been given appropriate attention during the planning process, the adverse impacts could have been much less. ESAs have been given uneven, and in some cases, inadequate attention in the ACP development process throughout the Gulf of Mexico. There must be a comprehensive national planning process that identifies ESAs and assures that there are trained personnel, equipment, and strategies adequate to protect these resources. The Coast Guard needs to work with Federal, State, local, tribal, and natural resource trustee stakeholders to select an exemplar among those ACPs that adequately addresses ESAs and make that a benchmark for future planning efforts.

The use of two alternative response technologies, **dispersants and in situ burning (ISB), proved critical to prevent wholesale impacts to ESAs** because the characteristics of the spill were favorable to the use of both technologies. However, **important concerns and questions remain about their impacts on the environment, and more research is necessary before bringing them into the mainstream of spill response options**.

- Although pre-authorization of dispersant use was approved by the Regional Response Team (RRT) and implemented by the Federal On-Scene Coordinator (FOSC), significant public concern was expressed over the volume being used and toxicity of the dispersants, causing EPA to develop protocols for dispersant application and monitoring.
    - While the FOSC always has the authority to approve use of dispersants to protect human life, in this case, to control volatile organic compounds in the source area, EPA intervened to address the volume and toxicity issues, as well as subsea application at the source. **This resulted in a temporary suspension of dispersant application, which**

may have resulted in more oil reaching the coastline.

- While the issue of subsea application may not have been reasonably foreseen, **other issues such as toxicity and volumetric limitations should have been foreseen as part of the National Oceanic and Atmospheric Administration/Environmental Protection Agency preparedness programs, and should have been researched and addressed well before this event.**

- The use of dispersants in the Deepwater Horizon incident identified a need for a thorough review of this response option, its efficacy in minimizing environmental impacts, its overall effect on the environment, and conditions under which they are most effective. Dispersant protocols and authorization procedures should be established and articulated in ACPs, and the degree to which dispersants may be used in ESAs should be addressed.

Reference: https://www.uscg.mil/foia/docs/dwh/bpdwh.pdf

EPA Subpart J Proposed Rule

The EPA representative to the RRT, the Department of Commerce and the Department of the Interior natural resource trustees and, as appropriate the RRT representative from the state(s) with jurisdiction over waters and adjoining shorelines within the preauthorization plan area shall review and either approve, approve with modification, or disapprove **the preauthorization plans developed by the RRT and/or the Area Committees.**

Reference: https://www.epa.gov/emergency-response/revisions-national-oil-and-hazardous-substances-pollution-contingency-plan

API Comments on Subpart J

API General Comments
(pg 1-2) To this end, woven into every operational endeavor are release prevention measures, preparedness methods and plans for rapid, effective response should an incident resulting in a release occur. Developed alongside regulatory agencies, operators submit to and follow a distinct set of response principles which protect shared values. The framework by which these principles are employed and tradeoffs are made in order to protect these shared values is called Net Environmental Benefit Analysis (NEBA). NEBA is a process used by the response community for making the best choices to minimize impacts of oil releases on people and the environment. NEBA aids in protecting people and the environment, and is the matrix through which every decision is made in a response event. In the offshore context, oil dispersing agents are a primary tool in the NEBA process and the response toolkit, as they are a principal tool used for protecting human health and defending environmentally sensitive areas. When a release occurs, judgment and response speed are critical. In an offshore setting, dispersants are essential in creating a safe environment and are a key ingredient in marshaling an effective, swift response.

(pg 4-7) *A Net Environmental Benefit Analysis Process Ensures Response Choices that Minimize the Impacts of Oil Spills on People and the Environment*
Any changes to the rule must take into account the Net Environmental Benefit Analysis (NEBA)[2] process. When a spill occurs, the OSC must make time-critical choices about which response options to implement immediately and effectively to manage the potential impacts of the spill. The NEBA process helps the OSC select choices that minimize the impacts of the spill on people and the environment. **NEBA is a consensus-based planning tool** that is used to bring natural resource trustees, regulators and stakeholders together to

address resource-management decision-making needs for an oil spill response. It provides a structured, scientific method to evaluate the likely net reduction, or possible increase, **in environmental and socio-economic impacts** resulting from the implementation candidate response options as compared to the natural recovery or "do nothing" alternative. An assessment of the trade-offs associated with each option is then conducted taking into consideration the potential impacts to sensitive environmental resources and local community values. The NEBA process determines which response option or combination of options can best reduce the overall impact of spilled oil to common values and promote the fastest overall ecosystem recovery. **Of particular note, the NEBA process considers the potential effects to a wide range of concerns, ranging from likely environmental effects (i.e., deep marine to terrestrial, etc.) to possible economic consequences**. When initially considering the potential outcomes, no individual area receives a greater priority over another. Instead, all are weighed from an equal footing and only after evaluating all the likely effects is a determination made regarding the response option that offers that greatest environmental benefit. In so doing, **decision-makers ensure that an unbiased process is used, with input from relevant stakeholders,** to determine the best course of action. This process has been adopted all over the world to identify response methods that will yield the greatest benefit with the least impact.[3]

The NEBA process can be used in both oil spill preparedness planning and response. In the United States, **a formal NEBA process is conducted during the planning phase at the Area Committee and Regional Response Team (RRT) levels with input from state and Federal participants to determine the benefits and limitations from using each response technology within their individual areas of responsibility. In most offshore regions of the U.S., this is accomplished in the form of the Consensus-Based Ecological Risk Assessments (CERA) process (NEBA equivalent) used by the U.S. Coast Guard (USCG)[4] and supported by the National Oceanic and Atmospheric Administration (NOAA), EPA, other Federal and state agencies, and academia.** More than twenty workshops were held in various locations around the continental U.S., Caribbean, and Alaska from 1995 to 2011 to compare the benefits and risks of various response options when considering resource trade-off decisions. All of the workshops resulted in final publications (available from USCG) that were delivered to the Area Committees and RRTs to assist with response planning. One example of how this CERA/NEBA process was used to inform dispersant use decision-making is summarized in several papers authored by regulators in the state of California.[5] The applicability of the CERA/NEBA process as a tool for facilitating dispersant decision-making during spill response and planning was also evaluated by NOAA and published in a 2008 paper.[6]

In 2014, the practice of incorporating a NEBA review during Source Control drills in the Gulf of Mexico was implemented by RRT VI during several large scale spill response exercises,[7] which has fostered good cooperation between the agencies to focus on the goal of minimizing shoreline community and ecosystem impacts by selecting response options that can maximize the effective treatment of oil offshore. NEBA discussions during both of these recent spill drills resulted in the concurrence of the RRT to authorize dispersants (both aerially and subsea) to treat the offshore oil slick.

Government decision-makers and/or the Responsible Party can conduct a rapid NEBA during actual spill responses to compare and rank the strengths and weaknesses of different response options for the incident-specific conditions. Lessons learned following a spill are incorporated into future policies and plans. Ecological recovery studies of the 1996 *Sea Empress* spill in the UK demonstrate the benefit of dispersant application along the coastline to prevent persistent oil from stranding in shoreline habits.[8] A more recent publication examined the recovery rates for a tropical ecosystem during a controlled study of dispersed versus untreated shoreline oil slicks and concluded that better recovery occurred in the areas where dispersant was used.[9]

Regrettably, the Proposed Rule lacks a NEBA perspective. It incorrectly focuses on intrinsic, hazard-based criteria for substance listing and ignores the more appropriate risk-based trade-off decision process responders must consider during an oil spill response. It does not recognize that dispersants are only applied when regulators and response decision-makers deem them necessary to prevent more significant and harmful consequences. The Proposed Rule favors protecting pelagic and benthic species while putting **critical habitats, such as the ocean's surface and near-surface zones,** as well as sensitive shorelines, at greater risk to

environmental damage. **Modeling results** presented at the 2005 International Oil Spill Conference concluded that:

> *"...the **results of the modeling** support the contention that there are more opportunities to save wildlife, shorelines, and sensitive habitats along the shore with dispersant use than there are risks of impacting water column biota. If the areas that would be impacted by surface oil are those where wildlife are concentrated, as they typically are near shore, and the water column impacts resulting from dispersant use would be offshore where water column biota are lower in abundance, the trade-off is much more heavily weighted toward dispersant use before oil comes near the shoreline. In fact, for medium or smaller spills, or even larger spills where sensitive species and life stages are not present, the impact of dispersant use on water column biota could be negligible."*[10]

For oil spills where dispersant use is contemplated, a typical NEBA will predict the potential impacts to aquatic organisms from an increased exposure to dispersed oil droplets. Dispersant use is typically restricted to water depths greater than 10 to 20 meters so that dilution will minimize exposure or impacts to the benthic community. Studies have shown the dispersed oil concentrations are rapidly diluted within the large volume of receiving water from a high of a few hundred parts per million to a few parts per million within a few hours. Consequently, exposure to the toxic effects of the dispersed oil will be of short duration and limited to those aquatic organisms that inhabit near surface waters. The NEBA will also estimate the reduction of impacts to waterfowl, shoreline ecosystems and coastal communities resulting from the reduction in, or elimination of, the quantity of floating oil. The trade-offs of a short term increase in exposure of selected aquatic organisms to dispersed oil versus an increase in oil impacting coastal environments and communities must be evaluated and take into account local community values to determine if dispersant use is warranted.

Given the challenges of implementing other response options, a decision not to have dispersants available to responders could result in oil stranding on shorelines where it may persist for an extended time. Effectively dispersed oil will biodegrade rapidly so that the majority of the oil will persist for a much shorter period of time. Reducing the persistence of the oil in the environment is critical to reducing the overall impacts.[11] This is not to say that water column organisms are less intrinsically important than surface or shoreline species but using NEBA can and does provide a critical framework for deciding what is best for the overall ecosystem. Important considerations to understand in assessing this tradeoff include:[12]

- The impacts to the water column are mitigated by dilution – that is the potentially toxic levels of dispersed oil are limited in duration and physical coverage/extent and effected populations (e.g., plankton) tend to be ones that recover quickly.
- Oil effectively dispersed in the water column will generally biodegrade after a few days or weeks while oil stranded in near shore and shoreline areas can persist for years.
- Near shore and shoreline areas are the nursery grounds for many species, even those that live offshore as adults, so protecting the near shore areas also protects organism that live as adults offshore.
- The bio density of near shore areas (swamps and marshes) is far greater than the bio density in pelagic waters offshore.
- Dispersants also protect surface dwelling organisms offshore, i.e., marine mammals, birds, and turtles, through removal of floating oil.
- Slicks on the water surface are far more likely to impact fish eggs and larva that tend to float at or near the water surface than quickly removing oil from the surface with dispersants.
- In certain geographies, slicks can impact mangroves and other shoreline vegetation that can subsequently die off and result in shoreline erosion that increases sediments in the near shore water column and potentially affects corals and other species.

The Agency should consider the NEBA process and how and why dispersants are used before making changes to the Subpart J Regulations.

[2] NEBA is similar to the Consensus Ecological Risk Assessment (CERA) process developed by the U.S. Coast Guard in the mid-1990s.

[3] See, Incident management system for the oil and gas industry: good practice guidelines for incident management and emergency response personnel, IPIECA, August 2014, http://www.ipieca.org/publication/incident-management-system-oil-

and-gas-industry-good-practice-guidelines-incident-manage.
[4] Aurand, D., Walko, L., & Pond, R. (2000). Developing consensus ecological risk assessments: Environmental protection in oil spill response planning. Washington, D.C.: U.S. Coast Guard.
[5] Addassi, Y. N., & Faurot-Daniels, E. (2005). California oil spill dispersant plan-Achievement through cooperation. Proceedings of the 2005 International Oil Spill Conference, 2005(1), 433-437. doi:10.7901/2169-3358-2005-1-433; Addassi, Y. N., Sowby, Parker-Hall, H., & Robberson, B. (2005). Establishment of dispersant use zones in the state of California: A consensus approach for marine waters 3–200 nautical miles from shore. Proceedings of the 2005 International Oil Spill Conference, 2005(1), 187-191. doi:10.7901/2169-3358-2005-1-187.
[6] Mearns, A., & Evans, M. (2008). Evaluating the consensus ecological risk assessment workshop as a tool for facilitating decision-making during spill response and planning. *Proceedings of the 2008 International Oil Spill Conference Proceedings, 2008*(1), 739-741. doi:10.7901/2169-3358-2008-1-739
[7] **Freeport McMoran Source Control drill (April 30-May 1, 2014) and BP Source Control drill (Nov 5-6, 2014)**
[8] Lunel, T., Rusin, J., Bailey, N., Halliwell, C., & Davies, L. (1997). The net environmental benefit of a successful dispersant operation at the Sea Empress incident. *Proceedings of the 1997 International Oil Spill Conference, 1997*(1), 185-194. doi:10.7901/2169-3358-1997-1-185
[9] Baca, B., Rosch, E., DeMicco, E. D., & Schuler, P. A. (2014). TROPICS: 30-year follow-up and analysis of mangroves, invertebrates, and hydrocarbons. *Proceedings of the 2014 International Oil Spill Conference, 2014*(1), 1734-1748. doi:10.7901/2169-3358-2014.1.1734
[10] **French McCay, et al., Modeling Fates and Impacts of Hypothetical Oil Spills in Delaware, Florida, Texas, California, and Alaska Waters, Varying Response Options Including Use of Dispersants**. International Oil Spill Conference Proceedings: May 2005, Vol. 2005, No. 1 pp. 735-740. Also available at http://ioscproceedings.org/doi/pdf/10.7901/2169-3358-2005-1-735.
[11] Hazen, et al., Deep-Sea Oil Plume Enriches Indigenous Oil-Degrading Bacteria, Science, 330 (2010), pp. 204-208.
[12] (a) French McCay, D., and Graham, E. Quantifying Tradeoffs – Net Environmental Benefits of Dispersant Use. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 762-775.
(b) McManus, M.A., Woodson, C.B. Plankton Distribution and Ocean Dispersal. The Journal of Experimental Biology, 215 (2012), pp. 1008-1016.
(c) DeMicco et al., Net Environmental Benefit Analysis (NEBA) of Dispersed Oil on Nearshore Tropical Ecosystems: TROPICS – The 25th Year Research Visit, International Oil Spill Conference Proceedings, May 2011, Vol. 2011-282.
(d) Varela et al., The Effect of the "Prestige" Oil Spill on the Plankton of the N-NW Spanish Coast. Marine Pollution Bulletin 53 (2006), pp. 272-296.
(e) Addassi, et al., Establishment of Dispersant Use Zones in the State of California: A Consensus Approach for Marine Waters 3-200 Nautical Miles from Shore. International Oil Spill Conference Proceedings: May 2005, Vol. 2015, No. 1, pp. 187-191.

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Dispersant Toxicity Tests do not Accurately Simulate Real World Exposures.

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(pg 9) In the context of NEBA (and its forebear, the Consensus Ecological Risk Assessment, or CERA), scientists understand and accept that marine organisms may experience localized, transient toxic effects from exposure to dispersed oil, but these local effects are offset by the benefit of dispersant use in preventing or minimizing oil drifting ashore and causing severe and long-term harm to more sensitive coastal resources and communities. **While knowledge of the potential for toxic effects to marine organisms is useful for conducting a NEBA, it cannot be the sole indicator that dictates the use of dispersants.** All resources-at-risk as well as coastal communities must be considered in the response option decision-making process, with the emphasis on coordinating a response that will result in the least overall impacts while promoting the most rapid overall recovery of the affected ecosystem.

Section § 300.910 Authorization for Agent Use

The Unified Command (UC) determines the best use of response assets on a daily basis.

(pg 14) EPA should not establish a policy or rule that mechanical recovery is always the priority

choice of countermeasures to use in a response. In the preamble for this section (column 1, 80 Fed. Reg. 3387), the Agency makes the following statement:

> *"During the DWH response, a priority countermeasures scheme was established to first use mechanical recovery via skimming/booming or in-situ burning followed by subsea dispersant and lastly surface dispersant use."*

This may have been the conceptual prioritization from the perspective of EPA, but in reality dispersants played a much larger role and it was the responsibility of the UC to determine the best use of response assets on a daily basis to account for weather conditions, VOC suppression, oil slick locations, response equipment availability, etc. Every spill is different and specific references to a single spill event can indirectly and inappropriately be perceived as a recommended practice and should be avoided. In any spill scenario, all response tools must be used to their maximum effect. The Agency's unprecedented use of "Directives" during the DWH incident severely limited the use of dispersants and **circumvented the NEBA decision-making process allowing significantly more oil reaching the water's surface and, subsequently, the shoreline.** This resulted in additional environmental impacts with no documented benefits to the marine ecosystem.

The Agency should reconsider this statement and prioritization as it puts unneeded complexity into the response decision-making process and inappropriately prioritizes mechanical recovery over other response options. The effectiveness of mechanical recovery can be limited in large, offshore spills as a result of typical environmental conditions, such as wave action/height or wind conditions as well as the extensive surface area that must be covered. **Further, the Agency's artificial prioritization of this technique over other viable response options is contrary to the NEBA concept to determine the best blend of response options (with no pre-determined or pre-existing bias) to achieve the best overall protection and recovery for the ecosystem.**

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Proposed changes involving preauthorization planning will increase the workload of all Regional Response Teams (RRTs) and Area Committees (AC) and restrict their flexibility.

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(pg 16) The Agency must provide specific examples to show how this rule assists responders, particularly in relation to the OSC duties of making timely operational decisions, **especially those decisions based on using the concept of NEBA to guide a response.**

Section § 300.910(a) Use of Agents Identified on the Schedule on Oil Discharges Addressed by a Preauthorization Plan

Area Committees should identify shoreline habitats that can benefit from the appropriate use of dispersants.

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(pg 17) API and NOIA support the requirement that Area Committees should identify shoreline habitats that can benefit from the appropriate use of dispersants or other response methods. **This will advance the use of the NEBA concept.** Note that many of these resources are already identified in Area Contingency Plans.

Section § 300.910(a)(1) Preauthorization Plan Development
Dispersant use should not be limited by the preauthorization plan.

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(pg 19) If the Agency wants to determine whether and how to limit dispersant use, we propose a joint EPA/industry study of existing research results to provide scientific credibility to any limitations that are established. Without scientific justification, artificially-set limitations on dispersant use would threaten the intent of using NEBA to support response decision-making and would limit the OSC's ability to make the best overall decision concerning the actual scenario and the environment.

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We suggest that the Agency confer with other Federal agencies involved in oil spill planning and response and revise the language in the Proposed Rule to specify that preauthorization should rely on the concepts of CERA/NEBA as the foundation for plans and response decisions, not on artificially set limits on dispersant volumes. The USCG has conducted more than a dozen CERAs to help inform the decision-making process, but **the Proposed Rule appears to contradict the CERA/NEBA tenets that were previously used to define preauthorization zones.**

Section § 300.910(b) Use of Agents Identified on the Schedule on Oil Discharges Not Addressed by a Preauthorization Plan

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(pg 23) ***Early dispersant use decision-making should focus on documenting that a NEBA justification exists to support dispersant application.***
The Proposed Rule would unnecessarily establish new requirements for an OSC to document the parameters used to authorize dispersants. This is discussed in the same section (column 2, 80 Fed. Reg. 3423), as follows:

> *"...the OSC must consider and document the parameters for the use of agents including the quantities to be used, the duration of use, the depth of water, the distance to shoreline and proximity to populated areas, and should address factors such as environmentally sensitive resources or restricted areas that might be impacted, agent inventory and storage locations, agent manufacturing capability, availability of equipment needed for agent use, availability of adequately trained operators and appropriate means to monitor agent use in the environment."*

Because dispersants have a limited window of opportunity to be used on spills, it is important to decide quickly on their use. Decisions by the OSC should not be delayed to complete information that is not needed.

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As such, we believe that the immediate actions by the OSC should include a review of the pre-authorization plan(s) and **a rapid, incident-specific NEBA to support the selection of response options that may include dispersant application as a means to lessen or eliminate impacts to sensitive shoreline resources or to protect worker health and safety.**

Section § 300.910(g) Supplemental Testing, Monitoring, and Information

(pg 28) *API believes the standard efficacy and toxicity tests already required are more than adequate for regional use.*

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Regional data are unlikely to fundamentally change overall NEBA considerations for dispersant use.

Section § 300.910(h) Recovery of Agents from the Environment

The OSC has the authority to use the NEBA process to make decisions on recovery of agents from the environment.

(pg 29-30) In the preamble to this section, the Agency is requesting comments on new language that would require the Responsible Party, under OSC oversight, to remove specified products/agents from the environment after use. While the Proposed Rule hints at NEBA, it does not reference it specifically when suggesting that some situations (e.g., safety of personnel or greater harm to the environment) might preclude the removal of these agents. That would seem to contradict the main change in this section (h) while not providing any framework (e.g., NEBA) in which to make a determination for precluding the removal. The language is also potentially redundant as the OSC is already obligated to consider safety and additional adverse environmental impacts (i.e., via NEBA) as part of the normal decision-making process. Essentially, it is already an underlying tenet of the response process. Additionally, in some cases recovering 100 percent of these agents after application is not practical or even feasible regardless of the diligence of the Responsible Party

We suggest revising the proposed language to make it clear that the OSC has the authority to use the NEBA process to make these decisions:

> *(h) Recovery of Agents from the Environment. Depending on factors such as the safety of response personnel and harm to the environment (including consideration of Net Environmental Benefit Analysis [NEBA]), and as directed by the OSC, the Responsible Party shall, following application, endeavor to adequately contain, collect, store and dispose of the agents that are intended to be recovered from the environment.*

Section § 300.913 Monitoring the Use of Dispersants

The appropriate use of spill mitigating products will reduce the overall impact of the spill and protect the health and safety of response personnel.

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(pg 30-31) The main threat to response personnel, communities, and the ecosystem comes from the oil, not from the spill mitigating products. The concept of CERA/NEBA accepts that some effects might be caused by the response (including the use of spill mitigating products), but also recognizes the greater benefit of reducing the overall impact of the spill that can be achieved by using them. The Agency needs to acknowledge the importance of NEBA in justifying the use of dispersants.

We believe that the focus on the potential for negative environmental impacts that could be caused by a dispersant ignores the essential point that dispersants are used to mitigate (minimize) the negative human health and environmental impacts that could be caused by the oil. The main threat to the ecosystem comes from the oil itself, not from the dispersant. The wording of the preamble to a final rule needs to:

- reflect the ultimate aim of dispersant use;

- clarify that the toxicity of dispersed oil comes from the oil (not the dispersant); and
- acknowledge and emphasize the importance of using a NEBA process in dispersant use decision-making.

We request that the Agency consider including the following two paragraphs (or equivalent language) in the preamble to the final rule to briefly explain dispersant use and the importance of NEBA in making dispersant use decisions.

> *"Dispersant Use and Net Environmental Benefit Analysis (NEBA)*
> *The aim of dispersant use is to protect response personnel from VOC exposure and to prevent oil from drifting ashore and potentially causing severe and long-term damage to coastal resources and communities, by dispersing the oil into the water column where it will be diluted rapidly to very low concentrations and the majority of the oil will subsequently be biodegraded. This common aim of dispersant use is the same, whether it is applied to oil on the sea surface or directly at the outflow source in the case of a subsea release. The potential risk of dispersant use is that, by dispersing the oil into the water column, there is an increased potential for toxic effects to be caused to marine organisms. The severity of the toxic effects that could be caused is related to the exposure of the marine organisms to the dispersed oil (or the partly water-soluble oil compounds) and exposure is a function of concentration of the oil in the water and the duration for which such exposure persists.*
>
> *The issue of the environmental trade-offs caused by dispersant use is addressed by Net Environmental Benefit Analysis (NEBA). NEBA is a process used to make choices about oil spill response techniques to be used to minimize the potential impacts of the oil on people and the environment. NEBA takes into account the likely effectiveness and feasibility of conducting alternative response techniques under the prevailing conditions. The main principle of NEBA is that an oil spill response technique (or combination of techniques) that is used should be that which minimizes potential impacts of the oil on the environment to the greatest extent and promotes the most rapid recovery and restoration of the affected area. In many cases of dispersant use, the potential risks to the offshore marine ecosystem are very low because dispersed oil concentrations are low and persist only briefly. There is benefit in using dispersants in offshore environments to prevent damage to coastal communities and sensitive near-shore resources where persistent stranded oil can cause longer-term environmental problems."*

The Proposed Rule also appears to focus more on the environmental effects during the response rather than the health and safety of response personnel. The Agency should make it clear that one of the primary objectives of characterizing the efficacy and understanding transport is to protect the health and safety of response personnel. That critical aspect is not mentioned in this section.

Section § 300.913(a) Documenting and Monitoring the Oil Discharged and Dispersants Used Requirements
The Responsible Party should not be required to document information at the beginning of a response that has already been determined in planning and preparedness activities.

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(pg 35) Given current dispersant stockpiles in the U.S. and in the Global Dispersant Stockpile, it should be assumed that sufficient dispersants will be available if their use is warranted by NEBA.

Section § 300.913(d) Ecological Receptor Characterization
Monitoring required to determine possible environmental effects is too time consuming to support dispersant operations decisions.

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(pg 40) Rather than requiring the Responsible Party to make this real-time assessment [species sensitivity distributions (SSD)], a CERA/NEBA process (conducted as part of contingency planning) should serve as the basis to make operational decisions on whether dispersants and/or other agents should be used during a response. A CERA/NEBA is the only mechanism that allows a full environmental trade-offs analysis of all response options to be conducted.

Section § 300.913(e)(1) Daily Sampling and Data Analyses Reporting
The Agency should not develop requirements for daily authorizations of dispersant quantities.

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(pg 40) Furthermore, it [placing daily limits on volumes of dispersants] circumvents the NEBA process that evaluates the best response options that protect the environment as a whole.

Section § 300.913(e)(2) Immediate Reporting of Ecological Receptors
Real-time ecological receptor analysis is unrealistic and should be part of a CERA/NEBA process.

(pg 41) The requirement in this section for real-time ecological receptor analysis is unrealistic. Such efforts need time and broad stakeholder participation to be meaningful. This information should be part of a NEBA process to document the resources at risk of the potentially affected ecosystem. Only through this detailed NEBA process can an adequate understating of overall ecosystem recovery be developed and assessed. Further, the process of overall environmental trade-offs is independent of individual species impacts and should be based at the ecosystem level.

Section § 300.915(b)(2) Dispersant Toxicity tests and listing criteria

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Testing of dispersants using the developmental assay for the purple sea urchin is not relevant.
(pg 47) The relevance of this test [EPA test protocol involving sea urchin embryos], which was developed for the assessment of wastewater effluents, to dispersant use is highly questionable. Again, trying to estimate potential real world consequences to dispersed oil exposure should be part of a NEBA decision-based process. The environmental trade-offs of using dispersants in offshore environments to protect sensitive shoreline habitats from oil exposure is being circumvented.

Dispersant testing should only be used for screening individual dispersant products.

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(pg 48) In summary, the Agency's suggested toxicity testing changes in the Proposed Rule do not take into account the essential role of NEBA in considering the potential benefits and risks of dispersant use as a response option for an offshore oil release. The Product Schedule should focus on the basic testing

to compare the efficacy and toxicity of the dispersants against each other with the sole purpose of screening good products that should be listed. The Proposed Rule should not attempt to translate any laboratory data into possible real-world implications. This process should instead be defined by full stakeholder NEBA discussions specific to a given spill scenario.

Conclusions

(pg 51) The Proposed Rule does not recognize that response option decisions must be based on NEBA and that dispersing oil in offshore environments, where it may dilute and biodegrade, is often preferred over the long-term environmental damages that will occur when untreated oil strands and persists in shoreline environments;

Gulf ACP Updates http://www.rrt6.org/ResponsePlans.aspx

Area Committee defined in the NCP (40 CFR 300.5): Area Committee (AC) as provided for by CWA sections 311(a)(18) and (j)(4), means the entity appointed by the President consisting of members from qualified personnel of federal, state, and local agencies with responsibilities that include preparing an area contingency plan for an area designated by the President.

BSEE Well Control and Arctic Rules

Arctic Rule (6-27-2016 version)

Previous draft BSEE preamble stated: "Oil discharged into the environment will always result in the potential for some level of toxic effects to organisms and their habitat. Spill response countermeasures have the potential to reduce or mitigate these toxic effects. **Conducting net environmental benefit analyses is the best way to plan for and make operational decisions regarding which spill response countermeasures will result in the most effective reduction of the harmful effects of spilled oil**." (pg 178).

- EPA commented that the preamble "Should be clearly highlighted here that the analysis "to plan for and make operational decisions regarding which spill response countermeasures" to use is conducted as part of the ACP/RCP process as described elsewhere in this preamble."
- BSEE's response: deleted text at issue – not necessary to response. (the entire text cited above)

Previous draft BSEE preamble stated: BSEE also supports the use of a process to compare the environmental outcomes associated with using various response techniques and countermeasures in order to assess and select the most appropriate response technologies for use during an event. However, the selection and use of response technologies during a spill event is governed by EPA regulations contained within the NCP, and by the FOSC, which is a pre-designated senior USCG official. BSEE is not dictating the selection or use of any particular strategies for responding to any specific spill situation through its regulations or the OSRP process. **BSEE does have a separate regulatory rulemaking study underway that is considering a requirement for all OSRPs to include the use of an assessment process that would evaluate the environmental tradeoffs of various response countermeasures in their planning for a response**. (pg 258-259)

- EPA commented: How is this not relevant to the RCP/ACP effort, as opposed to the OSRP, which have the "…focus and purpose is to address how the operator will supply, manage, and sustain the necessary response resources for implementing the strategies and tactics." as stated in BSEE's response below?
- BSEE response: Revised – deleted language (in the bold text)

"One commenter recommended that strategies and tactics listed in the OSRP, including use of dispersants and burning, should be based on the latest regional-specific research, historical oil spill data, field tests conducted by the operator or its Oil Spill Response Organization (OSRO), and exercises, and environmental analysis.

While BSEE agrees that response strategies and tactics should be informed by all the methods recommended by the commenter, **BSEE disagrees with their assertion that plan holders are responsible for gathering this information, or that plan holders are responsible for field testing or validating these strategies and tactics as part of the process of developing and submitting their OSRPs. Rather, response strategies and tactics are developed and approved for use geographically and temporally, and should be exercised and validated by the Regional Response Teams and Area Committees, and should be contained in the appropriate RCPs and ACPs.** As such, Regional Response Teams and Area Committees would be the appropriate entities to review ongoing trends, new research or testing information, and to adjust the response strategies in the RCPs and ACPs accordingly. While OSRPs must be consistent with the strategies and tactics identified for use in the relevant RCPs and ACPs, their focus and purpose is to address how the operator will supply, manage, and sustain the necessary response resources for implementing the strategies and tactics."

"Two commenters recommend that the requirements in § 254.80 should contain specific protection and

response strategies and maps for environmentally sensitive areas and subsistence resources. One of the commenters further suggests that plan holders should have response personnel and equipment pre-staged near those sensitive sites, and that the strategies and equipment should be tested through a plan holder's exercise program, prior to being included in an OSRP.

While BSEE agrees protection and response strategies for sensitive resources are a critical part of oil spill response, **BSEE disagrees that these strategies should be developed by industry plan holders, nor does BSEE believe it is feasible for a plan holder to pre-stage personnel and equipment throughout the Arctic wherever sensitive resources might be located. The correct place for the development of protection and response strategies for sensitive areas and resources, in accordance with guidance in the NCP, is in the ACP.** In this case, the appropriate place would be within the North Slope SubArea Contingency Plan. Existing regulations do, however, require that operators address strategies for protecting environmentally sensitive areas in their OSRPs. See, e.g., §§ 254.23(i)(3)-(4); 254.26(c). BSEE does not believe that further treatment of this issue is necessary in § 254.80. The Alaska Regional Response Team and the North Slope SubArea Committee are responsible for testing and validating these strategies. **It is not the responsibility of an industry plan holder to develop these geographical response strategies, nor is it a requirement for a plan holder to test any strategies listed in an ACP prior to referencing them in their OSRP."**

DWH NRDA

RRT 6 Industry Liaison Committee
RRT VI Subsea Dispersant Use - Guidelines for Industry on Requesting Concurrence with Subsea Dispersant Injection (SSDI) Decisions

Prepared by: RRT VI Industry Liaison Committee (ILC) and API D3 Subsea Dispersants Joint Industry Task Force (JITF) - March 2015

API OSRP Guidance document review

OGC added the disclaimer: "This document does not necessarily reflect the opinions of the regulatory community, has not been approved by the regulatory community, and does not constitute an endorsement of this RP by the regulatory community"

- API response: "**Disagree.** At EPA's request, we deleted all references to EPA being part of the work group but considered all comments they provided even though only work group members were allowed to submit comments. Additionally, USCG and BSEE did not take exception to being listed as members of the work group but in consideration of EPA's request that no federal agencies be mentioned, BSEE and USCG felt just referring to participation by the "regulatory community" would at least partially satisfy EPA's request. **Since this statement is EPA's position and not that of USCG or BSEE, it will not be included in the final RP**."

API document state: The recommendations developed by the Workgroup in Section 3 include a number of features and concepts that were incorporated into the design of this RP."

- EPA requested that "…by the Workgroup…" be changed to "…in coordination with the Workgroup…".
- API response: "**Disagree – The recommendations were developed by the workgroup** not in coordination with another unnamed entity."

API document state: "The content recommended by this RP was, however, benchmarked against BSEE's regulations (30 CFR Part 254 and associated guidance in NTL 2012-N06) and found to be in general compliance but will depend on the specific information plan holders include in each section.

- EPA stated that "Compliance determinations are made by regulatory agencies and are specific, not general." And requested that the statement be changed to "…API believes them to be found to be in general compliance…."
- API's response: "**Disagree. The workgroup found them to be in general compliance and not API.**"
- Caplis email [August 4, 2016]: "I agree with your thoughts about compliance."

AIP OSRP document includes a section on Net Environmental Benefit Analysis (NEBA) [Section 6.3.2] and cites references that haven't been published and don't appear to be currently available: Response Strategy Development Using SIMA, API 2016 and Guidelines on Implementing Spill Impact Mitigation Assessment, SIMA, API/IPIECA/IOGP 2016.

Although the document states refers to applicable regulatory authorities in establishing specific worst-case discharge criteria, Annex B instructs the plan holder to "**Describe how and why the worst-case discharge scenarios were selected, referring to the oil spill risk and impact analyses conducted by the plan holder**." In response to a previous comments on WCD planning scenario, API noted that the sentence "**Planning Scenario selection should also consider those with unique circumstances, such as relatively close proximity to shore or sensitive resources**, or resource requirements such as sour or Group V oils as well as **those that represent a variety of potential environmental impacts**" was added to address a BSEE comment that special consideration be given to facilities that are close to shore or possess unique characteristics in addition to the facility with the WCD. API section on Oil Spill Impact/Consequence Analysis [Section B.3] contains similar factors cited in API NEBA documents.

March - May 2016 - API Industry Guidelines on Requesting Regulatory Concurrence for Subsea Dispersant Use - API BULLETIN 4719 - Draft

Reincarnation of the RRT VI Industry Liaison Committee efforts that were of concern last year. We took issue with some of their statements.

Sections include:

Introduction
Scope
Terms, Definitions, and Abbreviations

- Overview

Summary of Core Information Submitted to Regional Response Teams
Evaluating the Use of Subsea Dispersant Injection
Use of Modelling to Support Response Decision-making
Use of Subsea Monitoring to Support Response Decision-Making
Importance of Effective Data Management Techniques

- **Use of NEBA to Support Response Decision-Making**
- Methods traditionally used for evaluating the potential net environmental impacts of various response technologies include Net Environmental Benefit Analysis (NEBA), and Consensus Ecological Risk Assessment (CERA). Such analyses are typically conducted in support of planning activities, but the principles and some of the methods employed can also be used during response actions, or response simulations and drills. Such analyses are typically referred to as "expedited or qualitative NEBAs" or "Environmental Trade Off Analyses". During drills or exercises, unless a NEBA has been conducted through applicable planning activities that take the release scenario into account, an "Expedited NEBA" should be conducted and included as part of the RRT concurrence package.

Regional Response Team Concurrence Request Process
Incident Command System Positions with Significant SSDI Roles
Annex A - Recommended Submittal Elements for SSDI Approval Request
Annex B - Summary of Primary Response Options
Annex C - Example Timeline for Utilizing Subsea Dispersant Injection
Annex D - Subsea Dispersant initial Injection Rate Calculation
Bibliography

Even though this is supposed to be Industry Guidelines, the document directly references to RRT VI, stating that its offering a "clarification on how RRT VI has interpreted requirements of 40 CFR Section 300.910 as applied specifically to subsea dispersant use…" It also characterizes other parts of the NCP, as well as roles and responsibilities under the Incident Command Structure / Unified Command.

API characterized the guidelines as describing the RRT concurrence request process, proposed information submission recommendations that are specific to subsea dispersant injection and the use of Net Environmental Benefit Analysis (NEBA) and other forms of tradeoff analyses as decision support tools.

PREP 4C Guidelines

BSEE Incident Management Team Exercises - Objectives

BSEE ORIGINAL: **Demonstrate the ability to apply and coordinate the use of multiple countermeasures based on an informal, incident-specific net environmental benefit analysis** and the response Concept of Operations as outlined in the OSRP.

FINAL: Ability to select and propose the use of an optimal mix of response countermeasures to the FOSC, **based on an assessment of the operational feasibility, expected effectiveness, and projected environmental tradeoffs associated with using each countermeasure.**

EPA questions for BSEE (Nov. 4 2015)

What is the process to conduct a "NEBA"?
What is the specific process that is used to conduct a NEBA? We are aware of USCG's "Developing Consensus Ecological Risk Assessments", where an Ecological Risk Assessment (ERA) is defined as "a process through which to evaluate the possible ecological consequences of human activities and natural catastrophes. An ERA emphasizes the comparison of exposure to a stressor or stressors (i.e., oil and/or the response options) with an ecological effect (e.g., population disruption, changes in ecological community structure or function, toxicological effects). As much as possible, this comparison is made quantitatively, including an estimation of the probability that the predicted consequences will occur and of the associated severity and magnitude of the effects. "In addition, the ERA recognizes its uncertainties and explains the limits of the analysis. However, it is unclear if the reference to NEBA in the 4C guidelines is intended to reflect a similar type of analysis. We are suggesting edits because of concerns that NEBA appears to be used as a general justification solely for protection of the shoreline without considering all of the potential ecological effects.

What is the scope of a NEBA?
The only place that NEBA is referenced in the 4C guidance is in this BSEE/IMT section. What information (including site specific) is required to be considered in a NEBA? BSEE is requiring the plan holder to develop an "informal, incident specific NEBA". What does this owner/operator ecological risk assessment addresses? Do they include relevant information contained environmental impact analysis regulations that is required per 30 CFR 550, for EPs and DPPs?

What is an "informal, incident-specific NEBA"?
How does this process differ from a "formal" NEBA? The preamble does not have any comments or discussion on including a NEBA as part of IMT exercises. So it is unclear what led to this language being inserted.

NEBA relative to chemical countermeasures.
We understand that the reference to NEBA in this document is to assessing "the use of multiple counter measures" (which would include mechanical). However, it is our understanding that at least some regulated industry believe that NEBA is used solely in support of the use of chemical countermeasures, particularly dispersants. The concern is that the NEBA process should not be conducted absent similar considerations for other response options and/or for the optimal combination of response options. To the extent that NEBA does include chemical countermeasures, then specifics of what both the analysis and the use decision-making process entails needs to be clearly established.

Who is conducting the NEBA?
For the internal exercises, the 4C guidelines establish that the owner/operator would be conducting exercises based on a NEBA that presumably the owner/operator would develop. While we understand a NEBA can serve to inform planning/exercise/use decisions, the decision to use dispersants, or any other chemical countermeasure is ultimately a government decision, and must be done in accordance with the Subpart J of the NCP. To reflect this, to the extent that the owner/operator relies on any NEBA type of environmental tradeoffs assessment, it should be clear that it is to "inform" planning, not to make "use decisions" by the owner/operator. Any owner/operator environmental tradeoff assessment should also be referring back to those prepared by the Area Committees for the Area Contingency Plans.

Reference:
https://www.bsee.gov/sites/bsee_prod.opengov.ibmcloud.com/files/final_2016_prep_guidelines.pdf

6.2	FE: Incident Management Team Exercise – Offshore Facilities
Applicability:	IMT.
Frequency:	Annually.
Initiating Authority:	Owner or operator.
Participating Elements:	IMT and plan holder company officials as established in the spill response plan.
Scope:	Exercise the IMT's organization, communication, and decision - making in managing a response.
Objectives:	Exercise a select combination of the Core Components as outlined within Appendix A of the PREP Guidelines. During each triennial cycle, all of the applicable Core Components in Appendix A need to be exercised at least once. In addition, effective demonstration of any of the following components may be included in the scenario for the exercise: A. Ability to detect, assess, project, track and monitor the spill, properly map the spill information necessary to respond, direct response resources appropriately, and share that information with others as indicated in the response plan. B. Knowledge of OSRP, any referenced OSRO Inventories, tactics manuals, and well containment plans. C. Ability to access information in the appropriate Regional Contingency Plans (RCPs) and ACPs for the location of sensitive areas, protective best management practices, resources available within the area, unique conditions of area, recommended response strategies, etc. D. For any chemical or biological countermeasures or *in - situ* burning cited in the OSRP, the ability to prepare and submit a request and usage plan to the FOSC. The preparation of a usage and monitoring plan/request for each such countermeasure listed in the plan must be exercised during the triennial cycle. 1. Ability to select and propose the use of an optimal mix of response countermeasures to the FOSC, based on an assessment of the operational feasibility, expected effectiveness, and **projected environmental tradeoffs associated with using each countermeasure**. 2. In the case of a request for aerial/vessel applied dispersants, API Technical Report 1148 ("Aerial and Vessel Dispersant Preparedness and Operations Guide") contains an example of a Daily Aerial/Vessel Dispersant Application Plan that may be appropriate for use in this situation. 3. For OSRPs that also list SSDI as a response capability, the IMT should complete an application request and usage and monitoring plan for SSDI, as well as a management plan for coordinating the allocation of dispersant stockpiles between surface - application and SSDI operations, as appropriate. 4. Ability to implement and coordinate the use of multiple response countermeasures, as approved by the FOSC, in accordance with the offshore response Concept of Operations outlined in the OSRP. E. Demonstrate the effective and coordinated integration of source control and subsea containment operations with other incident management activities, including oil spill response operations. F. Identification of corrections necessary to address any noncompliance or preparedness issues encountered while conducting the exercise and the incorporation of these corrections into the OSRP.
Certification:	Self - certification.
Verification:	Verification by BSEE; records must be available upon request.

http://www.bsee.gov/uploadedFiles/BSEE/About_BSEE/Divisions/OSPD/Final%202016%20PREP%20Guidelines.pdf

RRT VI Dispersant Exercises - At least 4 RRT VI Incident Specific Activation Reports on epaosc.org website for Subsea dispersant use and 1 for Surface dispersant use

May 2016 - HWCG-LLOG 2016 Gulf of Mexico Exercise

On May 10-11, 2016, HWCG-LLOG conducted their annual industry-led Preparedness for Response Exercise Program (PREP) exercise. As part of the exercise, they requested RRT concurrence to use subsea dispersants, specifically COREXIT EC9527A, FINASOL OSR 52, and ACCELL Clean DWD, as an effective means to minimize environmental impact.

Exercise Scenario is located in the **Mississippi Canyon 300, Well #2** block approximately 59-miles south of the mouth of the Mississippi River, and was based on their oil spill response plan's worst-case discharge. HWCG-LLOG requested RRT-6 approval for the use of subsea dispersants to reduce volatile organic compounds (VOCs) exposure to responders, and reduce the potential for oil impacts to the shoreline and resources at risk.

On April 29, 2016, HWCG-LLOG's exercise planners provided their subsea dispersant package to RRT-6 (i.e., **Summary Slide Deck, Resources at Risk, Critical Review of Toxicity, Monitoring Plan, Logistics, Schedule, RRT Incident Data Sheet, Scenario, and Mass Data comparisons**). On May 10, 2016, at 1400 CT, the Incident-Specific RRT (ISRRT) teleconference commenced; call adjourned at 1500.

RRT members were provided a read-ahead package prior to the call. This helped facilitate a meaningful discussion and allowed more productive feedback to HWCG-LLOG personnel. Despite the many unknowns with this exercise, RRT members unanimously agreed that injecting subsea dispersants at the source of the spill was the best and preferred method, thus minimizing oil from reaching the surface and shoreline.

- **NOAA acknowledged that using subsea dispersants at the source is generally the best option to keep the oil out of critical habitats; however, as the lead trustee for numerous "at risk" species in the subsea, surface, near-shore and on-shore environment, they have a more difficult challenge when weighing the tradeoffs between response techniques**. Another variable in the decision process is what time of year the incident occurs (e.g., Sea Turtle nesting).
- DOI recommended that responders should do everything possible to keep the oil out of the wetlands and minimize impact to bird rookeries and fish nurseries. To do this effectively in the open ocean environment, subsea dispersant use at the wellhead would be the best option. Also, in-situ burning and mechanical recovery would not be effective in rough water, allowing the oil to remain on the surface for longer periods of time, resulting in weathering of the oil, which in turn makes it even harder to disperse, cleanup and remove.

Outcome

Mr. Ronnie Crossland: Approved, with the understanding that in an actual incident, there could be several calls leading up to an actual approval. RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback / progress on the subsea application and monitoring process.

Mr. Greg Pollock - State of Texas (TGLO): Approved. Although spill is located in federal waters, **TGLO recognizes that if "no action" (i.e., subsea dispersants) is taken, the oil could eventually impact state waters.** They are also in favor of fighting the spill as far offshore as possible.

Mr. Brian Wynne -State of Louisiana (LOSCO): Approved. **Although spill is located in federal waters, LOSCO recognizes that if "no action" (i.e., subsea dispersants) is taken, the oil could eventually impact state waters.**

RRT Incident Specific Activation Summary: https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20-%20HWCG-LLOG%20--%205-10-2016.pdf

August 2015 - Chevron USA Inc. - Chevron USA Inc. conducted their annual industry led PREP exercise (requested RRT concurrence to use subsea dispersants as part of the exercise).

Nine days prior to a one hour RRT VI Incident Specific teleconference that the USCG RRT-6 Co-Chair convened at the request of the Exercise FOSC, Chevron's exercise planners provided their subsea dispersant package to RRT-6 that included:

- **Summary Slide Deck,**
- **Resources at Risk,**
- **Critical Review of Toxicity,**
- **Monitoring Plan, Logistics, Schedule,**
- **RRT Incident Data Sheet,**
- **Scenario, and Incident Map.**

The purpose of the call was to review, discuss and potentially approve Chevron's request to apply subsea dispersants to mitigate the discharge.

Exercise Scenario is located in **Keathley Canyon 785** approximately 210-miles south of Morgan City, LA, and was based on their oil spill response plan's **242K worst case discharge**. Chevron requested RRT-6 approval for the use of subsea dispersants to reduce VOCs to promote responder safety, and to reduce impacts to the shoreline and resources at risk. Despite the many unknowns with this exercise, RRT members unanimously agreed that injecting subsea dispersants at the source of the spill was the best and preferred method, thus minimizing oil from reaching the surface and shoreline.

The following are key takeaways that were discussed during the call:

- In the event that subsea dispersants are actually requested, the UC must provide the RRT with a Monitoring Plan that is both aggressive and adaptive. The plan should include the following factors for measuring the efficiency of subsea dispersants:
    - Have the ability to measure and evaluate the effectiveness of both contact time and mixing efficiency while injecting dispersants.
    - Ability to measure the distribution of droplets, and ensuring the smaller droplets are less than the 200 micron range.
- During a spill where dispersants are to be applied, it is a good idea to work in close coordination with the academic community (e.g., National Science Foundation, State Universities, etc.) to promote transparency and facilitate the sharing of monitoring data, so that everyone is working towards a common goal.
- NOAA acknowledged that using subsea dispersants at the source is generally the best option to keep the oil out of critical habitats; however, as the lead trustee for numerous "at risk" species in the subsea, surface, near-shore and on-shore environment, they have a more difficult challenge when weighing the tradeoffs between response techniques. Another variable in the decision process is what time of year the incident occurs (e.g., Sea Turtle nesting).
- DOI recommended that responders should do everything possible to keep the oil out of the wetlands and minimize impact to bird rookeries and fish nurseries. To do this effectively in the open ocean environment, subsea dispersant use at the wellhead would be the best option. **Also, in-situ burning and mechanical recovery would not be effective in rough water, allowing the oil to remain on the surface for longer periods of time, resulting in weathering of the oil, which in turn makes it even harder to disperse.**

Outcome

Charlie Henry (NOAA natural resource trustee) and Stephen Spencer (DOI natural resource trustee): Agreed that subsea dispersant use was the best option in this case; monitoring plan needs to be in place.

Brandi Todd (EPA): Approved, with the understanding that in an actual incident, there could be several calls leading up to an actual approval. RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback / progress on the subsea application and monitoring process.

RRT Incident Specific Activation Summary: https://www.epaosc.org/sites/5083/files/Activation%20Call--EXERCISE%20-%20Chevron-%208-19-2015.pdf

November 2014 - BP Hopkins - BP conducted their annual industry-led PREP (requested RRT concurrence to use subsea dispersants as part of the exercise).

The exercise planners provided subsea dispersant package to RRT-6

- **Incident Data Sheet,**
- **Proposed High Level Subsea Dispersant Operations Plan,**
- **Proposed Subsea Dispersant Injection Monitoring Plan,**
- **Expedited Net Environmental Benefit Analysis (NEBA) of Subsea Dispersant Injection, and**
- **Oil Spill Trajectory and Fate Modeling Summary**

One hour and ten minute RRT-6 ISRRT teleconference to review, discuss and potentially approve BP's request to apply subsea dispersants to mitigate the discharge ongoing from **Green Canyon 327**.

The Environmental Unit (EU) presented overview of NEBA that led to the request for subsea dispersant approval. Key benefits outlined during the call:

- Responder Safety – reduce volatile organic compounds (VOCs) and exposure limits.
- Reduce large surface slicks – that could potentially migrate over large surface areas and impact the following:
    - Wildlife – reduce the potential exposure to sensitive areas of concern, such as the upper layer of the water column, where marine mammals and turtles are found.
    - Critical Habitats – modeling software predicted impact to the Flower Garden Banks if subsea dispersants were not used.
    - Shoreline – reduce potential of oil impacting and stranding on shorelines.
    - Economic – reduce economic impacts (commercial, sport, and recreational)
- Weather – high winds and large waves expected to make conventional recovery methods impossible.

Outcome

Charlie Henry (NOAA) – Recognized that this is an exercise and that the information that is discussed and agreed on during this incident will not be the same for every incident. It is important to note that every incident is unique and will have to be assessed individually on a case-by-case basis.

Ronnie Crossland (EPA) - Approved, with the stipulation that in an actual incident, RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback/progress on the subsea application and monitoring process. Also, the RRT would most likely require daily reports/follow-up calls to review efficacy of the subsea dispersants, and to make course corrections as needed.

RRT Incident Specific Activation Summary: https://www.epaosc.org/site/doc_list.aspx?site_id=5083

https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20--%20Incident%20Specific%20Activation%20Report%20BP%20Hopkins%20--%2011-05-2014.pdf

April/May 2014 - HWCG-Freeport-McMoRan Oil & Gas (HWCG-FMOG) Gulf of Mexico - HWCG-FMOG conducted their annual industry led PREP exercise (requested RRT concurrence to use subsea dispersants as part of the exercise)

Exercise Scenario is located in the **Green Canyon 393** block in a water depth of 3,800-feet;

Nineteen days prior to a one hour and five minute RRT VI Incident Specific teleconference that the USCG RRT-6 Co-Chair convened at the request of the Exercise FOSC, the exercise planners provided their subsea dispersant package to RRT-6 that included (as examples):

- **Facility Incident Report,**
- **Proposed Subsea Dispersant Operations Plan,**
- **Subsea Dispersant,**
- **Subsea Dispersant Monitoring Plan,**
- **Incident Action Plan,**
- **Application Monitoring Materials and Equipment List.**

The USCG RRT-6 Co-Chair convened a second 17 minute call the next day at the request of the Exercise FOSC

DOC and DOI trustee representatives provided consultation and outlined the following action items in advance of RRT-6 concurrence, which EPA, Texas, and Louisiana representatives agreed.

- Explain the **positive net benefit of using subsea dispersants as opposed to not using them.**
- **Work with Resource Trustees to determine the trade-offs of using versus not using subsea dispersants**, and how will it affect the following:
    - Sport fishing
    - Habitat Fisheries
    - Long-term effects in marsh versus deepwater
- Provide RRT-6 with **the benefits/tradeoffs of each of the following cleanup techniques:**
    - **Subsea dispersants**
    - **Surface dispersants**
    - No Action – what would be the trade off if no action is taken?
- Consult with the NOAA SSC to help with the modeling, fate of oil, and to help determine resources at risk.
    - What is the trajectory if we do not disperse?
    - Long-term monitoring for ESA, (e.g., Sea Turtles, Marine Mammals, and dolphins)
- **Work with BSEE to get 30-day trajectory predictions from the RP's Oil Spill Response Plan (OSRP).**

Outcome

Charlie Henry (NOAA natural resource trustee) and Stephen Spencer (DOI natural resource trustee): Agreed with the request. No further comments

Steve Mason on behalf David "Wes" McQuiddy (EPA): Agreed with the request. No further comments

RRT Incident Specific Activation Summary: https://www.epaosc.org/site/doc_list.aspx?site_id=5083
https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20--%20Freeport%20McMoran%20--%2004-30-2014.pdf

November 2013 - Chevron USA Inc. - Chevron USA Inc. conducted their annual industry led PREP exercise (requested RRT concurrence to use subsea dispersants as part of the exercise).

Over a three-day period (19-21 November 2013), Chevron conducted their Full-Scale Exercise in accordance with the Preparedness for Response Exercise Program (PREP) guidelines. As part of the exercise, the Coast Guard FOSC pursued RRT concurrence to use dispersants and in-situ burning to minimize environmental impact.

Prior to the exercise, Chevron planners provided several key read ahead documents to RRT-6, (e.g., Exercise Briefing, Dispersant checklist, and the In-situ Burning Checklist).

On 20 November 2013, at 1000, the RRT-6 Incident Specific Activation call commenced; call adjourned at

1037.

RRT Incident Specific Activation Summary: https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20--%20Chevron%20Oil%20Spill%20--%2011-21-2013.pdf

ConocoPhillips 2013 – Presentation to RRT VI. Exercise Scenario located in **Walker Ridge 460** in 6,915 ft of water. No Activation Summary on the EPAOSC.org website.

RRT VI presentation: https://www.epaosc.org/sites/11040/files/05-29%201530%20ConocoPhillips%20Exercise.pdf

NEBA Concerns/Questions

- Evaluate trade-offs associated with dispersant use, in part through use or review of NEBAs conducted for past oil spills
    - What were the NEBA protocols used (e.g., USCG CERA, ASTM)?
    - What is the scope (e.g., environmental, socioeconomic) and methodology of the trade-off analysis?
        - Qualitative vs quantitative
        - NEBA-type analyses are often characterize as determining the "best" option, ensure "maximum" or "greatest" environmental protection, "lowest" overall negative impact on the environment/socioeconomic, promotes the "quickest" overall ecosystem recovery
    - What factors are used when comparing response options?
- Are factors such as logistical, availability, efficiency considered? If so, how does this impact the analysis? Does response method inefficiency or inadequate availability drive the analysis to a suboptimal outcome?
- How are assumptions supported prior to and validated during a response?
- When is the analysis conducted (planning phase vs expedited)?
- Who conducted the analysis (e.g., responsible party, government, third party)?
    - Certain stakeholders may weigh factors differently
    - If multiple stakeholders involved, who selects the participants? What criteria are used to select the participants?
- How are uncertainties/unknowns addressed?

To: Barron, Mace[Barron.Mace@epa.gov]; Wilson, Gregory[Wilson.Gregory@epa.gov]; Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Conmy, Robyn
Sent: Tue 4/5/2016 2:05:40 PM
Subject: dispersant amounts

Here's what we are dealing with w/r/t dispersant volumes. Not much at all. Of the four proposed for the tox work, we only have enough of the Dispersit. Any luck with seeing if HQ could request some?

Current Inventory of Oil Spill Dispersants Line Items (July 2015)

date	dispersant name	quantity in lab	in use for preliminary testing
Apr-95	Corexit 9500	~ 80 mL	
Jul-97	EC9527A	~ 150 mL	
19-Dec-01	Nokomis 3-F4	1 qt.	
Aug-06	Dispersit SPC1000	~650 mL	*
undated, before 2010	JD-2000	~ 20 mL	*
undated, before 2010	Saf-Ron Gold	~ 300 mL	*
undated, before 2010	SX-100	~ 100 mL	
undated, before 2010	Corexit 9500A	~30 mL	
18-Jun-10	Corexit 9500 from Ohmsett	60 mL	*
25-Jul-13	new dispersant gel sent to AI from Tim @ ExxonMobil	~ 20 mL	
Apr-14	Finasol OSR52	1 qt.	
19-Mar-15	Nokomis 3-AA	1 pt.	*
19-Mar-15	Nokomis 3-F4	1 pt.	
9-Apr-15	FFT Solution	1 qt.	
16-Apr-15	Accell Clean DWD	1 qt.	
6-May-15	ZI-400	1 qt.	*
summer 2015	Corexit 9500 from DFO	~30 mL	

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Robyn N. Conmy, Ph.D.

Research Ecologist

USEPA/NRMRL/LRPCD

26 West MLK Drive

Cincinnati, Ohio 45268

513-569-7090 (office)

513-431-1970 (EPA mobile)

727-692-5333 (Personal mobile)

conmy.robyn@epa.gov

To: Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Wilson, Gregory
Sent: Mon 9/12/2016 6:34:19 PM
Subject: PROD Briefing - NEBA
PROD NEBA Briefing.docx

API SIMA Workshop Overview

Background

In recent years the oil and gas industry has placed significantly greater emphasis on the use of the net environmental benefit analysis (NEBA) methodology in the development of oil spill response strategies for at least the more significant incidents. While the general NEBA concept was well understood and many companies had developed their own NEBA methodologies, it was recognized there was not a common approach on how NEBAs should be conducted. Industry also recognized the NEBA term did not accurately represent the intent of the analysis in addition to it now addresses socio-economic and cultural impacts in addition to environmental. Consequently, IPIECA, IOGP and API collaborated on a project to develop a basic methodology for conducting NEBAs and have adopted the more descriptive term of spill impact mitigation assessment (SIMA).

SIMA Overview

The new SIMA guidelines can be summarized in the following four stages:

1. **Compile and evaluate data** for relevant oil spill scenarios.
2. **Predict outcomes/impacts** for the "No Intervention" option as well as the relative mitigation potential of other feasible response options for each scenario.
3. **Balance trade-offs** by weighing and comparing the range of benefits and drawbacks of each response option, including No Intervention, for each scenario.
4. **Select the best response option(s)** to form the strategy for each scenario that will minimize ecological, socio-economic and cultural impacts and promote rapid recovery.

The four stage process was adopted from the IPIECA/IOGP NEBA Good Practice Guide published in 2015 and the methodology was informed by the Consensus Ecological Risk Assessment (Aurand et al, 2000) as well as other NEBA/SIMA related documents and tools. The new methodology is a qualitative approach that is recommended for use in the planning phase with the outcomes modified during the response phase as necessary to account for incident specific conditions and circumstances. It can also be used independently in the response phase or in a more quantitative form for either phase if it is expected to materially change the outcomes and not time constrained.

It is important to note that this new SIMA methodology is not intended to be an industry standard applied to all oil spills but rather a methodology that can be utilized in the absence of other methods and particularly for more significant spills.

Workshop Objective

To better ensure the new SIMA method will be a viable approach in mitigating oil spill impacts and to promote broader acceptance within the spill response community, this workshop was organized to review the SIMA method and apply it to selected oil spill scenarios (i.e., stress test). It will involve key regulatory and industry representatives from the US. Another workshop involving international regulators and industry representatives will likely be organized as well.

The primary objectives of the workshops are to:

- identify potential significant gaps/flaws in the approach and obtain input on how best to address them, and
- obtain feedback on the suitability of the SIMA method for mitigating oil spill impacts and any potential application limitations

Gina Coelho email 3-2-2016: "The American Petroleum Institute and IPIECA have undertaken several projects to help industry improve understanding and consistent application of the "Net Environmental Benefit Analysis (NEBA)" process for spill response decision making. One effort (in which I am involved) involves taking the IPIECA GPG and tweaking it to make it more relevant to U.S. stakeholders. **Industry recognizes the importance of involving Federal and state agencies in this process, and suggested that I seek your input. I have developed a short survey to help inform that effort. If you agree to participate, I will schedule a 30 minute phone interview during which you may verbally share your thoughts and ideas.**

The information you share with me will be kept confidential and will not be publicly distributed; it will be used to help my team (comprised of myself, David Fritz, and Jim Staves) tailor the IPIECA GPG to the US spill response framework. I understand that you may not have the same experience as other individuals within your agency, and would ask you to share information based on your own personal understanding of NEBA concepts as they apply to oil spill planning and response in the US."

- Gina Coelho was a BP contractor for DWH and is an industry consultant, Dave Fritz was a BP employee, and Jim Staves worked for EPA Region 6 during DWH, but now retired from EPA and works as an industry consultant.
- OGC raised potential ethics concerns with responding to the survey.
- R6 referenced the IPIECA guidance in their two page NEBA justification for subsea dispersant use as part of the 2014 Green Canyon Exercise (see attached email). At that time we raised concerns with DOI's statement (attached email train) that indicated that if "subsea dispersant application is contemplated for an actual incident, this is what the justification will likely look like as it is put forward by the offshore exploration and production industry." We have significant concerns with the lack of detailed documentation and with the conclusions of the analysis that was offered as part of that exercise.
- The IPIECA guidance was also referenced in the RRT VI Subsea Dispersant Use Guidelines (draft version in the attached RRT Subsea Guidance Email) that were developed by the ILC (those were not finalized as an RRT document, but API has hinted to developing that document into an API recommended Practice).

CWA and NCP Requirements

Area Contingency Planning - 40 CFR 210(c):

- The ACP shall include the following…A description of the area covered by the plan, including the areas of special economic or environmental importance that might be damaged by a discharge;

Fish and Wildlife and Sensitive Environments Plan (FWSEP)

- All ACPs incorporate detailed annex containing FWSEP
- Consistent with the RCP and NCP
- Prepared in consultation with the USFWS and NOAA and other interested natural resource management agencies/parties.
- Among other requirements, the annex is to:
    - identify and establish priorities for fish and wildlife resources and their habitats and other important sensitive areas requiring protection from any direct or indirect effects from discharges,
    - provide a mechanism to be used during a spill response for timely identification of protection priorities of those fish and wildlife resources and habitats and sensitive environmental areas that may be threatened or injured by a discharge, and
    - identify potential environmental effects on fish and wildlife, their habitat, and other sensitive environments resulting from removal actions or countermeasures, including the option of no removal
    - Based on the evaluation of potential environmental effects, the annex should establish priorities for application of countermeasure and removal actions to habitats within the geographic region of the ACP

Reference: http://www.ecfr.gov/cgi-bin/text-idx?SID=f9a9c0ef0be4091830b5282ad7c0d670&mc=true&node=pt40.30.300&rgn=div5

- 33 USC 1321 (d)(2)(G) – Prepare a schedule, in cooperation with the States, identifying—
  (i) dispersants, other chemicals, and other spill mitigating devices and substances, if any, that may be used in carrying out the Plan,
  (ii) the waters in which such dispersants, other chemicals, and other spill mitigating devices and substances may be used, and
  (iii) the quantities of such dispersant, other chemicals, or other spill mitigating device or substance which can be used safely in such waters,

  which schedule shall provide in the case of any dispersant, chemical, spill mitigating device or substance, or waters not specifically identified in such schedule that the President, or his delegate, may, on a case-by-case basis, identify the dispersants, other chemicals, and other spill mitigating devices and substances which may be used, the waters in which they may be used, and the quantities which can be used safely in such waters

- EO 12777 delegates 33 USC 1321(d)(2)(G) to the EPA Administrator
- Implemented under Subpart J of the NCP

Authorization of Use (40 CFR 300.910)

- RRTs and ACs address the desirability of using appropriate dispersants, other products listed on the NCP Product Schedule, and burning agents

- RCPs and ACPs shall, as appropriate, include applicable preauthorization plans and address the specific contexts in which such products should and should not be used
- Mechanical recovery is NOT subject to authorization of use under Subpart J
- No NEBA requirement under Subpart J
- Pre-authorization plans require approval of:
    - EPA RRT representative
    - States with jurisdiction over the waters of the area to which a preauthorization plan applies and;
    - DOC and DOI natural resource trustees
- Authorization of use for spill situations that are not addressed by the preauthorization plans requires:
    - Concurrence of the EPA representative to the RRT
    - As appropriate, concurrence of the RRT representatives from the states with jurisdiction over the navigable waters threatened by the release or discharge
    - Consultation with the DOC and DOI natural resource trustees

- Exception only to prevent or substantially reduce threat to human life
    - Insufficient time to obtain the needed concurrences/consultations
    - OSC must inform the EPA RRT representative and, as appropriate, the RRT representatives from the affected states and, when practicable, the DOC/DOI natural resources trustees as soon as possible
    - Not intended to circumvent preauthorization or case-by-case use authorizations
        - NCP addresses worker health and safety under 40 CFR 300.150

<u>USCG ISPR</u>

- Overall, the team found these ACPs to be inadequate for this incident, and possibly for smaller, more localized incidents. (pg 5)

In the Gulf of Mexico or anywhere offshore oil production occurs, there must be direct linkage between the Oil Spill Response Plan (OSRP) and local ACPs.

- The ISPR Team found that not including worst case discharge (WCD) scenarios from offshore oil exploration, development, and production activities in ACPs for areas in which such activities are occurring was unacceptable.
- The NCP directs Area Committees to address ESAs and include booming and protection strategies to address a WCD.
    - In some planning areas, the ESAs were simply not identified in any plan. In some plans where the areas were listed, they were not prioritized.
    - In few instances, ESAs did have protection strategies for the areas that were most heavily impacted.
    - The equipment, trained personnel, and other response resources needed to implement the protection strategies were not included in many plans.
    - While many responders stated that impact to wildlife and habitat could have been much worse in the Deepwater Horizon incident, there is a consensus among team members that, had ESAs been given appropriate attention during the planning process, the adverse impacts could have been much less. ESAs have been given uneven, and in some cases, inadequate attention in the ACP development process throughout the Gulf of Mexico. There must be a comprehensive national planning process that identifies ESAs and assures that there are trained personnel, equipment, and strategies adequate to protect these resources. The Coast Guard needs to work with Federal, State, local,

tribal, and natural resource trustee stakeholders to select an exemplar among those ACPs that adequately addresses ESAs and make that a benchmark for future planning efforts.

The use of two alternative response technologies, **dispersants and in situ burning (ISB), proved critical to prevent wholesale impacts to ESAs** because the characteristics of the spill were favorable to the use of both technologies. However, **important concerns and questions remain about their impacts on the environment, and more research is necessary before bringing them into the mainstream of spill response options**.

- Although pre-authorization of dispersant use was approved by the Regional Response Team (RRT) and implemented by the Federal On-Scene Coordinator (FOSC), significant public concern was expressed over the volume being used and toxicity of the dispersants, causing EPA to develop protocols for dispersant application and monitoring.
    - While the FOSC always has the authority to approve use of dispersants to protect human life, in this case, to control volatile organic compounds in the source area, EPA intervened to address the volume and toxicity issues, as well as subsea application at the source. **This resulted in a temporary suspension of dispersant application, which may have resulted in more oil reaching the coastline.**
    - While the issue of subsea application may not have been reasonably foreseen, **other issues such as toxicity and volumetric limitations should have been foreseen as part of the National Oceanic and Atmospheric Administration/Environmental Protection Agency preparedness programs, and should have been researched and addressed well before this event.**
- The use of dispersants in the Deepwater Horizon incident identified a need for a thorough review of this response option, its efficacy in minimizing environmental impacts, its overall effect on the environment, and conditions under which they are most effective. Dispersant protocols and authorization procedures should be established and articulated in ACPs, and the degree to which dispersants may be used in ESAs should be addressed.

Reference: https://www.uscg.mil/foia/docs/dwh/bpdwh.pdf

Gulf ACP Updates

Area Committee defined in the NCP (40 CFR 300.5): Area Committee (AC) as provided for by CWA sections 311(a)(18) and (j)(4), means the entity appointed by the President consisting of members from qualified personnel of federal, state, and local agencies with responsibilities that include preparing an area contingency plan for an area designated by the President.

BSEE OSRP Regulations (30 CRR 254) required:

- An appropriate trajectory analysis specific to the area in which the facility is located, which must identify onshore and offshore areas that a discharge potentially could affect. The trajectory analysis chosen must reflect the maximum distance from the facility that oil could move in a time period that it reasonably could be expected to persist in the environment,
- A list of the resources of special economic or environmental importance that potentially could be impacted in the areas identified by the trajectory analysis and the strategies used for their protection. At a minimum, this list must include those resources of special economic and environmental importance, if any, specified in the appropriate Area Contingency Plan(s),
- A description of the response equipment that will be used to contain and recover the discharge to the maximum extent practicable and how to cope with the initial spill volume upon arrival at

the scene and then support operations for a blowout lasting 30 days. This description must include the types, location(s) and owner, quantity, and capabilities of the equipment,

- A description of the personnel, materials, and support vessels that would be necessary to ensure that the identified response equipment is deployed and operated promptly and effectively, and
- Must ensure that the response equipment, materials, support vessels, and strategies listed are suitable, within the limits of current technology, for the range of environmental conditions anticipated at the facility

http://www.ecfr.gov/cgi-bin/text-idx?SID=ae9d48e87e273e549942f003d6bc7f29&mc=true&node=se30.2.254_126&rgn=div8

Note: BOEM incorporates the same BSEE requirements into Exploration/Production Plans requirements at 30 CFR 550.219 (Exploration Plans), and 30 CFR 550.250 (for Development and Production Plans (DPP) and Development Operations Coordination Documents (DOCD))
http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title30/30cfr550_main_02.tpl

BSEE Well Control and Arctic Rules

Arctic Rule (6-27-2016 version)

Previous draft BSEE preamble stated: "Oil discharged into the environment will always result in the potential for some level of toxic effects to organisms and their habitat. Spill response countermeasures have the potential to reduce or mitigate these toxic effects. **Conducting net environmental benefit analyses is the best way to plan for and make operational decisions regarding which spill response countermeasures will result in the most effective reduction of the harmful effects of spilled oil**." (pg 178).

- EPA commented that the preamble "Should be clearly highlighted here that the analysis "to plan for and make operational decisions regarding which spill response countermeasures" to use is conducted as part of the ACP/RCP process as described elsewhere in this preamble."
- BSEE's response: deleted text at issue – not necessary to response. (the entire text cited above)

Previous draft BSEE preamble stated: BSEE also supports the use of a process to compare the environmental outcomes associated with using various response techniques and countermeasures in order to assess and select the most appropriate response technologies for use during an event. However, the selection and use of response technologies during a spill event is governed by EPA regulations contained within the NCP, and by the FOSC, which is a pre-designated senior USCG official. BSEE is not dictating the selection or use of any particular strategies for responding to any specific spill situation through its regulations or the OSRP process. **BSEE does have a separate regulatory rulemaking study underway that is considering a requirement for all OSRPs to include the use of an assessment process that would evaluate the environmental tradeoffs of various response countermeasures in their planning for a response**. (pg 258-259)

- EPA commented: How is this not relevant to the RCP/ACP effort, as opposed to the OSRP, which have the "…focus and purpose is to address how the operator will supply, manage, and sustain the necessary response resources for implementing the strategies and tactics." as stated in BSEE's response below?
- BSEE response: Revised – deleted language (in the bold text)

"One commenter recommended that strategies and tactics listed in the OSRP, including use of dispersants and burning, should be based on the latest regional-specific research, historical oil spill data, field tests conducted by the operator or its Oil Spill Response Organization (OSRO), and exercises, and environmental analysis.

While BSEE agrees that response strategies and tactics should be informed by all the methods recommended by the commenter, **BSEE disagrees with their assertion that plan holders are responsible for gathering this information, or that plan holders are responsible for field testing or validating these strategies and tactics as part of the process of developing and submitting their OSRPs. Rather, response strategies and tactics are developed and approved for use geographically and temporally, and should be exercised and validated by the Regional Response Teams and Area Committees, and should be contained in the appropriate RCPs and ACPs.** As such, Regional Response Teams and Area Committees would be the appropriate entities to review ongoing trends, new research or testing information, and to adjust the response strategies in the RCPs and ACPs accordingly. While OSRPs must be consistent with the strategies and tactics identified for use in the relevant RCPs and ACPs, their focus and purpose is to address how the operator will supply, manage, and sustain the necessary response resources for implementing the strategies and tactics."

"Two commenters recommend that the requirements in § 254.80 should contain specific protection and

response strategies and maps for environmentally sensitive areas and subsistence resources. One of the commenters further suggests that plan holders should have response personnel and equipment pre-staged near those sensitive sites, and that the strategies and equipment should be tested through a plan holder's exercise program, prior to being included in an OSRP.

While BSEE agrees protection and response strategies for sensitive resources are a critical part of oil spill response, **BSEE disagrees that these strategies should be developed by industry plan holders, nor does BSEE believe it is feasible for a plan holder to pre-stage personnel and equipment throughout the Arctic wherever sensitive resources might be located. The correct place for the development of protection and response strategies for sensitive areas and resources, in accordance with guidance in the NCP, is in the ACP.** In this case, the appropriate place would be within the North Slope SubArea Contingency Plan. Existing regulations do, however, require that operators address strategies for protecting environmentally sensitive areas in their OSRPs. See, e.g., §§ 254.23(i)(3)-(4); 254.26(c). BSEE does not believe that further treatment of this issue is necessary in § 254.80. The Alaska Regional Response Team and the North Slope SubArea Committee are responsible for testing and validating these strategies. **It is not the responsibility of an industry plan holder to develop these geographical response strategies, nor is it a requirement for a plan holder to test any strategies listed in an ACP prior to referencing them in their OSRP."**

DWH NRDA

RRT 6 Industry Liaison Committee
RRT VI Subsea Dispersant Use - Guidelines for Industry on Requesting Concurrence with Subsea Dispersant Injection (SSDI) Decisions

Prepared by: RRT VI Industry Liaison Committee (ILC) and API D3 Subsea Dispersants Joint Industry Task Force (JITF) - March 2015

API Comments on Subpart J

API OSRP Guidance document review

OGC added the disclaimer: "This document does not necessarily reflect the opinions of the regulatory community, has not been approved by the regulatory community, and does not constitute an endorsement of this RP by the regulatory community"

- API response: "**Disagree.** At EPA's request, we deleted all references to EPA being part of the work group but considered all comments they provided even though only work group members were allowed to submit comments. Additionally, USCG and BSEE did not take exception to being listed as members of the work group but in consideration of EPA's request that no federal agencies be mentioned, BSEE and USCG felt just referring to participation by the "regulatory community" would at least partially satisfy EPA's request. **Since this statement is EPA's position and not that of USCG or BSEE, it will not be included in the final RP**."

API document state: The recommendations developed by the Workgroup in Section 3 include a number of features and concepts that were incorporated into the design of this RP."

- EPA requested that "…by the Workgroup…" be changed to "…in coordination with the Workgroup…".
- API response: "**Disagree – The recommendations were developed by the workgroup** not in coordination with another unnamed entity."

API document state: "The content recommended by this RP was, however, benchmarked against BSEE's regulations (30 CFR Part 254 and associated guidance in NTL 2012-N06) and found to be in general compliance but will depend on the specific information plan holders include in each section.

- EPA stated that "Compliance determinations are made by regulatory agencies and are specific, not general." And requested that the statement be changed to "…API believes them to be found to be in general compliance…."
- API's response: "**Disagree. The workgroup found them to be in general compliance and not API.**"
- Caplis email [August 4, 2016]: "I agree with your thoughts about compliance."

AIP OSRP document includes a section on Net Environmental Benefit Analysis (NEBA) [Section 6.3.2] and cites references that haven't been published and don't appear to be currently available: Response Strategy Development Using SIMA, API 2016 and Guidelines on Implementing Spill Impact Mitigation Assessment, SIMA, API/IPIECA/IOGP 2016.

Although the document states refers to applicable regulatory authorities in establishing specific worst-case discharge criteria, Annex B instructs the plan holder to "**Describe how and why the worst-case discharge scenarios were selected, referring to the oil spill risk and impact analyses conducted by the plan holder**." In response to a previous comments on WCD planning scenario, API noted that the sentence "**Planning Scenario selection should also consider those with unique circumstances, such as relatively close proximity to shore or sensitive resources**, or resource requirements such as sour or Group V oils as well as **those that represent a variety of potential environmental impacts**" was added to address a BSEE comment that special consideration be given to facilities that are close to shore or possess unique characteristics in addition to the facility with the WCD. API section on Oil Spill Impact/Consequence Analysis [Section B.3] contains similar factors cited in API NEBA documents.

March - May 2016 - API Industry Guidelines on Requesting Regulatory Concurrence for Subsea Dispersant Use - API BULLETIN 4719 - Draft

Reincarnation of the RRT VI Industry Liaison Committee efforts that were of concern last year. We took issue with some of their statements.

Sections include:

Introduction
Scope
Terms, Definitions, and Abbreviations

- Overview

Summary of Core Information Submitted to Regional Response Teams
Evaluating the Use of Subsea Dispersant Injection
Use of Modelling to Support Response Decision-making
Use of Subsea Monitoring to Support Response Decision-Making
Importance of Effective Data Management Techniques

- **Use of NEBA to Support Response Decision-Making**
- Methods traditionally used for evaluating the potential net environmental impacts of various response technologies include Net Environmental Benefit Analysis (NEBA), and Consensus Ecological Risk Assessment (CERA). Such analyses are typically conducted in support of planning activities, but the principles and some of the methods employed can also be used during response actions, or response simulations and drills. Such analyses are typically referred to as "expedited or qualitative NEBAs" or "Environmental Trade Off Analyses". During drills or exercises, unless a NEBA has been conducted through applicable planning activities that take the release scenario into account, an "Expedited NEBA" should be conducted and included as part of the RRT concurrence package.

Regional Response Team Concurrence Request Process
Incident Command System Positions with Significant SSDI Roles
Annex A - Recommended Submittal Elements for SSDI Approval Request
Annex B - Summary of Primary Response Options
Annex C - Example Timeline for Utilizing Subsea Dispersant Injection
Annex D - Subsea Dispersant initial Injection Rate Calculation
Bibliography

Even though this is supposed to be Industry Guidelines, the document directly references to RRT VI, stating that its offering a "clarification on how RRT VI has interpreted requirements of 40 CFR Section 300.910 as applied specifically to subsea dispersant use…" It also characterizes other parts of the NCP, as well as roles and responsibilities under the Incident Command Structure / Unified Command.

API characterized the guidelines as describing the RRT concurrence request process, proposed information submission recommendations that are specific to subsea dispersant injection and the use of Net Environmental Benefit Analysis (NEBA) and other forms of tradeoff analyses as decision support tools.

PREP 4C

6.2	FE: Incident Management Team Exercise – Offshore Facilities
Applicability:	IMT.
Frequency:	Annually.
Initiating Authority:	Owner or operator.
Participating Elements:	IMT and plan holder company officials as established in the spill response plan.
Scope:	Exercise the IMT's organization, communication, and decision - making in managing a response.
Objectives:	Exercise a select combination of the Core Components as outlined within Appendix A of the PREP Guidelines. During each triennial cycle, all of the applicable Core Components in Appendix A need to be exercised at least once. In addition, effective demonstration of any of the following components may be included in the scenario for the exercise: A. Ability to detect, assess, project, track and monitor the spill, properly map the spill information necessary to respond, direct response resources appropriately, and share that information with others as indicated in the response plan. B. Knowledge of OSRP, any referenced OSRO Inventories, tactics manuals, and well containment plans. C. Ability to access information in the appropriate Regional Contingency Plans (RCPs) and ACPs for the location of sensitive areas, protective best management practices, resources available within the area, unique conditions of area, recommended response strategies, etc. D. For any chemical or biological countermeasures or *in - situ* burning cited in the OSRP, the ability to prepare and submit a request and usage plan to the FOSC. The preparation of a usage and monitoring plan/request for each such countermeasure listed in the plan must be exercised during the triennial cycle. 1. Ability to select and propose the use of an optimal mix of response countermeasures to the FOSC, based on an assessment of the operational feasibility, expected effectiveness, and **projected environmental tradeoffs associated with using each countermeasure**. 2. In the case of a request for aerial/vessel applied dispersants, API Technical Report 1148 ("Aerial and Vessel Dispersant Preparedness and Operations Guide") contains an example of a Daily Aerial/Vessel Dispersant Application Plan that may be appropriate for use in this situation. 3. For OSRPs that also list SSDI as a response capability, the IMT should complete an application request and usage and monitoring plan for SSDI, as well as a management plan for coordinating the allocation of dispersant stockpiles between surface - application and SSDI operations, as appropriate. 4. Ability to implement and coordinate the use of multiple response countermeasures, as approved by the FOSC, in accordance with the offshore response Concept of Operations outlined in the OSRP. E. Demonstrate the effective and coordinated integration of source control and subsea containment operations with other incident management activities, including oil spill response operations. F. Identification of corrections necessary to address any noncompliance or preparedness issues encountered while conducting the exercise and the incorporation of these corrections into the OSRP.
Certification:	Self - certification.
Verification:	Verification by BSEE; records must be available upon request.

http://www.bsee.gov/uploadedFiles/BSEE/About_BSEE/Divisions/OSPD/Final%202016%20PREP%20Guidelines.pdf

RRT VI Dispersant Exercises - At least 4 RRT VI Incident Specific Activation Reports on epaosc.org website for Subsea dispersant use and 1 for Surface dispersant use

May 2016 - HWCG-LLOG 2016 Gulf of Mexico Exercise

On May 10-11, 2016, HWCG-LLOG conducted their annual industry-led Preparedness for Response Exercise Program (PREP) exercise. As part of the exercise, they requested RRT concurrence to use subsea dispersants, specifically COREXIT EC9527A, FINASOL OSR 52, and ACCELL Clean DWD, as an effective means to minimize environmental impact.

Exercise Scenario is located in the **Mississippi Canyon 300, Well #2** block approximately 59-miles south of the mouth of the Mississippi River, and was based on their oil spill response plan's worst-case discharge. HWCG-LLOG requested RRT-6 approval for the use of subsea dispersants to reduce volatile organic compounds (VOCs) exposure to responders, and reduce the potential for oil impacts to the shoreline and resources at risk.

On April 29, 2016, HWCG-LLOG's exercise planners provided their subsea dispersant package to RRT-6 (i.e., **Summary Slide Deck, Resources at Risk, Critical Review of Toxicity, Monitoring Plan, Logistics, Schedule, RRT Incident Data Sheet, Scenario, and Mass Data comparisons**). On May 10, 2016, at 1400 CT, the Incident-Specific RRT (ISRRT) teleconference commenced; call adjourned at 1500.

RRT members were provided a read-ahead package prior to the call. This helped facilitate a meaningful discussion and allowed more productive feedback to HWCG-LLOG personnel. Despite the many unknowns with this exercise, RRT members unanimously agreed that injecting subsea dispersants at the source of the spill was the best and preferred method, thus minimizing oil from reaching the surface and shoreline.

- **NOAA acknowledged that using subsea dispersants at the source is generally the best option to keep the oil out of critical habitats; however, as the lead trustee for numerous "at risk" species in the subsea, surface, near-shore and on-shore environment, they have a more difficult challenge when weighing the tradeoffs between response techniques**. Another variable in the decision process is what time of year the incident occurs (e.g., Sea Turtle nesting).
- DOI recommended that responders should do everything possible to keep the oil out of the wetlands and minimize impact to bird rookeries and fish nurseries. To do this effectively in the open ocean environment, subsea dispersant use at the wellhead would be the best option. Also, in-situ burning and mechanical recovery would not be effective in rough water, allowing the oil to remain on the surface for longer periods of time, resulting in weathering of the oil, which in turn makes it even harder to disperse, cleanup and remove.

Outcome

Mr. Ronnie Crossland: Approved, with the understanding that in an actual incident, there could be several calls leading up to an actual approval. RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback / progress on the subsea application and monitoring process.

Mr. Greg Pollock - State of Texas (TGLO): Approved. Although spill is located in federal waters, **TGLO recognizes that if "no action" (i.e., subsea dispersants) is taken, the oil could eventually impact state waters.** They are also in favor of fighting the spill as far offshore as possible.

Mr. Brian Wynne -State of Louisiana (LOSCO): Approved. **Although spill is located in federal waters, LOSCO recognizes that if "no action" (i.e., subsea dispersants) is taken, the oil could eventually impact state waters.**

RRT Incident Specific Activation Summary: https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20-%20HWCG-LLOG%20--%205-10-2016.pdf

August 2015 - Chevron USA Inc. - Chevron USA Inc. conducted their annual industry led PREP exercise (requested RRT concurrence to use subsea dispersants as part of the exercise).

Nine days prior to a one hour RRT VI Incident Specific teleconference that the USCG RRT-6 Co-Chair convened at the request of the Exercise FOSC, Chevron's exercise planners provided their subsea dispersant package to RRT-6 that included:

- **Summary Slide Deck,**
- **Resources at Risk,**
- **Critical Review of Toxicity,**
- **Monitoring Plan, Logistics, Schedule,**
- **RRT Incident Data Sheet,**
- **Scenario, and Incident Map.**

The purpose of the call was to review, discuss and potentially approve Chevron's request to apply subsea dispersants to mitigate the discharge.

Exercise Scenario is located in **Keathley Canyon 785** approximately 210-miles south of Morgan City, LA, and was based on their oil spill response plan's **242K worst case discharge**. Chevron requested RRT-6 approval for the use of subsea dispersants to reduce VOCs to promote responder safety, and to reduce impacts to the shoreline and resources at risk. Despite the many unknowns with this exercise, RRT members unanimously agreed that injecting subsea dispersants at the source of the spill was the best and preferred method, thus minimizing oil from reaching the surface and shoreline.

The following are key takeaways that were discussed during the call:

- In the event that subsea dispersants are actually requested, the UC must provide the RRT with a Monitoring Plan that is both aggressive and adaptive. The plan should include the following factors for measuring the efficiency of subsea dispersants:
    - Have the ability to measure and evaluate the effectiveness of both contact time and mixing efficiency while injecting dispersants.
    - Ability to measure the distribution of droplets, and ensuring the smaller droplets are less than the 200 micron range.
- During a spill where dispersants are to be applied, it is a good idea to work in close coordination with the academic community (e.g., National Science Foundation, State Universities, etc.) to promote transparency and facilitate the sharing of monitoring data, so that everyone is working towards a common goal.
- NOAA acknowledged that using subsea dispersants at the source is generally the best option to keep the oil out of critical habitats; however, as the lead trustee for numerous "at risk" species in the subsea, surface, near-shore and on-shore environment, they have a more difficult challenge when weighing the tradeoffs between response techniques. Another variable in the decision process is what time of year the incident occurs (e.g., Sea Turtle nesting).
- DOI recommended that responders should do everything possible to keep the oil out of the wetlands and minimize impact to bird rookeries and fish nurseries. To do this effectively in the open ocean environment, subsea dispersant use at the wellhead would be the best option. **Also, in-situ burning and mechanical recovery would not be effective in rough water, allowing the oil to remain on the surface for longer periods of time, resulting in weathering of the oil, which in turn makes it even harder to disperse.**

Outcome

Charlie Henry (NOAA natural resource trustee) and Stephen Spencer (DOI natural resource trustee): Agreed that subsea dispersant use was the best option in this case; monitoring plan needs to be in place.

Brandi Todd (EPA): Approved, with the understanding that in an actual incident, there could be several calls leading up to an actual approval. RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback / progress on the subsea application and monitoring process.

RRT Incident Specific Activation Summary: https://www.epaosc.org/sites/5083/files/Activation%20Call--EXERCISE%20-%20Chevron-%208-19-2015.pdf

November 2014 - BP Hopkins - BP conducted their annual industry-led PREP (requested RRT concurrence to use subsea dispersants as part of the exercise).

The exercise planners provided subsea dispersant package to RRT-6

- **Incident Data Sheet,**
- **Proposed High Level Subsea Dispersant Operations Plan,**
- **Proposed Subsea Dispersant Injection Monitoring Plan,**
- **Expedited Net Environmental Benefit Analysis (NEBA) of Subsea Dispersant Injection, and**
- **Oil Spill Trajectory and Fate Modeling Summary**

One hour and ten minute RRT-6 ISRRT teleconference to review, discuss and potentially approve BP's request to apply subsea dispersants to mitigate the discharge ongoing from **Green Canyon 327**.

The Environmental Unit (EU) presented overview of NEBA that led to the request for subsea dispersant approval. Key benefits outlined during the call:

- Responder Safety – reduce volatile organic compounds (VOCs) and exposure limits.
- Reduce large surface slicks – that could potentially migrate over large surface areas and impact the following:
    - Wildlife – reduce the potential exposure to sensitive areas of concern, such as the upper layer of the water column, where marine mammals and turtles are found.
    - Critical Habitats – modeling software predicted impact to the Flower Garden Banks if subsea dispersants were not used.
    - Shoreline – reduce potential of oil impacting and stranding on shorelines.
    - Economic – reduce economic impacts (commercial, sport, and recreational)
- Weather – high winds and large waves expected to make conventional recovery methods impossible.

Outcome

Charlie Henry (NOAA) – Recognized that this is an exercise and that the information that is discussed and agreed on during this incident will not be the same for every incident. It is important to note that every incident is unique and will have to be assessed individually on a case-by-case basis.

Ronnie Crossland (EPA) - Approved, with the stipulation that in an actual incident, RRT would schedule a follow-up call within 48-72 hours for the UC to provide the RRT feedback/progress on the subsea application and monitoring process. Also, the RRT would most likely require daily reports/follow-up calls to review efficacy of the subsea dispersants, and to make course corrections as needed.

RRT Incident Specific Activation Summary: https://www.epaosc.org/site/doc_list.aspx?site_id=5083

https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20--%20Incident%20Specific%20Activation%20Report%20BP%20Hopkins%20--%2011-05-2014.pdf

April/May 2014 - HWCG-Freeport-McMoRan Oil & Gas (HWCG-FMOG) Gulf of Mexico - HWCG-FMOG conducted their annual industry led PREP exercise (requested RRT concurrence to use subsea dispersants as part of the exercise)

Exercise Scenario is located in the **Green Canyon 393** block in a water depth of 3,800-feet;

Nineteen days prior to a one hour and five minute RRT VI Incident Specific teleconference that the USCG RRT-6 Co-Chair convened at the request of the Exercise FOSC, the exercise planners provided their subsea dispersant package to RRT-6 that included (as examples):

- **Facility Incident Report,**
- **Proposed Subsea Dispersant Operations Plan,**
- **Subsea Dispersant,**
- **Subsea Dispersant Monitoring Plan,**
- **Incident Action Plan,**
- **Application Monitoring Materials and Equipment List.**

The USCG RRT-6 Co-Chair convened a second 17 minute call the next day at the request of the Exercise FOSC

DOC and DOI trustee representatives provided consultation and outlined the following action items in advance of RRT-6 concurrence, which EPA, Texas, and Louisiana representatives agreed.

- Explain the **positive net benefit of using subsea dispersants as opposed to not using them.**
- **Work with Resource Trustees to determine the trade-offs of using versus not using subsea dispersants**, and how will it affect the following:
    - Sport fishing
    - Habitat Fisheries
    - Long-term effects in marsh versus deepwater
- Provide RRT-6 with **the benefits/tradeoffs of each of the following cleanup techniques:**
    - **Subsea dispersants**
    - **Surface dispersants**
    - No Action – what would be the trade off if no action is taken?
- Consult with the NOAA SSC to help with the modeling, fate of oil, and to help determine resources at risk.
    - What is the trajectory if we do not disperse?
    - Long-term monitoring for ESA, (e.g., Sea Turtles, Marine Mammals, and dolphins)
- **Work with BSEE to get 30-day trajectory predictions from the RP's Oil Spill Response Plan (OSRP).**

Outcome

Charlie Henry (NOAA natural resource trustee) and Stephen Spencer (DOI natural resource trustee): Agreed with the request. No further comments

Steve Mason on behalf David "Wes" McQuiddy (EPA): Agreed with the request. No further comments

RRT Incident Specific Activation Summary: https://www.epaosc.org/site/doc_list.aspx?site_id=5083
https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20--%20Freeport%20McMoran%20--%2004-30-2014.pdf

November 2013 - Chevron USA Inc. - Chevron USA Inc. conducted their annual industry led PREP exercise (requested RRT concurrence to use subsea dispersants as part of the exercise).

Over a three-day period (19-21 November 2013), Chevron conducted their Full-Scale Exercise in accordance with the Preparedness for Response Exercise Program (PREP) guidelines. As part of the exercise, the Coast Guard FOSC pursued RRT concurrence to use dispersants and in-situ burning to minimize environmental impact.

Prior to the exercise, Chevron planners provided several key read ahead documents to RRT-6, (e.g., Exercise Briefing, Dispersant checklist, and the In-situ Burning Checklist).

On 20 November 2013, at 1000, the RRT-6 Incident Specific Activation call commenced; call adjourned at

1037.

RRT Incident Specific Activation Summary: https://www.epaosc.org/sites/5083/files/Activation%20Call%20--%20EXERCISE%20--%20Chevron%20Oil%20Spill%20--%2011-21-2013.pdf

ConocoPhillips 2013 – Presentation to RRT VI. Exercise Scenario located in **Walker Ridge 460** in 6,915 ft of water. No Activation Summary on the EPAOSC.org website.

RRT VI presentation: https://www.epaosc.org/sites/11040/files/05-29%201530%20ConocoPhillips%20Exercise.pdf

NEBA Concerns/Questions

- Evaluate trade-offs associated with dispersant use, in part through use or review of NEBAs conducted for past oil spills
    - What were the NEBA protocols used (e.g., USCG CERA, ASTM)?
    - What is the scope (e.g., environmental, socioeconomic) and methodology of the trade-off analysis?
        - Qualitative vs quantitative
        - NEBA-type analyses are often characterize as determining the "best" option, ensure "maximum" or "greatest" environmental protection, "lowest" overall negative impact on the environment/socioeconomic, promotes the "quickest" overall ecosystem recovery
    - What factors are used when comparing response options?
- Are factors such as logistical, availability, efficiency considered? If so, how does this impact the analysis? Does response method inefficiency or inadequate availability drive the analysis to a suboptimal outcome?
- How are assumptions supported prior to and validated during a response?
- When is the analysis conducted (planning phase vs expedited)?
- Who conducted the analysis (e.g., responsible party, government, third party)?
    - Certain stakeholders may weigh factors differently
    - If multiple stakeholders involved, who selects the participants? What criteria are used to select the participants?
- How are uncertainties/unknowns addressed?

To: Loring, Joseph B CAPT[Joseph.B.Loring@uscg.mil]; Weaver, James (USCG)[James.D.Weaver@uscg.mil]; Scott.A.Stoermer@uscg.mil[Scott.A.Stoermer@uscg.mil]; Ottenwaelder, Thomas A CDR[Thomas.A.Ottenwaelder@uscg.mil]; Sligh, Kevin M CIV[Kevin.M.Sligh@uscg.mil]; Carnegie, Tammie R LT[Tammie.R.Carnegie@uscg.mil]; Crecy, Stacey L LCDR[Stacey.L.Crecy@uscg.mil]; Platt, Jeffrey R LCDR[Jeffrey.R.Platt@uscg.mil]; Brooks, Rebecca J LT[Rebecca.J.Brooks@uscg.mil]; Maghini, Monica K CIV[Monica.K.Maghini@uscg.mil]; Hall, Gregory CDR (EDU)[Gregory.Hall@USCGA.EDU]; Fletcher, James E CIV[James.E.Fletcher@uscg.mil]; kurt.a.hansen@uscg.mil[kurt.a.hansen@uscg.mil]; Balsley, Alexander CIV[Alexander.Balsley@uscg.mil]; DiRenzo, Joseph CIV[Joseph.DiRenzo@uscg.mil]; mark.g.vanhaverbeke@uscg.mil[mark.g.vanhaverbeke@uscg.mil]; Catanach, Curtis P CIV[Curtis.P.Catanach@uscg.mil]; Chaves, Wendy[Wendy.G.Chaves@uscg.mil]; Jenkins, Shannon R CIV[Shannon.R.Jenkins@uscg.mil]; dave.westerholm@noaa.gov[dave.westerholm@noaa.gov]; scott.lundgren@noaa.gov[scott.lundgren@noaa.gov]; steve.lehmann@noaa.gov[steve.lehmann@noaa.gov]; john.kucklick@nist.gov[john.kucklick@nist.gov]; jason.boehm@nist.gov[jason.boehm@nist.gov]; Elena.Melchert@hq.doe.gov[Elena.Melchert@hq.doe.gov]; Erica.Folio@Hq.Doe.Gov[Erica.Folio@Hq.Doe.Gov]; kevin.easley@hq.doe.gov[kevin.easley@hq.doe.gov]; david.moore@bsee.gov[david.moore@bsee.gov]; Lori.Medley@bsee.gov[Lori.Medley@bsee.gov]; william.vocke@bsee.gov[william.vocke@bsee.gov]; joseph.levine@bsee.gov[joseph.levine@bsee.gov]; Walter.Johnson@boem.gov[Walter.Johnson@boem.gov]; brian.zelenke@boem.gov[brian.zelenke@boem.gov]; Jeff.Ji@boem.gov[Jeff.Ji@boem.gov]; barry_Forsythe@fws.gov[barry_Forsythe@fws.gov]; holly_herod@fws.gov[holly_herod@fws.gov]; christina_kravitz@fws.gov[christina_kravitz@fws.gov]; michael.carter@dot.gov[michael.carter@dot.gov]; tom.thompson@dot.gov[tom.thompson@dot.gov]; robert.w.smith@dot.gov[robert.w.smith@dot.gov]; james.merritt@dot.gov[james.merritt@dot.gov]; David.Lehman@dot.gov[David.Lehman@dot.gov]; Steven.V.Cary@usace.army.mil[Steven.V.Cary@usace.army.mil]; Andrew.J.Bruzewicz@usace.army.mil[Andrew.J.Bruzewicz@usace.army.mil]; Nathan.J.Lamie@usace.army.mil[Nathan.J.Lamie@usace.army.mil]; Kemp.skudin@navy.mil[Kemp.skudin@navy.mil]; frank.stone@navy.mil[frank.stone@navy.mil]; abe.nachabe@navy.mil[abe.nachabe@navy.mil]; michael.s.dean@navy.mil[michael.s.dean@navy.mil]; Stephanie A. Brown[stephanie.a.brown@navy.mil]; Conmy, Robyn[Conmy.Robyn@epa.gov]; Principe, Vanessa[Principe.Vanessa@epa.gov]; Wilson, Gregory[Wilson.Gregory@epa.gov]; michael.j.green-1@nasa.gov[michael.j.green-1@nasa.gov]; wayne.yoder@dhs.gov[wayne.yoder@dhs.gov]; jfarrell@arctic.gov[jfarrell@arctic.gov]; Sarah.Helinek@csra.com[Sarah.Helinek@csra.com]; Rebecca.Weissman@csra.com[Rebecca.Weissman@csra.com]
From: Brooks, Rebecca J LT
Sent: Fri 3/18/2016 3:57:52 PM
Subject: DRAFT ICCOPR Minutes for Review and Comment
Draft Minutes ICCOPR FY16-2nd Quarter Meeting_3_9_16.docx

Good morning all,

Attached are draft minutes from our ICCOPR meeting on March 9th. Please provide input on any changes to me via tracked changes/ comments in the document. I would appreciate any feedback by Friday, April 8th. Thanks for your time and have a great weekend!

Very respectfully,

LT Becca Brooks
U.S. Coast Guard Headquarters STOP 7516
Office of Marine Environmental Response Policy (CG-MER-3)
2703 Martin Luther King Jr. Ave SE
Washington, DC 20593-7516
Phone: 202-372-2259

To: Wilson, Gregory[Wilson.Gregory@epa.gov]; Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Conmy, Robyn
Sent: Wed 3/16/2016 12:23:27 PM
Subject: FW: State-of-Science for Dispersants Use in Arctic Water: Degradation & Fate Group
2016.02.25_Degradation and Fate with appendices for panel final review.docx

I'm sure you are already aware of the deadline, but wanted to reach out to see if you have any additional edits to the document?

<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>/<>

Robyn N. Conmy, Ph.D.

Research Ecologist

USEPA/NRMRL/LRPCD

26 West MLK Drive

Cincinnati, Ohio 45268

513-569-7090 (office)

513-431-1970 (EPA mobile)

727-692-5333 (Personal mobile)

conmy.robyn@epa.gov

From: Mandsager, Kathy [mailto:kathy.mandsager@unh.edu]
Sent: Wednesday, March 16, 2016 8:17 AM
To: Mandsager, Kathy <kathy.mandsager@unh.edu>
Subject: FW: State-of-Science for Dispersants Use in Arctic Water: Degradation & Fate Group
Importance: High

Sorry for the confusion on the due date. March 17 is actually tomorrow – Thursday. We would greatly appreciate your approval of this document.

From: Mandsager, Kathy
Sent: Thursday, March 10, 2016 1:38 PM

To: Mandsager, Kathy <kathy.mandsager@unh.edu>
Subject: FW: State-of-Science for Dispersants Use in Arctic Water: Degradation & Fate Group
Importance: High

Reminder…. Due on Thursday.

From: Mandsager, Kathy
Sent: Thursday, February 25, 2016 5:50 PM
Subject: State-of-Science for Dispersants Use in Arctic Water: Degradation & Fate Group

Dear Panel:

We would very much appreciate your review of this final version of the *Degradation and Fate* document. This document incorporates the edits and suggestions made via email and final discussion.

If you could reply by email with your approval of this document by **Monday, March 17** (2 weeks for this review) that would be greatly appreciated. I will need each of you that participated in this discussion to reply in the affirmative that you approve this document.

Please also confirm that your name and affiliation are listed correctly at the end of this document.

You deserve kudos for this great accomplishment! Thank you very much!

Kathy Mandsager

Program Coordinator

Coastal Response Research Center

Center for Spills and Environmental Hazards

234 Gregg Hall, Colovos Rd

University of New Hampshire

Durham, NH 03824

603.862.1545

To: Matthiessen, Craig[Matthiessen.Craig@epa.gov]
Cc: Barron, Mace[Barron.Mace@epa.gov]; Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Wilson, Gregory
Sent: Wed 1/13/2016 6:03:40 PM
Subject: FW: spoke with Drew Landry....can I send him this presentation?
Barron dispersant tox.pdf

Craig –

See below. Mace got this request below.

From: Barron, Mace
Sent: Wednesday, January 13, 2016 12:47 PM
To: Robbins, Chris <Robbins.Chris@epa.gov>; Scaggs, Ben <Scaggs.Ben@epa.gov>
Cc: Raimondo, Sandy <Raimondo.Sandy@epa.gov>; Wilson, Gregory <Wilson.Gregory@epa.gov>
Subject: spoke with Drew Landry....can I send him this presentation?

Greg, putting you in the loop.

All I know is Drew is from Louisiana and is doing a documentary on the oil spill, and was interested in talking with someone in EPA about dispersants off camera. Chris and Ben asked me to speak with him; they could better explain the context of what he is doing and who he is.

I just gave him a lay person overview of dispersant ecotox, explained that other Agencys deal with worker safety issues of dispersants, cleared up some of his misconceptions about how dispersants are listed (not approved) by EPA, and what are some of the tradeoffs considered in spill response. I also told him that the intention of aspects of the proposed new rule for Subpart J were to list less toxic and more effective dispersants, which was a big concern of his. He seemed to be happy and more informed.

He asked if I would send him some links to dispersant information.

Can I send him the attached? It is public domain already, as I presented it to the US Coast Guard a month ago, and it is posted on a NOAA Sea Grant site (not sure where).

He is visiting DC right now, and asked if there was someone he could interview on camera.

His email is: drewlandry@yahoo.com; cell: 3373269722.

Sincerely,

Mace

To: HQS-PF-fldr-CG-MER ICCOPR Staff[HQS-PF-fldr-CG-MERICCOPRStaff@uscg.mil]; Abe Nachabe[Abe.nachabe@navy.mil]; Barry Forsythe (FWS)[barry_Forsythe@fws.gov]; Brooks, Rebecca J LT[Rebecca.J.Brooks@uscg.mil]; Christina Kravitz (FWS)[christina_kravitz@fws.gov]; Dave Westerholm (NOAA)[dave.westerholm@noaa.gov]; David Moore (BSEE)[david.moore@bsee.gov]; David Ringelberg[david.b.ringelberg@erdc.dren.mil]; Elena.Melchert@hq.doe.gov[Elena.Melchert@hq.doe.gov]; Erica Folio (DOE)[Erica.Folio@Hq.Doe.Gov]; Wilson, Gregory[Wilson.Gregory@epa.gov]; kurt.a.hansen@uscg.mil[kurt.a.hansen@uscg.mil]; holly_herod@fws.gov[holly_herod@fws.gov]; jason.boehm@nist.gov[jason.boehm@nist.gov]; Jeff.Ji@boem.gov[Jeff.Ji@boem.gov]; Jenkins, Shannon R CIV[Shannon.R.Jenkins@uscg.mil]; jfarrell@arctic.gov[jfarrell@arctic.gov]; John Kucklick (NIST)[john.kucklick@nist.gov]; John Kucklick (NOAA Email)[john.kucklick@noaa.gov]; Kemp Skudin (Navy)[Kemp.skudin@navy.mil]; kevin.easley@hq.doe.gov[kevin.easley@hq.doe.gov]; Lori.Medley@bsee.gov[Lori.Medley@bsee.gov]; Loring, Joseph B CAPT[Joseph.B.Loring@uscg.mil]; mfocazio@usgs.gov[mfocazio@usgs.gov]; michael.carter@dot.gov[michael.carter@dot.gov]; michael.j.green-1@nasa.gov[michael.j.green-1@nasa.gov]; Nathan Lamie[nathan.j.lamie@usace.army.mil]; robb Hyde (Navy)[robb.hyde@navy.mil]; Robert Smith (PHMSA)[robert.w.smith@dot.gov]; Conmy, Robyn[Conmy.Robyn@epa.gov]; Scott Lundgren[Scott.lundgren@noaa.gov]; Stephanie A. Brown[stephanie.a.brown@navy.mil]; steve.lehmann@noaa.gov[steve.lehmann@noaa.gov]; steven.pearson@bsee.gov[steven.pearson@bsee.gov]; Steven.V.Cary@usace.army.mil[Steven.V.Cary@usace.army.mil]; Tom Thompson (MARAD)[Tom.thompson@dot.gov]; Principe, Vanessa[Principe.Vanessa@epa.gov]; Vocke, William CIV[William.T.Vocke@uscg.mil]; Walter.Johnson@boem.gov[Walter.Johnson@boem.gov]; wayne.yoder@dhs.gov[wayne.yoder@dhs.gov]; Weaver, James (USCG)[James.D.Weaver@uscg.mil]
Cc: Brooks, Rebecca J LT[Rebecca.J.Brooks@uscg.mil]
From: Vocke, William CIV
Sent: Wed 12/30/2015 3:38:48 PM
Subject: ICCOPR Biennial Report to Congress
FOUO - Report to Congress Draft 12-08-2015 CG Review Version Rev - 2.docx

All,

Thank you for your input to the draft ICCOPR Biennial Report to Congress. As discussed at the latest ICCOPR quarterly meeting, the report is undergoing internal Coast Guard review. CG Congressional Affairs will eventually send the report to the DHS Deputy Secretary for submittal to Office of Management and Budget for a 1 to 2 week government-wide review. Once it is returned from OMB, the Coast Guard will address the comments and prepare it for ICCOPR Chair signature and submittal to Congress. Based on the previous report experience, the OMB review will probably not occur until late winter or early spring.

As requested, I am sending the attached copy of the draft report for your information and early review. This draft is marked FOUO and should not be released to the public. If you find any errors or omissions, please let me know (until 08 JAN) or LT Rebecca Brooks after that date. We will try to make any corrections while it is still in CG review. If not, be sure to submit these corrections as part of the OMB review.

This Biennial Report documents the incredible volume of oil pollution research being conducted or funded by the member agencies. I have documented 378 publications with one or more authors from member agencies, as well as 212 research projects. I think we should all be proud to be a part of this important work.

Bill Vocke
ICCOPR Executive Director
(202) 372-2019

To: Principe, Vanessa[Principe.Vanessa@epa.gov]
Cc: Wilson, Gregory[Wilson.Gregory@epa.gov]; Jennings, Kim[Jennings.Kim@epa.gov]
From: Bove, James
Sent: Wed 2/22/2017 9:22:01 PM
Subject: RE: FOR REVIEW - IOSC Technical Paper
Barron et al. Alternate paper 2017_JB.docx

Looks good- I had a few suggestions to make clear that Sub J revision is a proposal and not something that is absolutely happening. There's no guarantees it'll get through anytime soon…

From: Principe, Vanessa
Sent: Wednesday, February 22, 2017 3:25 PM
To: Bove, James <Bove.James@epa.gov>
Cc: Wilson, Gregory <Wilson.Gregory@epa.gov>; Jennings, Kim <Jennings.Kim@epa.gov>
Subject: FOR REVIEW - IOSC Technical Paper

Jim:

As Greg mentioned, we were asked to review since it cites some regulatory aspects the research is supporting.

Took a shot at edits – but wanted to make sure nothing in here will shoot us on the foot relative to the proposed Subpart J.

Mace is on a tight deadline, we just got it yesterday. So when you get a chance that would be great – it's not long.

[Kim – FYI]

Thanks, V

To: Mandsager, Kathy[kathy.mandsager@unh.edu]
Cc: Gary Shigenaka - NOAA Federal[gary.shigenaka@noaa.gov]; doug.helton@noaa.gov[doug.helton@noaa.gov]; nancy.kinner@unh.edu[nancy.kinner@unh.edu]; Wilson, Gregory[Wilson.Gregory@epa.gov]; Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Ronald Tjeerdema
Sent: Mon 6/13/2016 8:33:58 PM
Subject: RE: State-of-Science for Dispersant: Eco-Tox panel
2016.05.10_Draft_EcoToxicity and Sublethal Impacts.RT.docx

Dear Kathy:

Thanks for your note. I approve of the document, and have also updated my name and affiliation on page 30.

Thanks again. I look forward to seeing the final version.

Best wishes,

Ron

Ronald S Tjeerdema, PhD, DABT

Associate Dean for Environmental Sciences

College of Agricultural & Environmental Sciences

http://caes.ucdavis.edu; 530-752-6730

Professor, Department of Environmental Toxicology

and Coastal & Marine Sciences Institute

Donald G. Crosby Endowed Chair in Environmental Chemistry

http://tjeerdemaresearch.ucdavis.edu; 530-754-5192

Co Editor-in-Chief, ***Aquatic Toxicology***

www.journals.elsevier.com/aquatic-toxicology

University of California, Davis

http://www.ucdavis.edu/

From: Mandsager, Kathy [mailto:kathy.mandsager@unh.edu]
Sent: Wednesday, June 08, 2016 8:59 AM
To: sarah.allan@noaa.gov; barron.mace@epa.gov; abejarano@researchplanning.com; jewel_bennett@fws.gov; DFrenchMcCay@asascience.com; michel.gielazyn@noaa.gov; peter.hodson@queensu.ca; sharon.hook@csiro.au; rrhopcroft@alaska.edu; john.incardona@noaa.gov; Angela_Matz@fws.gov; Teri.Rowles@noaa.gov; Mathijs.Smit@shell.com; Sprenger.Mark@epa.gov; robert.suydam@north-slope.org; Ronald Tjeerdema; dana@mote.org; john.wise@louisville.edu; bgardiner@environcorp.com; Michael Ziccardi
Cc: Gary Shigenaka - NOAA Federal; doug.helton@noaa.gov; Kinner, Nancy; 'wilson.gregory@epa.gov'; 'principe.vanessa@epa.gov'
Subject: State-of-Science for Dispersant: Eco-Tox panel

Dear Panelist,

I am attaching the latest draft of the Eco-tox document. I am hoping Teri Rowles, and others of you noted in this document could firm up the outstanding information needed to finalize this document. It is ready for your approval.

Your task:

Step 1: please complete the missing information in this document.

Step 2: please confirm that your name and affiliation are noted correctly at the end of this document.

Step 3: please carefully review this document.

Step 4: and then please reply via email your written approval of this document.

As soon as we receive all panelists written approval, this document will then be posted for the public input period.

Again, thanks for your guidance on this important document.

Kathy Mandsager

Coastal Response Research Center

Center for Spills and Environmental Hazards

220 Gregg Hall, 35 Colovos Rd

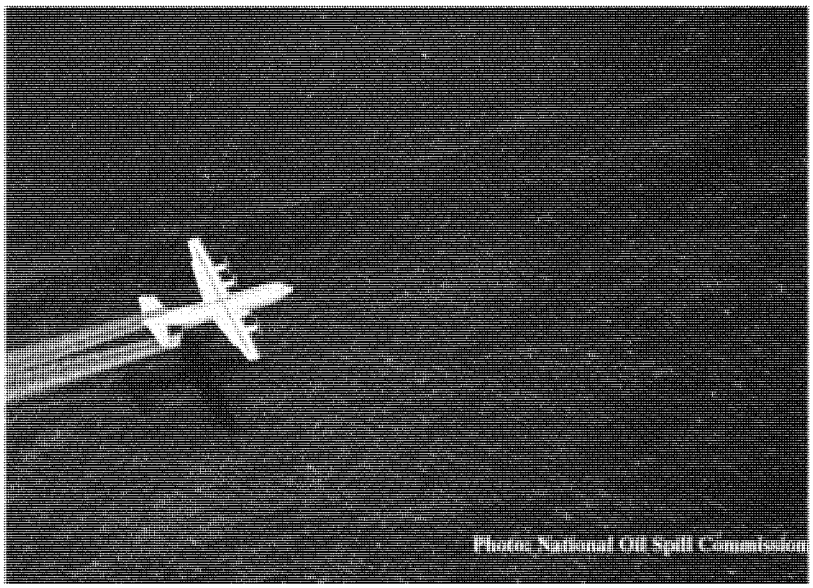
University of New Hampshire

Durham, NH 03824

603.862.1545

Addendum Report to

"Deadly Dispersants in the Gulf: Are Public Health and Environmental Tragedies the New Norm for Oil Spill Cleanups?"



Public Comments on EPA Proposed Rule to Subpart J of the National Oil and Hazardous Substances Pollution Contingency Plan that Governs the Use of Dispersants

By:
GAP Investigator and Legislative Director
Shanna Devine
&
GAP Legal Director
Tom Devine

April 22, 2015

GAP GOVERNMENT ACCOUNTABILITY PROJECT
Truth be told.

Acknowledgements

Deep appreciation is due to all the whistleblowers and community activists who were the driving force of this addendum report. Special thanks to The ALERT Project, the Louisiana Environmental Action Network, and Ecorigs, which have been invaluable partners throughout GAPs investigation, and to Dr. Michael Robichaux, the savior for so many whistleblowers abandoned by the conventional medical community.

This report is dedicated to Rick Piltz, a devoted environmental whistleblower and founder of GAP's Climate Science Watch program. Rick passed in 2014, yet his impact on the world will continue to be felt through the future generations of activists that he has mentored to shed light on reckless government policies, including the use of toxic dispersants.

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include endnotes beginning on p32 of 65 where applicable

1. Introduction

The 2010 Deepwater Horizon disaster was the largest U.S. oil spill, and second largest in world history. Even worse, evidence suggests that the use of the dispersant Corexit to "cleanup" the spill was more destructive to human health and the environment than the spill itself. On the third anniversary of the Deepwater Horizon disaster, GAP released the report, "Deadly Dispersants in the Gulf, Are Public Health and Environmental Tragedies the New Norm for Oil Spill Cleanups?"[1]

As we enter the fifth anniversary of the worst environmental disaster in U.S. history, this addendum provides updated evidence that has emerged over the past two years and reinforces original report findings pertaining to Corexit impacts. In the wake of the BP spill "cleanup", the oil industry has declared toxic dispersants its tool of choice for s pill response efforts. If this vision becomes reality, long-term destruction to our health and environment will expand exponentially. Widespread human tragedies documented by Gulf whistleblowers will become the norm after significant spills.

An unprecedented nearly two million gallons of Corexit were used during the BP disaster response. When this product is mixed with oil, a deadly synergy occurs that becomes 52 times more toxic than the oil alone.[2] The only so-called advantage of Corexit is the false impression that the oil disappears – in reality, the more toxic chemical mixture spreads throughout the environment, or settles on the seafloor.

As offshore drilling expands off U.S. coasts, it is inevitable that other incidents will occur. BP has declared it will continue to use the deadly dispersant as long as the government does not stop it. Notwithstanding grave warnings from the Exxon Valdez disaster and lessons learned from the BP spill, Corexit remains a listed dispersant on the National Contingency Plan (NCP) – the federal government's blueprint for responding to oil spills and hazardous substance releases. However, the Environmental Protection Agency (EPA) is in the process of updating outdated and inadequate dispersant regulations. GAP's report illustrates the imperative for the EPA to implement responsible dispersant regulations that limit human health and environmental impacts.

GAP's evidence comes from those whistleblowers who experienced the cleanup's effects firsthand. For its original report, GAP investigators interviewed 25 whistleblowers from Alabama, Louisiana and Mississippi, conducted extensive Freedom of Information Act requests, and off-the-record interviews with government employees. GAP's latest evidence comes from more than one dozen whistleblowers impacted by Corexit. Witnesses range from cleanup workers and fishermen, to scientists and residents. Together, their accounts produce a frighteningly consistent picture of health and ecological devastation that is starkly at odds with official BP and government statements that Corexit is no more dangerous than Dawn dishwashing soap. GAP worked closely with The ALERT Project and the Louisiana Environmental Action Network to conduct this investigation.[3]

The updated evidence included in this addendum is consistent with, and in some cases more severe than, the following findings documented in 2013:

ED_001324_00007458-00004

Existing Health Problems

- Coined "BP Syndrome," all GAP witnesses experienced spill-related health problems. Furthermore, 95% report that they continued to experience spill-related health problems as of April 2013, and more than 50% living in affected areas reported that their children and/or grandchildren's health has deteriorated.
- Select effects include: blood in urine; heart palpitations; kidney & liver damage; migraines; multiple chemical sensitivity, including hyper-allergies to common household cleaners; neurological damage resulting in severe IQ loss and memory loss; hyper-allergies to processed foods, causing extreme weight loss; exhaustion and loss of stamina for routine activities; respiratory system & nervous system damage; seizures; skin lesions throughout the body; and temporary paralysis.
- Victims also are extremely concerned about recognized long-term health effects from chemical exposure, such as reproductive damage and cancer.
- Blood test results from a majority of GAP interviewees showed alarmingly high levels of chemical exposure – to Corexit and oil – that correlated with experienced health effects. These chemicals include known carcinogens.

Failure to Protect Cleanup Workers

- Contrary to warnings in BP's own internal manual, BP and the government misrepresented known risks by asserting that Corexit was low in toxicity.
- Despite the fact that the Occupational Safety and Health Administration (OSHA) has developed a highly-lauded safety training program for cleanup workers, the workers interviewed reported that they either did not receive any training or did not receive the federally required training.
- Federally required worker resource manuals detailing Corexit health hazards (according to a confidential whistleblower) were not delivered or were removed from BP worksites early in the cleanup, as health problems began.
- BP and the federal government, through their own medical monitoring programs, each publicly denied that any significant chemical exposure to humans was occurring. 90% of workers and community residents interviewed by GAP reported contact with Corexit or Corexit-based chemicals, and blood test results revealed high levels of chemical exposure.
- BP and the federal government believed that allowing workers to wear respirators would not create a positive public image. As a result, OSHA permitted BP threats and retaliation against workers who insisted on wearing this protection. Nearly half of the cleanup workers interviewed by GAP reported that they were threatened with termination when they tried to wear respirators or additional safety equipment on the job. Many received early termination notices after raising safety concerns on the job.
- All workers interviewed reported that they were provided minimal or no personal protective equipment on the job.

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Ecological Problems & Food Safety Issues

- A majority of GAP witnesses reported that they found evidence of oil or oil debris after BP and the U.S. Coast Guard (USCG) announced that cleanup operations were complete.
- BP and the federal government reported that Corexit was last used in July 2010. A majority of GAP witnesses cited indications that Corexit was used after that time.
- The oil-Corexit mixture coated the Gulf seafloor and permeated the Gulf's rich ecological web. GAP witnesses have revealed underwater footage of an oil-covered barren seafloor, documenting widespread damage to coral reefs.
- The Food and Drug Administration (FDA) grossly misrepresented the results of its analysis of Gulf seafood safety. Of GAP's witnesses, a majority expressed concern over the quality of government seafood testing, and reported seeing new seafood deformities firsthand. A majority of fishermen reported that their catch has decreased significantly since the spill.

Inadequate Compensation

- BP's Gulf Coast Claims Fund denied all health claims during its 18 months of existence. Although a significant precedent, the subsequent medical class action suit excluded countless sick individuals (less than 2,000 Louisiana residents qualified), bypassed the worst health effects resulting from exposure to dispersant and oil, offered grossly inadequate maximum awards compared to medical costs, and did not include medical treatment.

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2. Human Health Impacts

Five years after Corexit was used throughout the Gulf, the overwhelming majority of original and new witnesses continue to experience adverse health impacts associated with dispersant and oil exposure. The phenomenon has been coined the "BP syndrome" or "Gulf Coast Syndrome." Consistent with initial reports, symptoms include, but are not limited to, blood in urine and rectal bleeding; seizures; hyper-allergies to processed foods; violent vomiting episodes that last for hours and result in rapid weight loss; weakness and fatigue, at times leading to depression; migraines; abdominal pain attacks; skin irritation, burning and widespread lesions; rashes; inability to withstand exposure to sun; Multiple Chemical Sensitivity, resulting in new sensitivities to everyday household cleaning products or petroleum based products (plastic water bottles); neurological damage resulting in memory loss and severe IQ drop; impotence; heart palpitations; and hypertension. Witnesses have begun reporting long-term health effects, including reproductive damage (such as genetic mutations), endocrine disruption, and cancer.

There remains a dearth of research around human health impacts resulting from dispersant exposure. However, several significant peer-reviewed studies have been released since 2013 that support initial and updated investigatory findings.[4]

A study conducted by the University Cancer and Diagnostic Centers and published in the American Journal of Medicine found Gulf spill cleanup workers are at an increased risk for blood-related disorders, including cancer, as a result of their exposure to dispersants and oil.[5] The study acknowledged that "COREXIT used as a dispersant is currently banned in the United Kingdom because of its potential health risks to clean-up workers."[6] Similar to the methodology employed by LEAN, it examined the blood tests of more than 100 spill workers in Louisiana who were exposed to oil and dispersant with to the blood test results of 138 unexposed individuals. Based on high levels of chemical exposure in the test results for the former group, it concluded, "This oil spill and use of massive amounts of dispersant has the potential to affect human health" and concluded that "clean-up workers exposed to the oil spill and dispersant experienced significantly altered blood profiles, liver enzymes, and somatic symptoms."[7]

A 2015 study conducted by the University of Alabama found that Corexit can cause serious damage to human lungs as well as marine life.[8] It found that Corexit exposure can damage tissue, and ultimately result in an "obstruction of the airways in humans with exacerbation of pre-existing respiratory diseases such as asthma." Senior author Dr. Veena Antony stated, "There were some 48,000 workers involved in the cleanup operations, and it is possible that workers were exposed to Corexit via inhalation." Similarly, the study reported "Cough, shortness of breath and sputum production" as some symptoms reported by spill workers. Dr. Antony concluded, "Unfortunately, the likelihood of another oil spill is high, and the need to use dispersal agents will remain."[9]

Additionally, LEAN conducted an extensive sampling effort following the BP disaster. Its sampling combined with the growing health concerns resulted in the creation of the Gulf Coast Health Alliance: Health Risks Related to the Macondo Spill (GC-HARMS). GC-HARMS is a 5 year, NIEHS funded collaborative research project utilizing community based participatory research.[10]

Whistleblower Record

a. Health Symptoms

I have had the pleasure and frustration of working with a group of ill people who were involved with the Deepwater Horizon oil spill in 2010. I have formally treated over 100 of these victims and have advised or managed about 100 more. WITHOUT A DOUBT, there is a large number of individual who were rendered ill by chemicals involved in the spill and many of them remain ill to this day. Their illnesses were, and often continue to be, severe and different from anything I had encountered in over 40 years of being a physician. While I am not qualified to definitely identify the causes of their illnesses, it appears that the dispersant Corexit is likely responsible for the medical problems we have encountered." (Dr. Michael Robichaux, 1)

"I continue to see and treat innocent citizens who were rendered ill from the oil spill and their illnesses have continued, largely unabated, to this time. Several of these previously healthy citizens are currently on social security and more are requesting the same. Most of these individuals are young and were in excellent health at the time of the spill." (Dr. Michael Robichaux, 1)

"I heard from other residents that when a dispersant plane was flying over Perdido Key it wouldn't close its 'sprayers'. I learned this firsthand. On March 11, 2011, I was sprayed around 8:00 pm. I went to get groceries out of my car and heard a plane. It couldn't have been more than a few hundred feet above me, and the sprayer was wide open. I felt something spray onto my arm, and once it happened, I almost immediately realized what was occurring and held my breath. I ran into my home and instantly threw up … My arm was red and sensitive as my skin was exposed. I remained sick throughout the night, and I couldn't eat or keep water down." (Lani Kaiser, 2)

"One VOO boat captain (Vessels Of Opportunity – independent boats contracted to help BP clean the oil) I know had 10 workers helping him, and a bi-plane flew over them in the summer of 2010. At the time, he was a big guy almost 300 pounds. When I first met him in 2012, he weighed 200 pounds and was really sick. You could tell from his eyes. He said he decided to work on the cleanup, but BP and the government were basically killing them by the exposure. He can no longer be a captain or swim in the Gulf of Mexico. It scared me because when I saw photos of him before the cleanup, he was a large man at six and a half feet tall, but now he looks like a walking skeleton." (Lani Kaiser, 3)

"I'm experiencing severe health problems now – problems in my blood, the weaknesses, the falling out, the respiratory problems, the nausea, the fact that I can't stand in the sun for 10 minutes. It used to take me two hours to cut all of my grass. I have to do it in days now. I cut a part of the grass and then I have to sit down for the rest of the day and go out the following day and cut some more. My weight constantly fluctuates. During the cleanup I would be in the hospital for one to two weeks and lose a lot of weight due to nausea and violent vomiting episodes." (Andre Gaines, 7)

"My whole team and I were sprayed in late June 2010. We were in a fleet of 20 vessels in a line a plane flew over us as it was spraying Corexit and went along the whole beach line spraying. The wind carried the dispersant and it blew back on us; it looked like a hundred people were smoking

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cigarettes in a straight line and there was smoke in the air. I really got the brunt of it because as a supervisor, I was standing off to the side as everyone else was pulling boom out of the water on the other side. After I got sprayed, I told my crew 'This is burning, you all better move.' It felt like somebody threw some hot coffee on my arm. The burning stopped, then it started back up 20 minutes later, and then it started itching." (Andre Gaines, 7)

"[A]fter I got sprayed it all went downhill. My employer said in the beginning that the dispersants were not harmful and would not hurt you. But Corexit is banned from several countries. If it's banned in other countries why would it be OK here? I may not be the smartest person in the world, but I don't get this … Out of the three [crew members] that I know personally, we have all had the same health problems. Three days after we were sprayed, my skin and eyes started burning, and I was coughing. In early July 2010 I had sores, and in between my fingers stuff was pussing out. I tried to figure out what was going on. The puss bumps and rashes were on my arms, my stomach, my back and the back of my legs. They looked like little tennis balls. Since we put cream on it, it looks like a whole lot of bumps. The ones on my arms looked the worse, which is why I try to cover them with tattoos." (Andre Gaines, 7)

"My weight was readily dropping every time I would go back to the dock. When I began I was muscular, and close to 230 pounds. By the end of working on the cleanup, I weighed 175 pounds. Now, if I stand in the sun too long or in the heat too long, anything I do for too long, I'm falling over weak and dizzy and I can't breathe. I don't know how to say it, but it's terrible." (Andre Gaines, 9)

"I have become intolerant of chemical smells that have never affected me before. For instance, I cannot stand the smell of perfumes, air fresheners, cleaning products or anything that comes out of aerosol cans; I have to remove myself from the smells. I can no longer wear cologne or even burn a scented candle, because anything that releases a strong smell repulses me, as if my body is rejecting it. I never had those reactions before I worked on the cleanup." (Randy Varney, 1-2)

"I have also noticed myself forgetting a lot … I did not have memory problems before the spill, but now I have good days and bad days. I went to Ohio for a week in the summer of 2013, and I felt much better; my symptoms began to subside. When I returned home I felt the way that I had felt when I left; the symptoms began to come back … I don't know what is wrong with me. I feel like I have been poisoned, almost as if I'm dying. It is one thing to have symptoms for a week or a month, but I have been through years of ineffective treatment. It's as if the doctors are treating me for something that I don't actually have." (Randy Varney, 1-2)

"I am not the only person who has had health problems since the spill, but it seems to affect people in different ways. When I was a captain, I had a deckhand in his mid-thirties. He would bag the oil and unload it onto other boats. Since working on the spill he has developed heart problems. People who I've known for years and were in fine health prior to the spill are now using breathing apparatuses. One of my friends now has brain cancer. One man who I used to go trolling with for years is now breathing out of his throat through a breathing tube, and the doctors don't know what is wrong with him. He never smoked." (Randy Varney, 3)

"The marina supervisors told me that I did not have to wear safety equipment because I was the

captain and therefore I was not supposed to come in contact with the oil and dispersants. However, that was not true. For instance, when my deckhands were handling the oil boom it would splash on me. I would also inhale the chemicals … Once my deckhands became HAZWOPER trained they would wear safety equipment, such as rubber boots and tyvek suits, at times, but their faces were not covered and they did not have respiratory protection. One of the deckhands complained to me about the chemical smell, and often my workers complained of headaches and discomfort. Regularly water splashed us in the face." (Richard Russell, 2)

"I regret that no one informed me of the health risks that came with the job. Since working on the cleanup my symptoms range from a constant sore throat to nausea, difficulty breathing, violent vomiting and cramps at the same time. I have stomach problems now, and I never know when they are going to occur … Now my bones are real sore, and I am in chronic pain. I am achy in my arms and my legs all the time. Before the spill I was in good health and I did not have any of these symptoms." (Richard Russell, 3)

"Whenever we finished for the day we put our equipment away and tried to get out of the oiled areas so that we didn't drift into the dispersant at night. Despite my best efforts, we often couldn't escape it and had to sleep over patches of oil and dispersed oil. After the frequent dispersant sprays, I developed a skin rash, blurred vision, headaches and dizziness." (David Hill, 3)

"The odor from the oil and dispersant was constant. I was the first one exposed to the fumes, because I was located in the front of the boat. The vessels are only a few feet off the water, and I could detect the odor before anyone else. The crude oil had more of a petroleum smell, whereas the dispersant had more of a sharp foul rotten type smell, similar to H2S gas. It would take our breath away and fill our lungs … I noticed that we had stronger headaches, sickness and nausea when we stayed around the dispersed oil than when we were in the presence of un-dispersed oil." (David Hill, 5)

"In the beginning I had pneumonia-like symptoms, staph infections, and an infected lymph node in my left armpit. I was admitted me into the hospital, and the doctors removed my lymph node … In January 2011 I was admitted again with pneumonia, and my white blood cell count plummeted to near death. It was at 100, and I had no immune system. I had an infection in my neck that swelled up to the size of a softball." (David Hill, 7)

"Currently I am experiencing chronic itching all over my body, and I have scratched myself so much that my skin is raw in some areas. I have skin blisters that randomly appear, and then they burst and heal. I deal with a tremendous amount of pain. I don't like complaining about how much I hurt, but my bones are constantly aching. It is getting increasingly difficult for me to walk because of something that is going on below my waist, as if a large horse kicked me and the pain won't go away. When I lie down in bed I feel a sharp stabbing pain, and the pain is so acute that I scream. There is no swelling or redness, but when I twist or turn a certain way it results in an unbearable pain. This is just the latest health problem … I am on disability now." (David Hill 8-9)

"My long-term memory seems to still be intact; however, my short term memory has vanished. I have notebooks sitting beside me right now, because throughout the day I have to make a record of

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my actions. Otherwise, I will not remember what I did or still need to do. I even have to refer back to my notes to remember people's names. I rely on my wife a great deal to help me remember things. I never used to have that problem. I used to pride myself on my strong memory, and now I can't even remember a conversation from a few days ago." (David Hill, 9)

"What will happen to us? Prior to the spill, my friend had cancer of the stomach but the doctors had removed it all. After the spill he developed it again and passed away. Another friend found out that he had cancer six months ago and they will bury him today. There are so many people on our bayou dying from cancer. A 40 year-old mother who is a neighbor of mine developed rare cancer of the appendix after the spill. The doctors told her that the cancer is ongoing and there is no cure. She goes into remission and then the cancer comes right back. In addition to rising cancer rates, we have so any allergy problems ... Most people in our community are also living with awful sinus problems and migraines now. These problems were not common during previous oil spills or prior to the Deepwater Horizon disaster; they became widespread in the aftermath of the BP oil spill." (Confidential Whistleblower, 3)

"We've been impacted health wise down here, me and the rest of the people here, and you still have a lot of people here because our entire community is either in the oil field or commercial fishing. The problem is that a lot of the families are in both. A lot of them will never say anything like, 'since the spill I've been sick', whether they have become diabetic or are on heart medicine because of the heart palpitations that we all dealing with. I still deal with them today. They will never point the finger at the oil spill because they are so tied to the oil industry. The oil companies don't play. You fight them, they fight back and they fight dirty. They lay everybody off."(David Arnesen, 1)

"One of my other friends died in December 2014 at 36 years old. Last year one of my other friends had to have her thyroid cut out. Another friend eight months after her had to have her thyroid cut out. My mom just fought cancer ... Before the spill it was never the situation where every weekend you have to decide which funeral to go to, because there are now two to three funerals almost every weekend. My girlfriend who died in December at age 36 has three kids. She wasn't even sick beforehand; she woke up to a heart attack and died. She didn't smoke or drink. My other friend Carla just died of a heart attack as well ... Another friend of mine shot himself after his son was diagnosed with a terminal illness. His son died a month after his suicide from brain cancer. Another friend of mine just died of cancer eight months ago, and I didn't go to his service or their sons' services. They all lived in this community. It's like waiting for the other boot to drop. Who's going to be diagnosed next?" (Kindra Arnesen, 5)

"After my health problems escalated, I finally broke down and went to the doctor in late July of 2010. My wife chose a doctor out of the phone book. My memory was really bad so I made a list of symptoms and it probably included 20-25 issues on it. My skin crawled and tingled all the time as if my hands and feet were asleep, I was extremely weak. I never needed glasses before the spill, and now I have blurred vision and I have to wear glasses. I get chills too. I developed a rash that to this day only occurs when I come in contact with certain things. Anything from soap to deodorant would set me off, and fabric softener is really bad. I can't wear cologne or aftershave, and I can't even have hairspray in the house." (Rocky Meadows, 3)

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"My memory became very sketchy. I knew that I was losing my mental capabilities. I would get confused, and eventually it evolved to the point where I couldn't drive my own car. I couldn't focus and I forgot what if a red light meant stop or go. It got so bad that I couldn't use my phone to call someone when I got lost and didn't know how to get back home. I couldn't watch TV in color; I had to watch black and white shows because they were simple, and I couldn't follow stories. Mentally I was destroyed. It was the worst in November 2013; that is when I bottomed out. I was sitting on my couch and I called my wife to tell her what my final arrangements were to be. Fortunately, it hasn't come down to that." (Rocky Meadows, 3)

"I have always had migraines, however, immediately following the oil spill and Corexit spraying the intensity of my migraines became greater, my breathing suffered, and I developed severe insomnia. My lung capacity was not nearly as low before the spill. Urgent Care told me that I had bronchitis, and my oxygen level was at 96 percent. I have always had an inhaler but never used it every day. After the spill, I've had to use a breathing machine … Now I feel like my body is constantly tired, but it comes in waves. My white blood cell count elevates every time I don't feel well, and my stomach is always upset. I never had stomach problems as severe as they are now. Every time I eat now, I must remain close to a restroom or else I am in trouble, and I have lost 40 pounds since 2010. (Lani Kaiser, 3-4)

"During the spill, my sister lived in Peninsula a resort golf club area in Gulf Shores, Alabama. It consists of nice homes and condos directly on the Gulf of Mexico and Mobile Bay. As bi-planes sprayed, dispersants were distributed along Mobile Bay. The planes would fly across the Peninsula resort, and several homes/condos were exposed. Since the spill, my sister has been very sick with severe lung problems, although she was never a smoker. She has been hospitalized several times over the past few years, and her immune system is low. Several people in Peninsula are still sick from the exposure." (Lani Kaiser, 3)

b. Vulnerable Populations

"Within days of when I began working, when I would come into the house our son would swell up immediately … When my wife went to the doctor they asked what he was exposed to and she explained my job and they said, 'That's probably the problem.' A friend of mine's son who I worked with had problems too. He would break out in hives and when he went to the hospital, they treated him for scabies. It's still bothering him. It itches and irritates him real bad." (Andre Gaines, 11)

"I would hang a lot of my clothes in my mother-in-law's room because there was space … My mother in law died in February of 2011. My wife later discussed whether some of the chemicals that I wore home on my clothes could have affected her, so we had an autopsy done. We got her autopsy back, and they said there were chemical and breathing and respiratory problems. She already was on oxygen sometimes and had some breathing problems, but she was living well for the most part and was fine. Then instantly after I got my oil spill job she would start coughing, almost choking, and we never even thought about a possible connection. Then out of the blue she passed." (Andre Gaines, 11-12)

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"The first week or so in July 2010 we had unusually strong breezes off the Coast blowing toward us. In early July 2010 I was in my front yard with another man named Carl, when we were overcome by a cloud of chemicals … We made eye contact with each other like 'What just happened?' We both dropped immediately down to the ground. Carl remained on the ground in pain. He was holding his stomach and vomiting profusely. He forgot who he was or where he was right after that. I ran inside to my bathroom immediately and I was sick everywhere … We eventually got Carl home, and his family carried him to the emergency room. He stayed in the hospital for four days. The doctors could not point to anything other than to say that they thought he had stomach ulcers. The man had never had ulcers on his life, however. He never fully recovered, and he eventually died. Carl was in his 70s." (Rocky Meadows, 1-2)

"My in-laws and I were located southeast toward the blowout, and we could see Corexit and oil in the water. At least it looked as if it were Corexit, because it made a brownish beige foam. [My wife's] dad didn't want to take the boat in it, so we headed back in as it was getting toward the evening. During the return, we ran over something and the boat got stuck. I had to continually dive into the water to try and unwind some metal material from around the wheels … During the period of time that I was unraveling the boat, they were spraying the Gulf with what we believed to be Corexit. Our boat got sprayed and [my wife's] parents got sprayed … They both got sick on the boat and had severe headaches. They told me that they were feeling nauseas and dizzy, so we had to get back as fast as possible. After we returned to the dock, my mind went blank for a few days." (Rocky Meadows, 2)

"Both of my in-laws have since passed. Within about three months of us going out on the boat, my mother-in-law began to show signs of mental impairments. Within six months she had Alzheimer's … Her rapid deterioration surprised all of us, because she had been in good health before the spill. My father-in-law seemed to be in perfect health before the spill. He was one of those guys who never even needed to go to the dentist. He had donated a kidney to someone a few years earlier, and the only kidney he had began to shut down." (Rocky Meadows, 2)

"[My daughter] Aleena started to get sick in September of 2010. We put her through the detox program, as well as our entire family, and my headaches and sinus problems got better. Aleena seemed to get better and then it came back all over again. With my son David, almost every time I turn around he has a sinus headache and tells me 'I don't feel good'. My mom barely made it through cancer last year. I have been to eight funerals in the last six months. My concern now is what does this hold for their future? Am I going to take them into the doctor for their headaches and the doctor says, 'Well, Aleena needs a CT scan and oh, she has brain cancer or bone marrow cancer or lung cancer.' You get scared to go to the doctor. These are my fears for my children." (Kindra Arnesen, 5)

"I thank god on a daily basis for the health that my family does still have. I pray for my husband's health and I pray for us financially, but I also pray for these other kids in our area and these families that are struggling with these illnesses, some of these kids are much sicker than mine ever got. The one little girl, who is the sickest I found on the Gulf Coast who is still alive, has been sick like this for five years. She is only 10 years old, and she does not recall what it was like to be well. She does not remember what it was like not to be scared from head to toe and her hair falling out and her skin

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seeping out and her body scarred from head to toe, and not being able to breathe. She does not recall what it was like to live a normal life before the spill. She lives two streets over. Her grandmother had to go on two inhalers since all of this happened, and she died in November of 2014 at age 52. She was one of my closest friends, and she was raising this little girl. The kids are back with their mom now, and the little girl's health remains bad." (Kindra Arnesen, 5)

"My two daughters have also had health impacts problems since the spill, although both of them rarely ever got sick before the spill. They are only 28 and 30 years old. My 28 year old was 23 at the time of the spill, and she was living with my wife and me. At the time her daughter was one years old, and she is often sick now as well. My younger daughter has one health problem after another. She is on medication to balance out a hormonal imbalance that developed after the spill, and she has had reproductive problems. She is also on medication to stimulate her mind, because she now experiences mental fatigue. Before the spill, she had never been on medication. My older daughter's son was born about a year after the cleanup, but he was born prematurely. Some of the doctors think that the Corexit may have impacted him. His lungs and vision were not fully developed." (Rocky Meadows, 1)

"We don't know if it's from the oil, the dispersant, or the combination of the two. But you can only fill a glass so full before it overflows, and the human body is the same way; you can't take that much chemical exposure and be ok with it … When is it going to go from primarily the adult size casket to a kid's casket? We already have too many sick kids, with brain tumors and cancer. There is another young girl who was a published author at 13 years old, she is about to be 18 now. Right after the spill her eyes started rolling back in her head she got a brain tumor. Her mom is sick, the middle child in her household had to stop playing football because of heart problems, and the little one has nose bleeds, hair falling out, stomach aches and headaches. It's everywhere down here, but you can't convince people that it's related to anything to do with the oil field. Physicians are just diagnosing the illness and treating the illness, they aren't treating the cause." (Kindra Arnesen, 5)

c. Medical Response

"One of the things we can do to assist these individuals is to have them go through a self-detoxification program by using a sauna with niacin and exercise. One of the fathers of a victim recently wrote back to me explaining that his son has experienced a very objective improvement with what he was doing. His son had worked the spill." (Dr. Michael Robichaux, 1)

"[After I was sprayed by Corexit] I kept throwing up, and my mom asked if I wanted to go to the hospital. However, I already knew people who were sick, and the hospital wasn't helping them. So I didn't know what to do. By that point, my sister was already sick, and each time she went to the hospital someone looked at her like she was crazy. I told my mom I would wait it out. The next day I was fairly sick, so I called 'in sick' to work. I stayed home and slept drinking lots of liquids. The area on the left side of my upper forehead would swell. It became so bad the following day that I went to a primary care doctor in Perdido Key. He said that my white blood cells were crazy. The doctor asked if I had an inflammation disease. My mom looked at him and said, 'No, last night she was exposed to Corexit' and he replied, 'Well what does that have to do anything?' … This was almost a

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year since the spraying, and the doctors still didn't believe there were any health problems associated with exposure to Corexit." (Lani Kaiser, 2-3)

"I've been to two different neurologists, and both said I have migraines with nausea and stomach issues. I found a holistic doctor in Orlando who took an MRI and found that I had four transient ischemic attacks (TIA), mini-strokes located on the left side of my head. In the beginning the left side of my forehead would swell, my left eye would twitch, and tremors would be frequent. If I take high concentrations of Niacin, B-6, B-12, and Vitamin C, they help to relax the symptoms. My migraines and stomach seem to be connected. If my head hurts then I will have nausea. Smoothies and coconut water help lower the intensity levels." (Lani Kaiser, 4)

"I saw a toxicologist in Baltimore, Maryland about three years ago when I was living in Auburn, Alabama. A friend had contacted me to explain that the toxicologist was creating a health database related to the spill. The lab where he worked is associated with John Hopkins, and they are creating a database of people involved in the spill or who have been exposed to chemicals from the spill. He wanted to track my medical symptoms about once a year. During our last call in 2012, he was direct and said that he wanted to tell me something that most doctors may not say. He warned me that in the next five to ten years things would change for me. He said he couldn't pinpoint it, but he was concerned that my health may domino or get worse. The best advice he could give me is to make as much money as I can now because I may soon be at the point of having to take disability. He told me this as my body feels worn out and tired." (Lani Kaiser, 4)

"The woman at Ocean Springs Hospital asked … me about my breathing and listened to my lungs. She said 'Oh, it sounds like you have asthmas or bronchitis.' I've never had respiratory problems before in my life, until working on the cleanup. She asked if I smoked cigarettes and I responded that I didn't. She said 'Your lungs sound like you smoke 10 packs a day.'" (Andre Gaines, 8)

"I told [the hospital] about the conditions that I had been working in during the cleanup, and about being sprayed. They did not treat me for chemical exposure, however … They kept saying my problem was viral and will go away tomorrow. However, it never went away the next day; it went on for weeks … They finally took my blood and said that I had benzene poisoning in my blood in high levels." (Andre Gaines, 8, 9)

"[D]uring the one year anniversary of the Deepwater Horizon explosion, I went to DC for PowerShift, an environmental conference. I met with Lisa Jackson, the head of the EPA, Stacy Elmer of Health and Human Services, and an admiral from the Coast Guard … I asked the HHS representative why the doctors are not treating me beyond my symptoms when I go to the hospital? … She responded, 'No one is coming forward – the workers are not coming forward…' And I've got all of this paperwork, and I was coming forward. Then I asked the admiral toward the end of our meeting about the use of respirators … His response to me was, 'Since the heat is so tremendous down on the Coast, they would rather not provide respirators, because you would take it on and off of your mouth and you run the risk of contaminating your digestive track with oil.' As if breathing it is ok? … With my lungs I will continually breathe in these chemicals." (Andre Gaines, 13)

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"I had all types of doctors coming by my bedside to study why I could not produce white blood cells. I had a blood transfusion and a toxicologist removed bone marrow twice. He couldn't figure out what was wrong with me either … my right leg turned red and it was incredibly painful. It looked like it had been in a deep fryer, and it has blisters all over it. I thought I was going to lose my leg. They removed my gallbladder and later did surgery on my groin and removed an infectious material from that area. They also gave me foot medication because they were concerned that I had Stevens-Johnson syndrome, which is a potentially fatal skin disorder … I also became anemic after working on the spill." (David Hill, 7)

"National Institute of Environmental Health and Sciences contacted me about their 10-year Gulf Study. They took blood, toenail, fingernail, hair, skin and urine samples. They said they would be contacting me every three months; however, I have not heard from them. Supposedly they want to monitor me for 10 years to study what the health implications are for those of us who worked on the cleanup. However, they are not offering treatment." (David Hill, 9)

"The doctor I met with explained that my liver probably is not functioning correctly and my gull-bladder needs to be removed immediately. I may also have a problem with my pancreas. My tonsils are inflamed and probably need to be removed as well. He explained that my nasals and ear cavities are inflamed. One of my tonsils is bigger than the other with bumps all over it. He said it was a possibility that I was exposed to chemicals while working on the spill. He could notice that my eyes looked drained and aged as well. I used to look and feel much healthier. It worries me because I am only 45 and I have never had a history of poor health … I do not have a regular doctor because I cannot afford one, so I just live with my symptoms." (Richard Russell, 4)

"When we first brought Aleena to Children's Hospital we said we were from Venice, and we shared the history and our concern about being chemically exposed. Kindra said, 'We would like to have a Volatile solvent profile done so that we can see what she is exposed to.' That doctor replied that if we felt like we'd been exposed then that is where we would have to start. She wrote the prescriptions for Aleena to be tested for the Volatile Solvent Profile, and when we called the lab for the results they said the order has been cancelled by hospital administration. This was in 2011. All four of us had the blood tests done and our results were high in Benzene, Xylene and Ethylbenzene" (David Arnesen, 6)

"Before I had the blood tests done, they had that Eco Gulf Restoration Task Force meeting in Pensacola. They provided a print out that explained you could get [VOC] chemicals in your blood by pumping gas, smoking cigarettes, and so forth and I'm like, wait a second, how did my eight year old at the time get [chemicals] in her system?" (Kindra Arnesen, 6)

"Before my father-in-law passed he was in the VA hospital in Jackson, Mississippi, and his doctor was a real nice man. He asked me if my father-in-law had helped out with the spill with his boat. I explained that he didn't help with the spill, but he was down there every weekend on his boat. The doctor said, 'That's what I thought,' and that was the end of the conversation." (Rocky Meadows, 3)

"The office in Mobile did extensive blood work on me. The first time I met the specialist doctor he was reviewing my bloodwork. He said 'My god', and then he put my paperwork down and said, 'You

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need a lawyer, son.' I said that I thought I needed a doctor. He said, 'You need a lawyer.' He told me that my liver is 29 percent full of chemicals and I had been exposed to something … After a year or so of seeing the specialist, I was not getting better so he sent me to a very well known and respected forensic psychologist named Dr. Daniel Koch in Mobile, Alabama. The specialist wanted Dr. Koch to evaluate me for more than one reason." (Rocky Meadows, 3-4)

"Dr. Koch ran every test imaginable, and he reported the findings back to the specialist. He wrote a letter explaining that he believed I have health impacts from the oil spill. He had other patients like me, and some had the same chemicals in their body and symptoms as me. Dr. Koch wanted me to get a lawyer, and he wanted to offer to be an expert witness for me. He was known to fight and go to court on situations where other doctors would not want to represent you in court. One doctor explained to me, 'Whatever I was to say, BP would have 10 doctors saying that it's ignorant and I'm stupid, and I just can't go through all of that.' The specialist explained that he needed to be seeing patents, not a judge or a jury. But he knew that Dr. Koch would fight it. Unfortunately, after I began seeing Dr. Koch he had a stroke, and he can't practice anymore." (Rocky Meadows, 4)

d. Is the Gulf Toxic?

"Tomorrow is not promised to anybody, but BP is speeding up my death and thousands of others. I know people who didn't even work down there, but … they lived by the water, and the dispersants were being sprayed over their homes … I know a woman who had a house 50 feet from the beach. She said that she was scraping the dispersants off the top of her car with a butter knife into piles. If you look at a picture from last year of another woman I know, she was obese. You look at her this year and she is skinnier than 120 pounds. Now she has tumors and blood bleeding from her lungs and all of this kind of stuff, but BP and the government are still saying that there was nothing wrong with Corexit, just as the government said Agent Orange was ok to use." (Andre Gaines, 17)

"During the cleanup there were frequently strong winds at 25 to 30 miles per hour. I believe that we were exposed to the Corexit, because the chemicals from it became airborne or got into the water. I frequently detected a chemical detergent smell on the days that Corexit was sprayed … To my knowledge, BP and the government were only supposed to spray Corexit offshore, not inshore, but it looked like there was dispersed oil inshore. The foamy water would spray the other workers and me in the face. I would come home with my shirt covered in brown spots from where the water splashed me. Shorty after those experiences - within the first month on the job - I started to feel abnormal, as if had a bad cold." (Randy Varney, 1-2)

"During the cleanup my eyes often burned and my nose bothered me. The chemical smell was the most difficult part of the job; it was strong and constant. My dad lives on a lagoon on Gulf Shores and to this day you can smell it from his house. I was coughing all the time and it was difficult to breathe out there because it was hot and I constantly smelled the chemicals from the spill. It smelled like something in the air was burning. I didn't think to ask for safety equipment, however. We were focused on cleaning the oil, and I was told that I did not need any protections." (Richard Russell, 3)

"I am hesitant to even come in direct contact with the Gulf water, and I know we have tourists down

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here who swim in the Gulf. BP did not want to warn the public of the ongoing public health dangers resulting from the spill … I'm concerned that people who do not know any better will swim in it and get sick and possibly get cancer later down the road. I do not go swimming unless it is in a pool." (Richard Russell, 4)

"They were spraying dispersants everywhere around us because this is what the mayor, Robert Craft, wanted. He was convinced this was the quickest way to make the oil disappear. He was a proponent of Corexit because he didn't want to see any oil in the Gulf of Mexico. I felt like it was too soon to open the water only three or four months after the spill. However, Gulf Shores and Orange Beach generate close to 50 percent of sales and lodging tax for Alabama. In 2010, we didn't visit the beach after the spill, but we had family members that did. I have a first cousin who sat on the Gulf Shores public beach the first day after it re-opened. A year later, she developed a brain tumor. It doesn't mean it's necessarily related to the spill, but we are concerned because we know she swam in the water." (Lani Kaiser, 1)

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4. Ecological Impacts

The more toxic Corexit/oil mixture coated the Gulf seafloor and permeated the Gulf's rich ecological web and food chain. Whistleblower reports, empirical evidence, and peer-reviewed scientific research all have shown far greater damage than the government predicted at the time of the BP spill when it authorized unprecedented dispersant use. Moreover, rather than "cleanup" the oil, Corexit dispersed it into the water column and sunk it to the seafloor. In 2014 as much as 10 million gallons of oil were found buried in the Gulf seafloor, and dormant oil continues to be unearthed in the aftermath of storms and hurricanes.[1] Coral, which are sensitive to environmental changes and play a central role in the Gulf ecosystem, continue to experience widespread damage and unprecedented mortality two years after the spill. Gulf fishermen, divers and coastal residents continue to witness the devastation of dispersant use on a daily basis. Corexit not only disrupted an entire ecosystem, but a way of life for coastal communities that recreate in the Gulf and survive on seafood for commercial and subsistence fishing.

A 2013 study by GAP witnesses found that polycyclic aromatic hydrocarbon (PAH) levels in Gulf seafood far exceeded EPA permissible threshold for human consumption when the fisheries were reopened. It also documented high PAH levels in Gulf sediment, seawater and biota.[2] In 2013, research by the Society for Experimental Biology found, "though chemical dispersants may reduce problems for surface animals, the increased contamination under the water reduces the ability for fish and other organisms to cope with subsequent environmental challenges."[3] A 2014 study found that "methane-derived carbon entered the food web through small particles" in the years following the BP spill.[4] Consistent with these findings, GAP witnesses explained how marine life uptake of small dispersed oil droplets would contaminate its catch and result in oiled seafood. Whistleblower from the fishing industry reported that 2013 and 2014 have been their worst years for fin fish and crab yields.

The damage on Gulf coral is arguably the most devastating and revealing of impacts documented in the five years since the BP spill. Corals, comprised of hundreds of individual animals known as polyps, are sensitive to environmental changes and help to assess the full impact of the disaster. Moreover, deep-sea coral provide habitat for many other life forms, including fish and invertebrate communities.[5] Like other marine life, coral often prey on microscopic organisms found in the water column such as the contaminated zooplankton. In addition to the 2013 report conducted by GAP witnesses that found visible signs of polyp mortality in the majority of coral colonies collected off the coast of Grand Isle, Louisiana[6], a 2015 report cautioned that "[l]ittle is known about the stress response of these foundation species yet they are increasingly exposed to anthropogenic disturbance as human industrial presence expands further into the deep sea. A recent prominent example is the Deepwater Horizon oil-spill disaster and ensuing clean-up efforts that employed chemical dispersants."[7] During its examination of coral, it found that higher concentrations of dispersant alone and the oil dispersant mixtures resulted in more severe health declines than exposure to the oil alone.[8]

Whistleblower Record

a. Oil Not Gone

"Days before the fourth of July [in 2010], BP increased its cleanup crew numbers to try and make the beaches look clean in time for the holiday … Instead of cleaning the oil, however, beach cleanup crews were instructed to survey the beaches and cover tar balls with sand … I started dumping sand over the giant tar ball like he told me to do. He had me cover it as much as possible, but I tried to leave spots open so people could see the tar ball was there … I thought to myself, wow, who do you tell when things like this happen?" (Andre Gaines, 4)

"It hurts me to now see the kids digging in the sand, because in many cases the beach cleanup workers covered up the oil with sand. The workers made videos of this practice and posted them online, and I also saw reports of it on the news." (Randy Varney, 4)

"Dispersing the oil into the water column was the worst thing that BP and our government could have ever done to our environment. Even when they had the boats there to pick the oil up and they had the equipment on a beautiful slick calm day, the boats would locate big patches of oil and then they would be sent away so that the planes could come to spray it with dispersant, rather than remove the oil mechanically." (Kindra Arnesen, 4)

"Our job was to find the 'workable' oil - oil that had not dispersed yet. We could not collect the oil in locations where dispersant was sprayed, because it just made a long sheen of miles of little orange and purple droplets and bubbles floating everywhere." (David Hill, 2)

"When we came back from inshore and could only find dispersed oil, we went to ground zero at the site of the Deepwater Horizon explosion. Dispersant was being injected at the wellhead, and we saw a lot of dispersed oil. When the oil was dispersed at the seafloor, it went through different currents in all different locations." (David Hill, 3)

"My sister and I are avid seafood eaters and beachgoers, but neither of us would eat the seafood, go to beach, or swim in the water after the spill. My sister is now living in Seaside, Florida. When there have been bad storms in Seaside, the beach and water become covered in oil. It only takes one good storm to wash the oil back along the shore which is strange for this area." (Lani Kaiser, 3)

"I believe the difference is that when the oil is floating on top, it's like bamboo, so it's not penetrating on the top. When you sink the oil into the roots, it kills it … The dispersed oil came in from the Gulf and went into the vegetation. It looked like you had sprayed RoundUp into the marsh for 60 feet of our coastline. It killed Catfish Bend and Jackass Bay in the surrounding shoreline, and it has increased coastal erosion. Later we came across oil floating during hunting season from another spill. The oil was not dispersed, however. When we went back to the same area this year, the vegetation and shoreline was still there. The oil itself doesn't kill the vegetation, but when they disperse and sink it, it kills it." (David Arnesen, 1)

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b. Seafood Devastation

"[S]ince 2011 we have been catching shrimp that are deformed. I have worked in these bayous and canals my whole life and I never saw shrimp like this before the spill, especially inshore where the shrimp are born and raised. Some look like they had acid dropped on their shell, or they have black gills and tar. Some of the shrimp have sores and tumors on both sides of their heads and discoloration, as if they are rotten but still alive. I only come across a few shrimp without eyes, but some shrimp have eyes that are clear and not fully developed. If you take the heads off the shrimp often look fine, but if you take the heads off and put them in a bag and let the gook ooze out then it turns your stomach." (Randy Varney, 3)

"Just like the beaches, I don't know if the shrimp are safe. The government said it has tested the public beaches and seafood for chemicals, but how am I supposed to feed the shrimp to people when I am catching deformed shrimp?" (Randy Varney, 4)

"As a tour guide I occasionally fish, but I am scared that the water is still contaminated with dispersants and oil. It is difficult not to avoid coming in contact with the water as a guide, however. At times I get small cuts on my hands and then the open wounds are exposed. I'm concerned about touching the water due to the dispersants … Now I do not know whether or not the Gulf seafood that we catch is contaminated." (Richard Russell, 4)

"Until recently, I helped run a seafood restaurant in Louisiana. [The owner] and I decided to close the restaurant after we realized that the seafood we served was contaminated by oil. I could not bear to serve other people's children and grandchildren a product that I did not want my own children to eat. Gulf seafood is being shipped all over the world. Who is going to take care of those made ill by contaminated seafood?" (Confidential Whistleblower, 1)

"We specialized in boiled seafood, and offered boiled crabs, shrimp and seafood platters … One night in June 2012 when we were serving boiled crabs, a patron was eating the crabs and said that she couldn't get a black substance off of her hands, even when she scrubbed it with a napkin. She showed me that when she opened the back side of the crab and squeezed it, a black oil-like substance came out of it. I asked if she would mind if I documented it, in the event that she got sick … I proceeded to give her a wet paper towel with Dawn dish washing liquid and the black substance on her hand came off right away. She then proceeded to keep eating the crabs, at which point I panicked and said, 'Let me get you some fresh crabs.' I had never seen anything like that before the oil spill; I was shocked." (Confidential Whistleblower, 1)

"After the patrons complained about the soft shell crab we decided to stop selling them; we were scared of someone getting poisoned. Folks weren't complaining about hard shelled crabs at that time, but we started findings problems with them as well. After the first oiled crab incident we started paying closer attention and noticed more crabs that looked like they were contaminated with oil. We also started looking more closely at the shrimp; to our surprise, they frequently had no eyes and their heads contained a thick black substance. I didn't know what it was but [the owner] explained that it must be oil." (Confidential Whistleblower, 2)

"[The owner] wanted to figure out what was wrong with the crabs. He put them in a tank and

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placed 10 gallons on cooking oil into the tank. Within days, the cooking oil had disappeared. I believe that the crabs were exposed to Corexit and the Corexit is responsible for this. If the Corexit is going to eat the oil that fast, what is it going to do to a person? [The owner's] processing plant was peeling crabs and he wanted to make sure they weren't contaminated. He contacted the Louisiana Department of Health and Hospitals, and it told him to get a black light to identify any contamination. [He] has photos of the crab under a black light that identifies chemicals, and the crab meat and shrimp are a neon blue color under the black light." (Confidential Whistleblower, 2)

"In 2011 we found black sludge in the fish. In 2012 we found tumors and sores in the livers and stomachs in a percentage of our catch offshore, along with holes penetrating the flesh of the fish. We saw visible signs of oil and damage to the fish in as high as 30 to 35 percent of our offshore catch at one point. As the years progressed the fish began to die off. By 2013 we saw almost a complete devastation in some species. We could find almost zero bait on the water's surface, no matter where we went in our area of the Gulf. In 2013 our mangrove snapper collapsed. In 2012, 2013 and 2014 we have seen a collapse in the king mackerel and amberjack, both of which we fish. Normally when we catch a greater amberjack it is a big fish, anywhere between 35 and 95 pounds. It's normally a head and a really big body that bows out. Now, its head is bigger than its body because they are so under weight. People don't understand that the reason the fish are under weight is because the bait source has been compromised. When you start pulling links out of a chain of life in a body of water, it has a ripple effect." (Kindra Arnesen, 3)

"Now we're not seeing the black sludge or sores that we saw before, but the population has decreased. Fishing is where I make the most money. Yet, BP paid the least amount of money to compensate for fin fish." (David Arnesen, 3)

"Our season last year and the year before were devastated. We had very few king mackerel. They are migratory fish and they won't stop if there is nothing to eat. They will keep going until they find a bait source that they can live on. That is the reason that we always had a lot of king mackerel and now we don't have them." (David Arnesen, 3)

"Here in Louisiana, our shrimp on average before the spill was about 100 million pounds a year. In 2013 Kindra called and asked the docks how many pounds they were down. On average they were about 51 percent down; that is approximately 51 million pounds of shrimp that is not being caught. That's a lot. I shrimp and I know everyone here who shrimps, and we know our catch is down by about half in pounds." (David Arnesen, 3)

"In 2012 I was fishing amberjack in January and February. We caught 10,000 to 12,000 pounds and they were full of roe. From March through May fishing was closed, and the remaining quota we have left over after the January opening then reopens in June. When we started back in June, they still had roe. When you have an entire spawning that doesn't happen then it will really impact the fish stock. The fish are having severe reproductive problems. Even in south Florida in 2012 the mullet roe did not mature, so there was a Gulf wide impact in the spawning process." (David Arnesen, 4)

"It really makes you sad looking at our government agencies and our government itself. Those are the people who are supposed to be in place to protect us and our environment. After the spill we

realized that they are the people attacking us from every direction. It was just like when they told us that we had to go back to work and catch the seafood. We were worried about contamination, so we went to one of the large meetings with EPA and FDA. There are not many docks between here and Grand Isle, maybe 10. We suggested that they put mobile units on the docks. When the boat comes in, we could pull a couple shrimp out and run a chemical test. If they are good then we could sell them. If they're not good then BP should buy them. They responded that the technology and equipment was not available for them to do mobile testing. Did you see the sniff test? Come on." (David Arnesen, 6-7)

"About two years ago a friend of ours went out shrimping, and he came in with a whole bunch of shrimp that has blisters on them and no eyes and black gooey stuff and he wanted them tested. He explained that he didn't know who to call or what to say. So we sat at my table and I called the FDA on speaker phone. We asked them, 'Who do we send this product to in order to have it tested and to make sure it is safe? Do you have someone to test this product?' They responded that it is up to the boat owner and the processor and manufacturer to make sure that the product they are selling is safe. They explained that the FDA is not required to test our product." (Kindra Arnesen, 7)

"I have always been one of those people that if I wouldn't eat the fish off my boat then I'm not going to sell it. We're catching less now, so I go to the middleman now to try and get a better price to try and make the money that I was making with less fish. When I started going to these guys, they were so impressed with how well I take care of our seafood that they wanted me to do Skype videos … They wanted to document the whole process that occurs within 24-hours, because we provide such a high quality product and that is what we strive for. When I'm catching these fish, if I could see anything wrong with them then I would throw them back. No one paid me for a third of my catch that I was throwing back. Worse off, you can't necessarily see the chemical exposure." (David Arnesen, 7)

"In 2011 when we were gutting some of our fish, their entire gut was full of the black sludge, the oil. Some had consumed so much of the oil through the bait fish that it had passed through the stomach wall, through the entire cavity through the meet, and you could see the oil under the scales. This is after the fisheries were open. Up to a third of my catch was like that. We arrive at the dock and the NOAA biologist is there. I gut the fish and we put them in a bucket, and she explains that Louisiana State University does the testing for NOAA and she would take them there. We waited and waited and waited and were eventually told that they disappeared." (David Arnesen, 8)

"We normally have two operations. Bayou Side is the live crabs and raw product. Cajun Crab is the factory that provides our boiled and cooked product. We haven't had enough crabs to operate Cajun Crab since November. That's really odd, because normally we will go until the middle or end of January before we start shutting it down. Crabs this year and last year have been two of the worst years for crab amounts that we've ever seen. It's as simple as that. Crab amounts in this area, from Morgan City all the way to the East, are the worst they have ever been. The last two years have been the worst. Everyone has been changing the way they do things around here in order to survive. They have been cutting back here, cutting back there." (Eric Blanchard, 1)

"Usually at this time a year we ship at least 30 to 40 boxes a day. Yesterday we shipped five boxes

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total. Early spring is when crabs start coming, but you can see that the numbers are not there. They have huge differences in the production, from Morgan City eastward. Everyone is complaining, and the key indicator for me that something is wrong is the number of crabs. The landing data for crabs has to be off, because I see it here. The biggest concern is the lack of seafood production." (Eric Blanchard, 1)

"If BP would look at the money made by these companies that would say everything is back to normal, but it's not. Even though fishermen made some money last year, it was because the price of oysters and crabs are high. It hurts our company because we make our revenue from volume, not price. Now a number one crab, the large male crabs, is $5 a pound. That is unheard of. The highest they got before the spill was in the $2 range. Number two males are $3.75. They were in the $1 range before the spill. Females barely got above the dollar before the spill, and now they're at $3.50. For me to buy oysters I have to pay $45 a sack. Before the spill I would pay $20 to $25 for a sack. The oysters aren't doing that great. That is the situation we're in; everyone has to alter their way or doing things in order to survive. And unfortunately, we are in survival mode. "(Eric Blanchard, 1)

"I have been in business since 1980. That is when I started crabbing and started selling crabs … I started a crab factory, and my idea was to keep growing … The crabs here are the same color as the Chesapeake Bay blue crabs … From Lake Charles to Venice, they all sell their crabs to Baltimore … A lot of people don't understand that these crabs go to Baltimore and the East Coast. Most people don't know that they are eating polluted crabs. They are sold as Chesapeake Bay crabs but they're from Louisiana. The Baltimore truck was here earlier to pick them up, but they didn't come today because we didn't have enough crabs. The worst part is in Baltimore, because they steam the crab. They add the spices and people eat the crab with their hands. That's the most dangerous because the shell is contaminated and people touch it and then eat it. It's the same with the shrimp; most people don't remove the black line, but that part is the most dangerous because it is the feces. BP sank the oil to in the bottom of the ocean now, so the shrimp and crab and are eating the dispersed oil. When the seafood eats it, the people also eat it. You don't have to be a scientist to understand that." (Ollen Blanchard, 2)

"In July of 2014 we took approximately 2,000 crabs. These crabs are from Cocodrie's outside edge, but we brought them in from Chauvin. We put the crabs, I was working with a man who has a soft shell crab system … The filters were set up and running several weeks in advance to make sure that the water chemistry was stable. We put them in and only two crabs made it in six days. I was shocked. We lost 250 pounds in the first day and then proceeded to lose about 50% a day for the next several days. I was trying to replicate my coral depuration to see what came out of them. Similarly, a brownish foam with black spec condensate came out. It was a thicker and heavier compound that came out and sat on top of the foam. As the crabs were dying I took them out and placed them in buckets of water to see if something was leeching out of them. A rainbow sheen leached out." (Scott Porter, 1)

"We are seeing those tentatively identified compounds in the test results. The benzene rings don't disappear easily, however. If there were chemicals digested or brought in by the crab, chances are that they won't look exactly the same after they have been metabolized. That is what we're trying to determine, and that is really the hard part. The government should be doing this, because they have

the money to run the analysis and see what the results are … They did find benzene rings in the crab samples, which I understand to be an indicator of oil exposure. Benzene symptoms include reproductive damage and it can make you lethargic." (Scott Porter, 1)

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5. Dispersant Reform

The government must reform dispersant policy so that we are not faced with the same public health dilemma during the next oil spill. It can take immediate action by banning the use of toxic dispersants, including Corexit. The more fundamental reform is to control and prevent future damage until the research on dispersants has been fully developed. In honor of Earth Day, Congressman Jerrold Nadler (D-NY) reintroduced the Ban Toxic Dispersants Act of 2015, which would require a temporary moratorium on the use of dispersants until rulemaking and a study to ensure their safety is complete. Rep. Nadler cautioned: "Recent studies have shown that exposure to Corexit may have been worse than the oil itself. We must follow the lead of Britain, and ban the use of dispersants that threaten the health of people, fisheries, marine mammals and their habitats."[21] To commemorate the BP disaster's fifth anniversary, Gulf community groups declared April 15 the End Toxic Dispersant Use Day of Action.[22]

After mounting public pressure, in January 2015 the EPA released a proposed rule to amend parts of the National Contingency Plan (NCP) that govern use of dispersants, other chemical and biological agents, and other spill mitigating products, when responding to oil spills in salt water and fresh water in the United States. According to the EPA, the proposed rule incorporates lessons learned from the federal government's experiences in the Gulf, as well as recommendations on agent use by the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling Report to the President.[23]

Although the proposed rule does not ban the use of toxic dispersants, it includes several improvements to dispersant regulations to control its use, including consideration of a product's toxicity, long-term environmental impacts, endangered species protection, and human health concerns. It also strengthens controls on planning requirements for dispersant use authorization, toxicity thresholds, and advanced monitoring techniques. Yet, the EPA is receiving considerable pushback from the oil and gas industry, and the current proposal does not go far enough in many areas.

For instance, while it includes human health and environmental standards for EPA to "delist" dispersants, the EPA still has too much discretion on when it must act to remove dispersants from the NCP. Moreover, the proposed rule still relies on manufacturer science rather than independent research to evaluate product safety and efficacy. Further, the revised toxicity testing standards are still too weak to prevent the listing of dispersants and other products that may harm human health and the environment.

This section will identify strengths in the current proposal, and make additional recommendations, as they pertain to human health and the environment. Recommendations incorporate lessons learned by whistleblowers, who should be the pioneer witnesses providing a foundation for this effort. Throughout GAP's investigation whistleblowers provided clear warnings and practical solutions that could have greatly reduced the disaster's health and environmental impact. They began by warning not to treat chemicals with chemicals, a premise that was ignored.

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The ALERT Project and the Prince William Sound Regional Citizen's Advisory Council have developed comprehensive technical comments.[24] While GAP is generally supportive, many go beyond the scope of this investigation or GAP's area of expertise. However, several recommendations that pertain to dispersants and product safety are incorporated below.

Testing Requirement

The proposed rule would "revise the toxicity testing requirements for dispersants, including the testing protocol and the use of the test results. The proposal would require acute toxicity testing for the dispersant alone, and the dispersant mixed with both oils used for efficacy testing."[25]

The EPA adjustments to testing requirements are a step in the right direction. For instance, as demonstrated by revelations that the oil/Corexit combination becomes 52 times more toxic than the oil alone, it is significant that the proposal accounts for the combined toxicity of the oil and dispersants. However, the proposed requirements are not sufficiently stringent to prevent the listing of dispersants and other products that harm human health and the environment. The EPA should require maximum toxicity test standards and minimum effectiveness standards for all agents, including potential adverse endocrine, immune, or developmental effects to human populations or the environment[26] [27]

Further, the proposed rule still relies on manufacturer science for product efficacy and toxicity. At a minimum, the EPA should require a controlled sample of independent testing to verify industry science and data. Specifically, the EPA should audit or independently vet studies to ensure fairness and transparency. It should require independent science or rigorous peer review of all studies conducted by the spiller or product vendor or manufacturer.[28] [29]

Removal of a Product from the Schedule

Among other criteria, the proposed rule would clarify that the EPA can remove a product from the Schedule if there is "[m]isleading, inaccurate, or incorrect statements within the product submission to EPA or to any person or private or public entity regarding the composition or use of the product to remove or control oil discharges, including on labels, advertisements, or technical literature; or Alterations to the chemical components, concentrations, or use conditions of the product without proper notification to EPA [or]; …New or previously unknown relevant information concerning the impacts or potential impacts of the product to human health or the environment."[30]

This is a significant measure for disclosure, but not for the ensured protection of human health or the environment. The EPA should have a pro-active duty to enforce standards, not limit enforcement action to false statements. The EPA should remove all products that contain known or suspected human health hazards or proprietary or secret ingredients that would prevent public disclosure of the chemicals in the product being used. Further, the EPA should add specific criteria for product removal such as product discontinuation, monitoring studies that find unanticipated consequences to the environment and/or human health, or changes in community acceptance especially in areas where product is being or was used.[31]

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Authorization of Use

The proposed rule would "clarify planning and preauthorization responsibilities, establish limitations and prohibitions on the use of certain agents, establish requirements for storage and use of agents, clarify authorities for requiring supplemental testing, monitoring and information on agents, establish requirements for agent recovery from the environment, and establish reporting requirements for agent use."[32] Under the proposed rule, the scope of preauthorization plans would be increased. In areas without preauthorization plans, it would take into consideration agent use parameters, including but not limited to quantity limitations, duration of use, distance to shore, and proximity to people.[33]

While it is important to clarify the scope of the preauthorization plans and to establish response measures for where there are gaps, it should include provisions to protect human health and the environment and ensure that committed decision makers are chosen accordingly.[34] During the BP disaster response, USCG asserted authority over the EPA regarding the use of dispersants, and then acted collusively with BP to thwart environmental enforcement. The EPA should clarify its authority under the Clean Water Act to make the final call on any product use. Further, the proposed rule should require that OSHA and the Department of Human Health and Services (DHHS) review the Area Contingency Plans.[35] Throughout the preauthorization process the EPA should prioritize consultation with scientific experts and natural resource trustees.[36]

Monitoring the Use of Dispersants

The proposed rule would "[e]stablish monitoring requirements for dispersant use in response to major discharges and/or certain dispersant use situations," including subsurface dispersant use and dispersant use over an extended period of time. Specifically, the proposed rule would require the responsible party to monitor the environmental impacts and efficacy of the dispersant being used.[37]

The monitoring of environmental impacts is a significant requirement. But it is only half the problem. The EPA should also require *human health* monitoring, and monitoring should take place for as long as is deemed necessary to understand a product's long-term impacts on humans and the environment.[38] In addition, the responsible party should not be in charge of conducting the monitoring due to an inherent conflict of interest. The natural resource trustees should conduct monitoring for wildlife and ecosystem impacts, and OSHA and DHHS should conduct monitoring for human health impacts. Monitoring should be funded by the Oil Spill Liability Trust Fund.[39]

Distribution of Safety Data Sheet

The proposed rule rightfully acknowledges "chemical and biological agents may contain substances that could cause harm to oil spill responders who, if unaware of the product's formula, may not wear the proper personal protective equipment." The proposed rule would require that the Safety Data Sheet (SDS) of a product be provided to both On-Scene-Coordinators and responders when authorizing and using a dispersant or other product.[40]

The requirement for greater dissemination of a product SDS is an essential lesson learned from the

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BP disaster. It is a prerequisite for responders to know the health risks associated with exposure to Corexit or other toxic products. Tragically, SDS warnings were virtually absent during the BP spill response. 100 percent of GAP witnesses who worked on the cleanup reported that they were provided minimal or no personal protective equipment. They were exposed without warning. Nearly all witnesses reported that they were not aware of available safety literature on the job site. The EPA should ensure that the public has access to this information, as GAP witnesses who did not work on the cleanup frequently reported direct exposure to Corexit and dispersed oil.

Further, the EPA should require that the submitter provide all additional information on potential adverse human health effects based on the product's formula and application methods not captured in the SDS. As demonstrated by BP's failure to ensure its employees had access to Corexit SDS during the spill response, the spiller cannot be trusted to warn workers and the public of human health impacts associated with dispersants. The SDS and all additional information should be displayed prominently on the EPA, OSHA and DHHS websites. The EPA should require that it be distributed to all responders by OSHA personnel *prior* to product use, through HAZWOPER and other worker safety trainings.

Implement Public Notification Policy for Dispersant Use

There is currently no requirement for the government or oil companies to notify the public when a dispersant is used. If dispersants continue to be used, the public has a right to know when and where through public notice and warnings. Many residents and workers believe that dispersant use continues today. As long as it remains a legal option for industry, those fears are warranted. During a meeting at BP headquarters in 2012, BP stated the company will continue to consider Corexit for use, except when stopped by the government. *The proposed rule does not prevent residents from being blindsided by poison again.* This is flatly unacceptable. The public has a right to know when their families are exposed to dispersants whose health impact may range from nightmarish illnesses to death.

Whistleblower Record

a. Public Left in the Dark

"My feelings on this matter are that it would be an abomination for us to continue to allow this chemical (Corexit) to be used in light of the likelihood that is was responsible for the horrendous illnesses that have been experienced by my patients. Unfortunately, these illnesses have been cleverly hidden from public recognition and most of the suffering of my patients has been unrecognized and ignored." (Dr. Michael Robichaux, 1)

"My wife and I, along with two representatives from the GAP (the Government Accountability Project) who arranged the trip, met with BP representatives at their U.S. headquarters in Houston. We petitioned the company to discontinue using this chemical in any future oil spills because of our suspicions that it had been responsible for most of the serious illnesses we had been observing. They declined to make that commitment to us, and when we requested that they notify us before

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using the chemical in the future, they said they would get back to us with their decision on this matter. We have not heard from them since that time." (Dr. Michael Robichaux, 1)

"[W]e would see planes flying but I had no idea that they were spraying the dispersants in order to sink the oil. The dispersant planes would fly right over me a few times a day. It seemed like they would go from the North side of the bridge from Jack Edwards Airport out toward the Gulf where there remained a concentration of oil. Often the planes spraying the dispersant were Coast Guard planes." (Richard Russell, 3)

"Last year we accidently found this big spill. We were just trying to film the marsh and infrastructure, and I took the kids because we weren't going into the Gulf and it was a nice day. When we arrived, we accidently found this huge spill in the state wildlife reserve. The people here were never notified. They don't notify us about anything. If we don't accidently come across an oil spill or dispersant use then we don't know about it. If there is a spill and toxic chemicals within an ears shot of me then I'd like to know." (Kindra Arnesen, 1)

"The news said that they weren't going to spray Corexit at night, but they were still spraying during that time. The news was also telling us that Corexit wasn't dangerous. You could see the oil spill workers walking along the beach, and they didn't have protective clothing on, so initially we didn't think twice about it. There is a lady who lives about a mile from my home, and she tried to take a photo of the planes spraying at night. Her whole family is so sick, they are practically dead. She can't even talk anymore; she is just a vegetable." (Rocky Meadows, 2)

b. Workers Misinformed and Exposed

"We all would monitor a particular marine VHF radio channel and we could hear the airplanes that were spotting the oil … The dispersant planes knew what channels we were monitoring, and when they were going to spray they would communicate with us through our channel and ask us to vacate the areas immediately. The closest a dispersant plane got to our vessel was three miles away. I could see it spraying dispersant. The plane was north of me and the wind was blowing from the north shore, so it drifted toward us." (David Hill, 3)

"At all of the safety and HAZWOPER meetings the instructor would say, 'Oh, the tar balls are safe once they sit in the water for 48 hours,' and that anything harmful would dissipate. It felt like anybody could run these safety meetings, because we were given such little educational material … I didn't learn anything about chemical exposure until I started taking safety classes on my own by OSHA, paying out of my own pocket … They didn't give out any safety training materials – not a booklet, not a pamphlet." (Andre Gaines, 2)

"In the future, oil spill cleanup workers should receive HAZMAT training and be fully informed of the potential health risks associated with the chemicals that they will be exposed to, before they begin working … We have a right to know what we are being exposed to." (Randy Varney, 4)

"During my second job on the VoO program I became the captain of a large supply boat for about one month. I do not remember receiving any safety information or literature when I worked as a captain … My third job on the VoO program involved pulling boom with one of my large vessels …

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We were pulling boom between our boats, and my boat was regularly sitting in the dispersed oil. The dispersant looked like bubbly white foam." (Richard Russell, 1-2)

"While working on the cleanup, I received no safety training, no safety equipment, no briefings and no safety meetings. However, from training in my earlier occupations I knew that any occupation's safety regulations were required to be kept on the vessel. There was nothing in the regulations book on our vessel that warned of chemicals or hydrocarbons or dispersants." (David Hill, 1)

"I understand now that my crew and I were bound to have health problems, with inadequate protective equipment and chronic chemical exposure. However, during most of our time on the job we never had a conversation about our health; we weren't thinking about it. We were too focused on cleaning up the oil." (David Hill, 4-5)

c. After the BP Disaster Response

"Dispersant is being used a lot more I believe now than before the disaster. Apparently they deemed that it worked so well for the BP oil spill that they've chosen to put [dispersant sprayers] on the jack up barges now. They put the hose into the pipe and let it rip, and the dispersants are right there. This is occurring more inshore from what I have witnessed." (Kindra Arnesen, 1)

"We have a spill here 365 days a year, from one to three every day. Three cleanup companies down here work every day of the week … They rigged up flat boats, jack up barges, and everything has dispersants on it now. They sprayed in the Mississippi Sound last in August, September and October of 2014. Those are the only three months I work out there. There is not more than 20 feet of water anywhere in the Sound and they have terrible spills, because that is an old [oil] field out there. There were miles of oil out there and they dispersed all of that. One man I worked with on the BP spill still works for Oil Mop now, and their flat boat had the tank and pump to spray dispersants. I said, 'Man, you all aren't wearing masks?' and he said 'That stuff's no more dangerous than Dawn dishwasher soap; it's not going to hurt you.' They're convinced that dispersants are not dangerous." (David Arnesen, 1)

"One thing that needs to change is who is in control of the cleanup when it occurs. You shouldn't have the companies that caused the spill then running and operating the cleanup; you won't get an honest outcome when they are also responsible for footing the bill of the oil that is picked up. The company should still foot the bill, but someone else has to control the operation." (Kindra Arnesen, 4)

"I personally believe that there are other dispersants that are more effective and less harmful to the environment and its human inhabitants. I also believe that using a safe and effective dispersant is preferable to allowing huge quantities of oil to saturate our coastline." (Dr. Michael Robichaux, 2)

"We should ban any and all toxic forms of dispersant. If it's banned to begin with then it can't be readily available because it won't be here. There are safe ways to disperse of the oil that cannot be mechanically collected. Let's make something readily available that is not so toxic, such as a bioremediation product. Currently there are less toxic forms of dispersants that can be used, but even those should only be used as absolute last resort. When there is a mechanical way to pick up

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oil, that is the way it should be done. You can't sink oil that is picked up and put it 'out of site, out of mind.'" (Kindra Arnesen, 4)

"It is critical that an objective assessment of the National Contingency Plan be undertaken. Every conceivable effort should be made to prevent the errors of judgment that resulted in the environmental disaster that we are still experiencing. BP and its cohorts have had their day and their way and the results have been devastating to our environment. It is time for honest and intelligent decisions to made by honest and intelligent individuals." (Dr. Michael Robichaux)

[redacted]

[illegible] Chemier et al., *Fossil Carbon in Particulate Organic Matter in the Gulf of Mexico Following the Deepwater Horizon Event*, Environmental Science and Technology Letters (Dec. 2013), *available at* http://pubsaccs.org/doi/abs/10.1021/es4001424.

[illegible] National Oceanic and Atmospheric Administration, Ocean Exploration and Undersea Research, http://www.research.noaa.gov/oceans/4_deepseacorals.html (last visited Apr. 15, 2015).

[illegible] Steve Kellan et al., *Degradation of Macondo (MC-252) Oil Found in Hetero-Trophic Scleractinian Corals (Tubastrea coccinea and Tubastrea micranthus) on Offshore Oil/Gas Platforms in the Gulf of Mexico*, Gulf and Caribbean Research (Apr. 2013), *available at* http://www.ecomgs.org/GandCResearch/8-0-0.pdf.

[illegible] Danielle M. DeLeo et al., *Responses of deep-water corals to oil and chemical dispersant exposure*, Science Direct (Mar. 2015), *available at* http://www.sciencedirect.com/science/article/pii/S0967064515300074.

[illegible] *Id.*

[illegible] Press Release, For Earth Day, Nadler Proposes Ban on Toxic Dispersants Used in Oil Spills (Apr. 21, 2015).

[illegible] Gulf South Rising, Gulf Coast Week of Action April 15 – 22, https://www.facebook.com/events/1562556780963319/permalink/1567050473547133/ (last visited Apr. 20, 2015).

[illegible] National Oil and Hazardous Substances Pollution Contingency Plan, 80 Fed. Reg. 3379 (proposed Jan. 22, 2015) (to be codified at 40 CFR 110 and 40 CFR 300), *available at* https://www.federalregister.gov/articles/2015/01/22/2015-00544/national-oil-and-hazardous-substances-pollution-contingency-plan.

[illegible] The ALERT Project, 10 Key Points on the New Rules for the National Contingency Plan, http://alertproject.org/ten-key-points-on-the-new-rules-for-the-national-contingency-plan/ (last visited Apr. 17, 2015). Prince William Sound Regional Citizens Advisory Council, Summary Comments on Subpart J, *available at* http://www.pwsrac.org/wp-content/uploads/filebase/programs/environmental-monitoring/dispersants/Key%20Issues%20and%20Summary%20Comments%20on%20Subpart%20J.pdf.

[illegible] The ALERT Project, 10 Key Points on the New Rules for the National Contingency Plan, http://alertproject.org/ten-key-points-on-the-new-rules-for-the-national-contingency-plan/ (last visited Apr. 17, 2015).

[illegible] Prince William Sound Regional Citizens Advisory Council, Summary Comments on Subpart J, *available at* http://www.pwsrac.org/wp-content/uploads/filebase/programs/environmental-monitoring/dispersants/Key%20Issues%20and%20Summary%20Comments%20on%20Subpart%20J.pdf.

[illegible] National Oil and Hazardous Substances Pollution Contingency Plan, 80 Fed. Reg. 3379 (proposed Jan. 22, 2015) (to be codified at 40 CFR 110 and 40 CFR 300), *available at* https://www.federalregister.gov/articles/2015/01/22/2015-00544/national-oil-and-hazardous-substances-pollution-contingency-plan#p-53.

[illegible] The ALERT Project, 10 Key Points on the New Rules for the National Contingency Plan, http://alertproject.org/ten-key-points-on-the-new-rules-for-the-national-contingency-plan/ (last visited Apr. 17, 2015).

[illegible] National Oil and Hazardous Substances Pollution Contingency Plan, 80 Fed. Reg. 3379 (proposed Jan. 22, 2015) (to be codified at 40 CFR 110 and 40 CFR 300), *available at* https://www.federalregister.gov/articles/2015/01/22/2015-00544/national-oil-and-hazardous-

substances-pollution-contingency-plan#p-53.

[33] The ALERT Project, 10 Key Points on the New Rules for the National Contingency Plan, http://alertproject.org/ten-key-points-on-the-new-rules-for-the-national-contingency-plan/ (last visited Apr. 17, 2015)

[34] *Id.*

[35] *Id.*

[36] Prince William Sound Regional Citizens Advisory Council, Summary Comments on Subpart J, *available at* http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/Key%20Issues%20and%20Summary%20Comments%20on%20Subpart%20J.pdf.

[37] National Oil and Hazardous Substances Pollution Contingency Plan, 80 Fed. Reg. 3379 (proposed Jan. 22, 2015) (to be codified at 40 CFR 110 and 40 CFR 300), *available at* https://www.federalregister.gov/articles/2015/01/22/2015-00544/national-oil-and-hazardous-substances-pollution-contingency-plan#p-amd-19.

[38] The ALERT Project, 10 Key Points on the New Rules for the National Contingency Plan, http://alertproject.org/ten-key-points-on-the-new-rules-for-the-national-contingency-plan/ (last visited Apr. 17, 2015)

[39] *Id.*

[40] National Oil and Hazardous Substances Pollution Contingency Plan, 80 Fed. Reg. 3379 (proposed Jan. 22, 2015) (to be codified at 40 CFR 110 and 40 CFR 300), *available at* https://www.federalregister.gov/articles/2015/01/22/2015-00544/national-oil-and-hazardous-substances-pollution-contingency-plan#p-226.

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Glossary

Boom: A temporary floating barrier used to control the spread of oil to reduce the possibility of polluting shorelines and other resources, as well as to concentrate oil in thicker surface layers, making recovery easier

C-130: A four-engine military transport aircraft, used to spray dispersants during the BP spill response

Contingency plan: A document that describes a set of procedures and guidelines for containing and cleaning up oil spills

Corexit: The chemical dispersant used during the BP spill response

Detoxification: Also known as "detox", the physiological or medicinal removal of toxic substances from the human body

Dispersant: Chemicals that are used to break down spilled oil into small droplets

DHHS: U.S. Department of Human Health and Services

EPA: U.S. Environmental Protection Agency

FDA: U.S. Food and Drug Administration

On-Scene Coordinator (OSC): Coordinates all federal containment, removal, and disposal efforts and resources during an oil or hazmat incident

HAZMAT: An abbreviation for hazardous materials

HAZWOPER: Hazardous Waste Operations and Emergency Response

Safety Data Sheet (SDS): An important component of product stewardship and occupational safety and health, it is intended to provide workers and emergency personnel with procedures for handling or working with that substance in a safe manner

National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling Report to the President: A bipartisan presidential commission, established by Executive Order 13543 to examine the root causes of the Deepwater Horizon explosion and develop options to guard against, and mitigate the impact of, future oil spills associated with offshore drilling

National Contingency Plan: The federal government's blueprint for responding to both oil spills and hazardous substance releases

National Institute of Environmental Health and Sciences (NIEHS): A research institute housed under the National Institute of Health, HHS

NOAA: U.S. National Oceanic Atmospheric Administration

Oil plumes: Underwater globules of oil that do not float to the surface of the ocean. The heavy use of chemical dispersants, which breaks up surface oil, is said to have contributed to the formation of these plumes

Oil Pollution Act (OPA): A law designed to prevent oil spills, ensure cleanup if they happen, and restore natural resources injured by these spills

OSHA: U.S. Occupational Safety and Health Administration

Polycyclic aromatic hydrocarbons (PAH): A family of chemical substances that are found in many types of oil, and include known carcinogens

Personal protective equipment: Equipment worn to minimize exposure to a variety of hazards

Sediment: Loose particles of sand, clay, silt, and other substances that settle at the bottom of a water body

Sheen: A very thin layer of oil floating on the water surface

Tar balls: Dense, black sticky spheres of hydrocarbons; formed from weathered oil

Toxicity: The inherent potential or capacity of a material to cause adverse effects in a living organism

Tyvek suit: A suit used to protect people from chemical hazards and contamination

Volatile organic compounds (VOCs): Include a variety of chemicals that evaporate quickly and can cause nerve damage and behavioral abnormalities in mammals when inhaled

Volatile solvent profile: A blood test used to help identify a patient's prolonged exposure to the most commonly found volatile solvents that have been shown to cause serious health problems

Vessels of Opportunity (VoO) Program: Created to employ local boat operators during the cleanup, it extended to near shore and offshore activities such as identifying oil, working with boom and skimming.

Water column: A conceptual column of water from surface to bottom sediments

USCG: U.S. Coast Guard

Appendix

Whistleblower Witness Statements

(Presented in alphabetical order)

Whistleblower Witness List*

David Arnesen: Louisiana expert fisherman

Kindra Arnesen: Louisiana resident and community activist

Eric Blanchard: Director of Operations for Louisiana seafood processing plants

Ollen Blanchard: Owner of Louisiana seafood processing plants

Andre Gaines: Supervisor during the cleanup

David Hill: Vessels of Opportunity captain

Lani Kaiser: Florida resident

Alton "Rocky" Meadows: Mississippi resident

Dr. Michael Robichaux: Louisiana physician

Scott Porter: Diver, coral and oyster biologist

Richard Russell: Vessels of Opportunity captain

Randy Varney: Captain and cleanup worker during the cleanup

Confidential Whistleblower: Partner of a former Louisiana seafood restaurant

* Affidavits are included in the appendix. Statements and interviews can be provided by the Government Accountability Project upon request and with the permission of the witness.

DH

AFFIDAVIT

My name is David Hill. I am submitting this statement without any threats, inducements or coercion, to Shanna Devine, who has identified herself to me as an investigator with the Government Accountability Project. I was born in Mobile, Alabama (AL) and raised in the fishing village Bayou La Batre. I am 53 years old. As a fourth generation fisherman in the Gulf of Mexico all my life, I was very concerned about what was happening in the aftermath of the Deepwater Horizon explosion. I wanted to do all that I could to help clean up the oil. For approximately nine months I worked as a captain on the cleanup with three different companies. There are no limitations on the use of this statement.

1. FOURTH GENERATION FISHERMAN

I am a fourth generation fisherman on both sides of my family. I began working with my father and catching shrimp at age seven. During high school and after I graduated, I worked in the fishing industry as a boat captain. I have spent at least three quarters of my life working in the fishing industry, offshore in the Gulf of Mexico. I continued in the fishing industry until I was 40 years old, and then I went to Houston Marine in New Orleans for maritime training. In 2005 I received my Coast Guard 100 ton master near coastal captain's license. I also received a 200 ton ITC international mate license. In 2007 I upgraded to a 200 ton master and 500 ton mate captain's license. I immediately went to work on a utility vessel in the offshore oil field. I spent 10 years working in that field, with different companies.

DH

2. VOO CAPTAIN; VIOLATIONS OF MINIMAL SAFETY PRECAUTIONS

I worked in the offshore oil field until April 2010, when the BP oil spill happened. I worked on the BP Vessels of Opportunity (VoO) program from May 2010 until November 2010, when the site that I was working from in Port Fourchon closed down. I went through an agency in Mobile and was placed with BP contractor KMJ Services, Inc. I was the lead captain for a 180 foot vessel that had functioned as an offshore supply vessel. The vessel was already outfitted for the VoO program. As the boat captain on a vessel of that size, there was a lot expected of me. I took over the vessel and quickly learned how to identify oil and catch it in skimming rigs and boom.

While working on the cleanup, I received no safety training, no safety equipment, no briefings and no safety meetings. However, from training in my earlier occupations I knew that any occupation's safety regulations were required to be kept on the vessel. There was nothing in the regulations book on our vessel that warned of chemicals or hydrocarbons or dispersants. The information involved standard safety protocol, such as to stay hydrated. It was my responsibility to relay the basic safety information to the crew during our daily safety meetings. Three employees from the BP contractor Ameri-Force stayed on the deck and handled the boom and skimming. The crane operator was also an Ameri-Force employee. There were two to three Coast Guard personnel on the vessel overseeing the project.

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DH

The contractor Ameri-Force was hiring anyone who would work on the cleanup, even if they were unqualified. I was in close quarters with everyone on the boat. I worked side by side with them, ate dinner together and listened to their chatter, and ultimately I got to know my crew and their backgrounds. I also had a bird eyes view of the deck and could see a lot of them make rookie mistakes. These guys, like shoreline cleanup workers, found an avenue where they could get a job and go to work for $300 to $400 a day without education or extensive training.

3. OBSTACLES TO CLEANING UP DISPERED OIL

I was part of the response team Western Strike Force. We were located on the west side of the Mississippi River. The spill was on the east side of the river. As soon as it was light enough to see, we wanted to go to work. At one time the Western Strike Force had as many as 14 vessels of similar size or larger than my vessel. Our job was to find the "workable" oil - oil that had not dispersed yet. We could not collect the oil in locations where dispersant was sprayed, because it just made along sheen of miles of little orange and purple droplets and bubbles floating everywhere.

There were many different currents, so it was difficult to locate the oil. Often the current would carry the oil miles away from the wellhead before it surfaced. Our vessel's Coast Guard leader took orders from Houston on what to do and where to go to look for oil. They were using satellite imagery and airplanes to locate the oil. The Coast Guard representative would ask us to space our vessels out one mile apart; we were searching for oil collectively. When we found workable oil, he would tell us to deploy equipment and begin work at that time.

DH

My boat on the Western Strike Force was one of the first to be outfitted. I had 1,800 barrel capacity "mud tanks," which are tanks traditionally used for drilling fluids, but in this case they were used to contain the oil. We had on-board pumps as well. When the vessel skimmed the oil, it went through the pumps. The oil was so thick that it tore the pumps. I couldn't go faster than one mile an hour or else we would lose the oil that was contained in the boom. The workers would pull the soiled oil boom in by hand and pile the nasty mess on the boat. They wore Tyvex suits that did not sufficiently cover them, because the vessel was fairly low to the water and the oil would spray all over their faces and hair from the waves and wind. When oil got inside of the boat or upper decks I would have one of the vessel crew members clean it up so that it wouldn't track onto the boat. The oil was supposed to remain in the back of the boat.

Once we got the boat loaded at full capacity, I would usually have to wait three to four days alongside the barge to offload the oil. After a long wait, I would frequently be informed that the barge was inoperative and we would proceed to offload the oil inshore. It would take 15 tractor trailer trucks to unload our product at that point. The delay in offloading the product resulted in prolonged exposure to toxic fumes from the oil, such as benzene, toluene and xylene.

Most of my time on the cleanup was spent north of the spill. In May and June, my vessel worked in the Florida straight. At one point I got as close as 40 miles from Pensacola, Florida. As the oil

DH

drifted toward Alabama and Florida, we deployed to find it before it hit the shorelines. We wanted to be heroes and prevent the oil from reaching the Alabama and Florida beaches.

When we had foul weather we were sent inshore to a safe harbor. When the weather got better we began to look again in an area we had just left. After we went back out, I saw dispersed oil everywhere. There was no skimmable oil, nothing that my equipment would pick up. We all would monitor a particular marine VHF radio channel and we could hear the airplanes that were spotting the oil. We also could hear and see the planes that were going to spray dispersant. The dispersant planes knew what channels we were monitoring, and when they were going to spray they would communicate with us through our channel and ask us to vacate the areas immediately. The closest a dispersant plane got to our vessel was three miles away. I could see it spraying dispersant. The plane was north of me and the wind was blowing from the north shore, so it drifted toward us. On the second occasion the plane was seven miles from me and approximately 40 miles offshore from Pensacola.

We would work from sunrise to sundown. There was a lot of fatigue; it was tiresome. Whenever we finished for the day we put our equipment away and tried to get out of the oiled areas so that we didn't drift into the dispersant at night. Despite my best efforts, we often couldn't escape it and had to sleep over patches of oil and dispersed oil. After the frequent dispersant sprays, I developed a skin rash, blurred vision, headaches and dizziness.

4. CHEMICAL EXPOSURE, AIR MONITORS BROKEN

When we came back from inshore and could only find dispersed oil, we went to ground zero at the site of the Deepwater Horizon explosion. Dispersant was being injected at the wellhead, and we saw a lot of dispersed oil. When the oil was dispersed at the seafloor, it went through different currents in all different locations. We finally found oil to contain about four miles east of the rig. Workers were conducting in-situ burns in that area. They would contain the oil with two boats and then have a small boat throw a flare into the oil to light it on fire. They would continue to skim oil while the other oil was burning.

On July 10, 2010 the in-situ crews got close to our boat while burning the oil, and I was very concerned about my crew's safety. I asked them to turn around and they responded, but as they turned a huge black smoke plume from the in-situ burn engulfed my boat. It went from day to night. I had to call the Coast Guard, because one of our men – an Ameri-Force employee – passed out during that incident. He was lying on the deck and flopping like a fish, and we didn't have any medical equipment on the vessel to assist him. A nearby fast response vessel named Miss Lauren overheard what was going on. It had Coast Guard personnel and the necessary medical equipment, so its crew transferred my sick crew member from my vessel to the Miss Lauren. From there, the Coast Guard took him inshore to receive medical help. I did not receive any additional information about him or his health. However, it worried me because he was only in his late 20's and in good shape when the incident occurred.

During that incident and throughout my time on the cleanup, we did not have respirators or defibrillators on board. We also did not have anyone on our boat that was medically trained in the event of an injury. Prior to working on the cleanup, I received respirator training and was test fitted to wear a respirator. The training course emphasized that if there is a hydrogen sulfide (H2S) gas outbreak, you must leave the area immediately. Otherwise, it can be fatal. There are warning signals available that can detect H2S gas and alert you to leave the area immediately. When I worked in the offshore oil field, often our vessels were outfitted with those devices. However, none of that was provided when I worked on the cleanup, and I later learned that we were exposed to dangerous levels of chemicals.

After our crew member passed out, I was concerned about the wellbeing of the crew. My Coast Guard representative directed me to return dockside for safety protocol. I didn't get inshore until around 2:00 AM. Early in the morning I woke up and realized that my whole crew had ailments, such as coughing and headaches. I contacted BP safety.

BP evacuated the boat, but first three neurologists came on board with chemical measuring instruments. I recall that they were concerned about the measurements they took. They told me the readings were abnormally high. They first took measurements in the cook's kitchen and attributed it to the frying pork chops. Then they went into sleeping quarters and the readings were still high. At that point they evacuated the vessel, opened all the doors and ventilated it. To my knowledge, that is all they did.

We always had one to three Coast Guard representatives on the vessel. They had their own chemical monitoring equipment. However, when the neurologists were taking the readings, I overheard my vessel's primary Coast Guard representative make the comment "our air monitoring equipment doesn't work." He proceeded to explain that it wouldn't even turn on. He had failed to inform anyone or correct the problem prior to that incident, however. When I learned that, I felt that he had no concern for my crew's safety. He was from Las Vegas, and I told him I was born and raised in the Gulf and it was my life. If he wasn't concerned for our well- being then he needed to leave. I spoke with his supervisor, who removed him from my boat. As the lead captain, I still had influence over who came on my boat and who didn't.

During the time that the boat was evacuated, my whole crew and I went inshore to a BP medical tent. BP didn't want us to go inshore, because media was there. The deck supervisor instructed us to stay in the tent until the media left. The whole process was very brief. The BP representatives took our names, but they did not ask us how we were, and we did not see doctors or receive physical examinations. Then they told us that we could return to the boat, which still had 1,000 to 1,200 barrels of oil on it.

I understand now that my crew and I were bound to have health problems, with inadequate protective equipment and chronic chemical exposure. However, during most of our time on the job we never had a conversation about our health; we weren't thinking about it. We were too

focused on cleaning up the oil. Our boat probably skimmed more oil than anywhere in the Western Strike Force, up to 1,000 barrels a day. There were four mud tanks on our vessel. Once they were full, it took four to five days to get the oil off of the boat. We didn't have a site gauge to monitor how full the tanks were, so we had to take the lid off and look inside of them. Fumes would pour out, and the person who checked the tanks did not have access to a respirator or anything to prevent chemical inhalation. I checked them at times, because I wanted to make sure that our tanks were as full as possible before we unloaded them. There was likely dispersed oil in the tanks as well, because sometimes the dispersed oil floated with the un-dispersed oil and it would get skimmed or boomed when it conjoined with the thick oil.

In addition to that direct exposure, we were regularly exposed to fumes on board. When we had limited wind and it was very hot, the sun would often melt the oil from the skimming equipment onto the deck, with nothing on the deck to contain the melted oil. This let off a sharp chemical odor that remained on the deck. The oil inside of the boat was ventilating out of the tanks as well. Our tanks had six to eight inch ventilation pipes located above deck. As the tanks were being filled and then sealed back up, they would ventilate through the ventilation tube and be released back onto the deck. The other ventilation system consisted of large high speed fans that forced the air into the engine room to keep it cool. The engine room where the tanks were located got very hot, so the ventilation system would blow air to cool it down. It was blowing fumes at the same time, however. The door to check the engine is in the galley inside the boat, and the draft from the door would release the fumes into the galley. There were bunkrooms located next to the engine door.

If I would have known that the air monitoring equipment by the Coast Guard was supposed to be available, I would have used it on a regular basis. The odor from the oil and dispersant was constant. I was the first one exposed to the fumes, because I was located in the front of the boat. The vessels are only a few feet off the water, and I could detect the odor before anyone else. The crude oil had more of a petroleum smell, whereas the dispersant had more of a sharp foul rotten type smell, similar to H2S gas. It would take our breath away and fill our lungs. When we did come into contact with strong odors, I could call my crew on the radio and warn them so that any unnecessary personnel could go inside and get off of the deck, since it only requires on man to run a mechanical skimmer. There were a few times that the smell was so strong we had to leave the area. It was extremely aromatic. All of a sudden I would come down with a headache and blurred vision. Once we didn't even wait to pull the boom in. I tore the boom up, rolled it in a knot first and we vacated the area as fast as we could. I noticed that we had stronger headaches, sickness and nausea when we stayed around the dispersed oil than when we were in the presence of un-dispersed oil.

I later learned that other boats had their tanks on deck, and that they had a better ventilation system than ours. I also learned that other crews could stay offshore for 10 days, but had to go inshore for four days. That wasn't the norm for my crew and myself; we stayed offshore for

lengthy periods at a time, but we were not made aware of the risks. I stayed offshore for 40 days straight without any breaks inshore.

5. FAST RESPONSE VESSEL

The first paycheck I received on the job was very small. I heard that other men in KMJ Services, Inc. had similar problems. My second paycheck bounced, and after the first part of the summer with the company I decided to switch companies. I secured employment as lead captain with Star Fleet Marine, which operates fast response vessels. My boat was called Wateree. My main duties were to service the fleets, primarily the Western Strike Force. Due to the speed of the vessels, I was exposed to more hydrocarbons with Star Fleet Marine. Often my vessel would run through miles of dispersed oil at 18 to 20 miles an hour in order to reach other fleets. There were few if any breaks between activities. In the oil field, speed is a necessity. It's a culture of, "If you can't get the job done, we'll get someone who can get the job done." I would pick up crews with soiled clothes, and speed through the areas where in-situ burns took place, or where there were large amounts of crude oil or dispersed oil.

I would have stayed actively on the job for as long as they needed, but by September BP began to understate the amount of oil that still needed to be cleaned and explained that we were no longer needed. We stayed dockside for a month, and in October we were shut down.

In May and June 2011 I took a job with GEO Shipyard out of New Iberia, Louisiana, as the captain for a 60-foot spud barge. They would load my vessel with equipment and I would travel through the Mississippi River marsh grass in order to get to Grand Isle. It was a shallow vessel, so I was able to move it through three to four feet of water and bring workers their supplies. I also would haul dead cut and oily boom from the marshes. During that job I was exposed to terrible gasoline fumes. BP would place 2,500 gallon gasoline tanks in my vessel and send me to fill them up and then return them to the barges. The vessel could carry three of those tanks at a time. A few times they overflowed, because we had no training on how to properly fill the tanks. When we filled them with gasoline, we did not realize that the tanks were full and the gasoline overflowed onto our vessel. There were times when we would have to stop for the night and the tanks would stay on our boat. The offshore barges used portable toilets as well. Human waste releases H2S gas. Again, I was not provided H2S respirators or air quality monitors.

6. RAPID HEALTH DETERIORATION

When I went to work on the spill cleanup I had the mentality of "I am going to work hard," and I was grateful to be a part of the response effort. I always excel at my jobs, and at this job I wanted to skim more oil than anyone else. I always wanted to be a good leader. As the lead captain, I consistently pay close attention to detail. It is my job to be alert, aware of my surroundings and to keep my crew as safe as I can. If I knew then what I know now, I never would have went out there. I didn't realize the health risks that were involved for my crew members and me. I recently

reconnected with the other captain of the first vessel that I worked on, and he told me that since working on the spill his esophagus has busted.

I first got noticeably sick in November 2010. Since then, I have had surgery six times. In the beginning I had pneumonia-like symptoms, staph infections, and an infected lymph node in my left armpit. I was admitted me into the hospital, and the doctors removed my lymph node. I was dismissed after eight to ten days. In January 2011 I was admitted again with pneumonia, and my white blood cell count plummeted to near death. It was at 100, and I had no immune system. I had an infection in my neck that swelled up to the size of a softball. The doctors put me into a glass room at the intensive care unit (ICU). The hospital told my wife that if she did not bring me to the hospital when she did, she may have found me dead that morning. They did a CT scan to see if the swelling was blocking my airway. If so, they were going to give me the trait, which is a hole in the throat that you breathe through. I had 40 to 48 percent airway still open and they provided me several medicines for the swelling to go down. It finally healed, and I did not need the trait. They also gave me Neupogen shots to boost my immune system. Neupogen is often used on cancer patients.

In March 2011 I went back to the hospital with pneumonia. They were bombarding me with antibiotics. I had all types of doctors coming by my bedside to study why I could not produce white blood cells. I had a blood transfusion and a toxicologist removed bone marrow twice. He couldn't figure out what was wrong with me either.

My oncologist had me come to her office for 30 consecutive days. She was very concerned and never charged me a dime. At first she thought I had leukemia, but she later ruled it out. She wanted to give me a diagnosis of cycling neutropenia – which is a disorder when someone cannot produce white blood cells. I was told that I would be highly susceptible to illnesses, so I needed to take additional precautions and not expose myself to sick people.

During that time I went to the hospital, because my right leg turned red and it was incredibly painful. It looked like it had been in a deep fryer, and it has blisters all over it. I thought I was going to lose my leg. They removed my gallbladder and later did surgery on my groin and removed an infectious material from that area. They also gave me foot medication because they were concerned that I had Stevens-Johnson syndrome, which is a potentially fatal skin disorder. When I got home I had severe diarrhea for several months. The hospital diagnosed me with clostridium difficile, which occurs when someone consumes too many antibiotics and depletes the good cells in the body. It was highly contagious and my wife contracted it, but we took her to the hospital early enough that she was able to treat it immediately. I also became anemic after working on the spill.

In early fall of 2012 I met with my attorney and a toxicologist who named different kinds of tests that I should take. He explained that the tests were expensive, and we needed to figure out who would pay for them. I couldn't afford to pay and never received the tests. He said he understood

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that there were health risks involved with the BP cleanup, and he also knew other cleanup workers with similar health problems. He explained that without taking the tests, however, he couldn't pin point my health to my chemical exposure while on the job. He wouldn't put his reputation on the line without being able to determine that my exposure was the cause of my physical decline.

It is so hard to get doctors in the Gulf to admit that there is the possibility of chemical exposure. I believe that the physicians don't want to stick their neck out on a limb and say that someone has chemical exposure, because it may put them at risk to admit it. Or they may not have the education and tools available to properly diagnose me, and unfortunately there is little incentive to receive further education on the topic. When I mention the BP oil spill as a possible reason for my health problems, doctors immediately tell me they don't want to discuss it and leave the room, or they dismiss me as a patient. This has occurred at least half a dozen times. But what other explanation makes sense for the nightmare I'm now living, after I was previously healthy all my life?

7. WHOLE LIFE IMPACTED

The fear is the worst part; I have a real fear that I'm dying. I wasn't like this before the spill. I was very active and energetic. When I gave my crew instructions I also worked with them to get the job at hand done. I had a lot of stamina, and a 16 to 18 hour day was normal for me. Now I can't make it throughout the day without taking naps. I have lost the interest and energy to do most activities. When I take short walks or perform small tasks, I get winded very quickly - to the point where I have to find a strategic area to rest until I regain my breath.

Currently I am experiencing chronic itching all over my body, and I have scratched myself so much that my skin is raw in some areas. I have skin blisters that randomly appear, and then they burst and heal. I deal with a tremendous amount of pain. I don't like complaining about how much I hurt, but my bones are constantly aching. It is getting increasingly difficult for me to walk because of something that is going on below my waist, as if a large horse kicked me and the pain won't go away. When I lie down in bed I feel a sharp stabbing pain, and the pain is so acute that I scream. There is no swelling or redness, but when I twist or turn a certain way it results in an unbearable pain. This is just the latest health problem.

Prior to working on the cleanup, I had 20/20 eyesight and I never needed reading glasses. Now I need glasses to read, especially small print. I barely go outside because the sun bothers my eyes during the day and bright lights bother them at night. My focus is hazy. For instance, when I am driving I see three green lights or three red lights, one stacked over another. When I am on a highway, I often don't see an oncoming car until it is near to me, at which point I see two cars. My depth perception is off as well; a car will often look farther away than it is. I also can't hear as well as I could prior to working on the cleanup, because there is a constant ringing noise in my ear.

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My long-term memory seems to still be intact; however, my short term memory has vanished. I have notebooks sitting beside me right now, because throughout the day I have to make a record of my actions. Otherwise, I will not remember what I did or still need to do. I even have to refer back to my notes to remember people's names. I rely on my wife a great deal to help me remember things. I never used to have that problem. I used to pride myself on my strong memory, and now I can't even remember a conversation from a few days ago. I don't remember to take my medications in the morning, even if they are right in front of me. My wife has to bring them to me. She cries a lot, because she is concerned about my health.

I am on disability now. We live off of $1,225 a month in social security and life has certainly changed. We have to plan what we are going to do when we leave the house so that we use less gasoline, because it is expensive to fill the tank. I was making up to $400 to $450 a day working in the offshore oil field, and I lived on a 20-acre yard with a very comfortable life style. As I lost work after getting sick, we couldn't pay for these things and began to sell our items. They deteriorated so much that we bought a motor home, and we have lived in it for two and a half years. It is very crowded and things have gone downhill. There has been a lot of crying and arguing at home.

The mental health impacts are extremely difficult. I can't put up with loud people, and I don't feel like I have the drive to do the things I used to do anymore. My health problems have destroyed me mentally, and as a result I have been in four mental health facilities for depression and anxiety. I deal with it now better than I used to, because I don't want to show weakness to my wife. She is bipolar and can be easily influenced in a positive or negative manner. You can say happy things and she is happy, or you can say sad things and she is sad. I try to control my behavior so that she can have a better day. Every night when I lay in bed 1,000 different things go through my mind, and I wonder what is wrong with me. I never had these problems or thoughts prior to my work on the cleanup.

At first I felt like no one cared about the health impacts from the spill; I wanted to go to sleep and not wake up. I made several calls to the governor's office and federal government offices, and I kept getting the runaround. Nine months ago the National Institute of Environmental Health and Sciences contacted me about their 10-year Gulf Study. They took blood, toenail, fingernail, hair, skin and urine samples. They said they would be contacting me every three months; however, I have not heard from them. Supposedly they want to monitor me for 10 years to study what the health implications are for those of us who worked on the cleanup. However, they are not offering treatment.

My attorney informed me that there is no treatment available for my health problems. It scares me, because I have deteriorating health and there are days I wonder if I am going to make it. I live in more pain than anyone should have to deal with. I cannot find proper medical treatment, and I just suffer and suffer. I don't like being tired. I love being in the oil field and working on the boats, but I can't any longer. My mind and body can't take it anymore. I am trying to

understand if I will ever get better so that I can live in happiness, pain-free and without sickness. I am most concerned about that fact that my family lives throughout the Gulf Coast. My dad is a fisher. We are all exposed to the ocean and eat Gulf seafood. What will the impacts be on their health in the years to come?

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I have read the foregoing 10 page statement, and declare that it is true, accurate and complete to the best of my knowledge and belief.

Executed on July 12, 2013.

Subscribed and sworn to before me
this 3RD day of December, 2013

William L. John #14013
NOTARY PUBLIC

R.L.R.

AFFIDAVIT

My name is Richard Lafayette Russell. I am 45 years old. I have lived my whole life in Gulf Shores, Alabama. Prior to the Deepwater Horizon disaster I had my own business since 2000. It was called Dolphin Express Cruises. When I was younger I ran the boat that my parents used to take people on dolphin tours. I have had my U.S. Coast Guard Master 100 ton near coastal captain license since I was 17. After I got married I bought a 40-foot pontoon boat and became certified to take dolphin tours. We would ride around in the bays looking at dolphins and talking about the area, conducting tourism. My wife at the time handled the books for the business, and we would make between $150,000 and $250,000 a year. During the BP oil spill I had to shut down my business due to the decline in tourism and the poor conditions of the Gulf.

Early in the spill I attended a Gulf Coast Claims Fund meeting and BP representatives told my community that they would "make us whole". They were also recruiting people to work for the Vessels of Opportunity (VoO) program through Zeke's Landing at Orange Beach, Alabama. They didn't share any of the health risks involved with working on the cleanup, however. I never would have agreed to work on the cleanup if I had known how much my health would be impacted.

1. WORKING FOR THE VOO PROGRAM

From May through July 2010 I worked on the VoO program. The cleanup operation was very unorganized; it was the most unprofessional operation that I have ever witnessed. Prior to beginning work I only received a boom class, which taught me how to lay oil boom in order to mechanically clean the oil. That was the only training I ever received. The only safety equipment I wore during the cleanup was a life jacket; we were not provided with significant protective equipment. I would wear jeans and a shirt. At one point our supervisors let us wear shorts for a week or so because it was hot. The BP contractor Parsons went through three or four different supervisors before it could figure out where to send our vessel on a regular basis.

During my first job on the VoO program I worked for a week as an oil observer, and the other workers on the vessel and I spotted some of the first oil from the spill. Dolphin Express II was the name of my boat. We were approximately a mile southeast of Perdido Pass. Our supervisors asked us to wait until someone responded, but after four to five hours no one ever came. We left the site because it was getting late, and we doubted that anyone would arrive. A boat next to me, the Jamie G, was another charter fishing boat working on the VoO program that witnessed the oil entering. We were not instructed to clean the oil that we identified, and to our knowledge no vessels arrived to clean the oil that we reported. The following day the oil came inside our pass at Alabama Point. The

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city of Alabama tried to put a big barricade in to stop the oil, but it did not prevent the oil from entering when the water was choppy. After the oil entered the pass it went into the Bayou St. John bay area.

During my second job on the VoO program I became the captain of a large supply boat for about one month. I do not remember receiving any safety information or literature when I worked as a captain. We would service the boats that were cleaning the oil and deliver different safety and cleanup equipment, such as hazmat suits, boom, and additional trash bags as requested. Our vessel had a safety worker certified in Hazardous Waste Operations and Emergency Response (HAZWOPER). He worked for Parsons, a BP contractor. If people needed a restroom break or were sick then they would get on our boat. Everyday at least one sick worker would board our vessel. At times the safety worker would evaluate the sick workers, and he would send them back to work the same day if he thought they were ok.

My third job on the VoO program involved pulling boom with one of my large vessels. We would pull heavier stuff, such as oiled boom, for a charter fisher boat called the Fishing Fool. We were pulling boom between our boats, and my boat was regularly sitting in the dispersed oil. The dispersant looked like bubbly white foam. I only performed that job for about a week.

My final job involved running a waste barge that would bag contaminated boom and send it to another barge to take the boom to the marina. The marina supervisors told me that I did not have to wear safety equipment because I was the captain and therefore I was not supposed to come in contact with the oil and dispersants. However, that was not true. For instance, when my deckhands were handling the oil boom it would splash on me. I would also inhale the chemicals from the oil. Most of the time I was up high in the vessel tower, about 30 feet off the water. It was windier up there than down below on the deck. The deck was unsafe as well, however. Once my deckhands became HAZWOPER trained they would wear safety equipment, such as rubber boots and tyvek suits, at times, but their faces were not covered and they did not have respiratory protection. One of the deckhands complained to me about the chemical smell, and often my workers complained of headaches and discomfort. Regularly water splashed us in the face.

They disbanded us after the tropical storm Bonnie in July of 2010. The VoO program informed us that they would call us back to continue the cleanup after the storm, since we were local workers. Therefore I took a course in post-oil spill cleanup and I received a purple card. It was supposed to allow me to continue working on the cleanup, since we did not have any income coming in after we were initially disbanded. However, we were never called back and they never explained why.

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While I worked for the VoO program I only received a few checks, but I had a hard time getting them. My wife and I had to keep faxing my work records because Danos and Curole kept disputing the time that I worked on the cleanup. I still do not know if I was fully paid for my work.

2. GULF COAST CLAIMS FUND

When I reflect on the oil spill it makes me mad because I had a great business and I lost it. After I stopped working on the VoO program I tried to get compensated for my losses through the Gulf Coast Claims Gund (GCCF), but I never received any payment. I also had oil in my motor from my work on the cleanup, which caused my boat to overheat. When I was a waste carrier I was tied up to the main barge, the Minnesota Barge, and I had a lot of damage and stress on my boat deck. My boat depreciated about $50,000 from working on the VoO program. BP said that it would cover the damage, however, the GCCF did not respond to any of the claims that I filed. Later I was guaranteed payment as part of the class action lawsuit. Claims Strategies, a claim support group, promised to try and help get me claims, but it has been nearly five years since the spill and I have not yet received compensation for my losses.

I was living out of my car for about six months in the spring and summer of 2012, because I could not afford to rent a home. I have two children, and my financial difficulties have been hard for the whole family.

3. HEALTH PROBLEMS, DISPERSANTS

During the cleanup my eyes often burned and my nose bothered me. The chemical smell was the most difficult part of the job; it was strong and constant. My dad lives on a lagoon on Gulf Shores and to this day you can smell it from his house. I was coughing all the time and it was difficult to breath out there because it was hot and I constantly smelled the chemicals from the spill. It smelled like something in the air was burning. I didn't think to ask for safety equipment, however. We were focused on cleaning the oil, and I was told that I did not need any protections. I regret that no one informed me of the health risks that came with the job. Since working on the cleanup my symptoms range from a constant sore throat to nausea, difficulty breathing, violent vomiting and cramps at the same time. I have stomach problems now, and I never know when they are going to occur. Prior to working on the spill I never had eye problems. I had 15/20 vision and never wore glasses. It could be due to age, but since working on the cleanup I have had trouble seeing up close. Now my bones are real sore, and I am in chronic pain. I am achy in my arms and my legs all the time. Before the spill I was in good health and I did not have any of these symptoms.

As for dispersant use, we would see planes flying but I had no idea that they were

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spraying the dispersants in order to sink the oil. The dispersant planes would fly right over me a few times a day. It seemed like they would go from the North side of the bridge from Jack Edwards Airport out toward the Gulf where there remained a concentration of oil. Often the planes spraying the dispersant were Coast Guard planes. I was never sprayed directly, but my friend was sprayed by dispersants. She was not even in the water or working on the cleanup. She lived a few miles from the Gulf in Pensacola, Florida. A dispersant plane was spraying and flew over her house one evening when she was bringing groceries inside. Since the oil spill she has developed breathing problems, but they worsened after she was sprayed.

Since I lost my business I lost my health insurance. However, I have participated in the National Institute of Environmental Health and Sciences (NIEHS) 10-year Gulf Study program to monitor the health of BP cleanup workers. Right after the oil spill a lady with NIEHS came to my house to include me in the study. She was located in Georgia and assigned as a worker for my area. She said that my heart rate and pulse were real low. She called the main office to tell them what I was experiencing. They said they were going to send my information through the mail but they never did. A few months ago they called to speak with me and check in. They asked me questions about my health, and then they told me I would receive a certificate of sorts in the mail. The first time they sent me a $50 gift card and I just used it for groceries. My former wife's friend told me I should participate in the study since I worked on the cleanup. The NIEHS contact told me I was two or three weeks away from going into a coma due to my alarmingly low heart rate and pulse. She told me to be careful and monitor myself closely. She also advised me to let her know if anything got worse.

Through a letter in the mail I learned about a meeting with lawyers in June 2013 to help identify health problems experienced by cleanup workers. I did not know if working with them would result in compensation or medical treatment, but I was hoping I would receive treatment. At the direction and assistance of the lawyers, I went to a doctor located in Foley, Alabama. There is a medical class action lawsuit, but they usually do not result in much and the money will not cover medical expenses if you are not healthy. I would rather receive proper medical treatment then a settlement for my health impacts. In 2014 I attended a meeting where the charter boat captains from the BP cleanup were offered $60,000 for settlement. As part of the settlement terms, the lawyers take 20 percent and then the captain has to pay taxes on their settlement, so they are left with about $20,000.

The attorneys associated with the class action settlement arranged for cleanup workers such as myself to see a physician. The doctor I met with explained that my liver probably is not functioning correctly and my gull-bladder needs to be removed immediately. I may also have a problem with my pancreas. My tonsils are inflamed and probably need to be

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removed as well. He explained that my nasals and ear cavities are inflamed. One of my tonsils is bigger than the other with bumps all over it. He said it was a possibility that I was exposed to chemicals while working on the spill. He could notice that my eyes looked drained and aged as well. I used to look and feel much healthier. It worries me because I am only 45 and I have never had a history of poor health. I have never been a smoker, and before the spill I was in good health. The doctor wanted me to follow up but I do not have the money to do so. I do not have a regular doctor because I cannot afford one, so I just live with my symptoms.

4. MAKING ENDS MEET, FISH WITH LESIONS

Before the spill we had plenty of money and now I am just barely getting by. We are still surviving, but I can't give my kids all that they want. At my age it is difficult to change jobs; I have always relied on my captain license, and my livelihood was conducting fishing and dolphin tours. In order to make ends meet, I now work as a fishing guide. My captain's license makes me eligible for the job. At first I worked at Outcast Marina on the East side of Alabama Point Bridge, and I ran fishing and dolphin tours. They had a dolphin cruise boat and I would take people fishing. I was on standby all the time so that I could pick up work whenever it became available. When I go onto the water I notice that I cough more frequently than when I am on land, and my sore throat gets worse.

After the spill there were a lot of fish with lesions. Today I still see them but it is not as common. I do not think the fishing is back to normal yet. We have good fishing here, but the marine life is not as abundant as it was before the spill. If the fish do not have food then they will die, and a lot of the smaller fish and organisms that comprise the marine food web were severely impacted from the spill. During and after the spill a lot of dolphins washed up on the beach and died. A lot of the baby dolphins were stillborn as well. As a tour guide I occasionally fish, but I am scared that the water is still contaminated with dispersants and oil. It is difficult not to avoid coming in contact with the water as a guide, however. At times I get small cuts on my hands and then the open wounds are exposed. I'm concerned about touching the water due to the dispersants.

After the spill almost every fish that we would catch would have some kind of lesion. Now I do not know whether or not the Gulf seafood that we catch is contaminated. When I took people into the Gulf for fishing trips, I would clean the fresh fish that they caught. It made me feel uneasy, however. I would ask them if they wanted to eat them or throw them back, and they normally wanted to eat the fish. I often worried the people who consumed the seafood would get sick, but it was not even my business; I was working for other people. I was just trying to work to survive.

5. CONCLUSION

R.L.R.

I am hesitant to even come in direct contact with the Gulf water, and I know we have tourists down here who swim in the Gulf. BP did not want to warn the public of the ongoing public health dangers resulting from the spill. In the northern part of the country BP said "Oh come down and swim in the beach." I'm concerned that people who do not know any better will swim in it and get sick and possibly get cancer later down the road. I do not go swimming unless it is in a pool.

The government works with the oil companies because our economy is so dependent on oil, but unfortunately the government does not want to take care of the people. There are a lot of people who have been unfairly impacted by the BP spill, and they deserve compensation and medical treatment. My throat stays scratchy and sometimes I lose my breath. It is worse when I am out by the water. There are days that I am worse than others, but I just never know how I am going to be. I was hoping it would leave on its own but it has been nearly five years now.

I was finally able to sell my boat, and my mom warned me that it may be the only money I would receive. It has been nearly five years and BP still has not paid me for the damage that I incurred from working on the cleanup. I never wanted to work on the cleanup but I knew we would not have the revenue from my normal business due to the spill, so I joined the cleanup. Now all I want to do is to get back on my feet again and fully regain my health.

I have read the foregoing five page statement, and declare that it is true, accurate and complete to the best of my knowledge and belief.

Executed on March 18, 2015.

Richard L. Russell

Subscribed and sworn to before me
this 18 day of March, 2015

R.L.R.

R.L.R.

Sandra Garcia

Notary Public

My Commission expires on: 10/03/2017

R.L.R.

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AFFIDAVIT

My name is Randy Varney. I am submitting this statement, without any threats, inducements or coercion, to Shanna Devine, who has identified herself to me as an investigator with the Government Accountability Project. I am 55 years old, and I was born and raised in Barataria, Louisiana. I started shrimping as a deckhand at age 11. I bought my first skiff boat more than 25 years ago, and I have always made a living off of shrimping. However, since the BP oil spill both shrimping and my health have declined. During the summer of 2010 I worked for BP contractor DRC Emergency Services, LLC (DRC) on the oil spill cleanup. At first I worked as a deckhand, then I provided supplies to boats working on the cleanup, and eventually I worked as a captain on the cleanup. Throughout that time I was provided minimal safety equipment and developed what are now chronic health problems. I would like to know what is compromising the health of my community and our seafood.

1. EXPOSED

Early in the job I received training for how to lay boom, a net used to contain and remove oil. However, I didn't receive the hazardous materials (HAZMAT) course until the end of my time working on the cleanup. The HAZMAT course was just a show, because you couldn't fail. The instructors gave us the answers for the final exam and everybody passed. They coached us through each question and said things such as, "If it's not answer choice A or B, it must be C."

During the HAZMAT course I learned that we were supposed to wear respirators and protective suits when we were cleaning up oil, because we could be exposed to chemicals such as benzene. The class also explained that exposure to different chemicals mixed together can be very dangerous. When we worked on the cleanup we did not wear proper gloves, respirators, suits, or any sufficient Personal Protective Equipment (PPE). I don't understand why we were sent to a safety course at the end of the job that told us how to protect ourselves, yet DRC did not provide us with the recommended safety equipment.

At one point I worked on a boat that was used to hold oil until it was collected by smaller boats. We had to sleep in close proximity to the oiled boom for four to five days, until it was removed. We had no choice. The boom was put into bags, but it would leak. We would put a mat on the deck, and then we would place the bags on top of the mat. We had to load and unload the boom, and it was heavy and oily. We had cheap rubber gloves and paper suits, but the oil would sink through them. Whoever ran the cleanup was focused on profits, not our health.

According to news reports, Corexit was often being sprayed on the same days that we were on our vessels. During the cleanup there were frequently strong winds at 25 to 30 miles per hour. I believe that we were exposed to the Corexit because the chemicals from it became airborne or got into the water. I frequently detected a chemical detergent smell on the days that Corexit was sprayed. At times I had to look for oil and oiled wildlife, such as pelicans. We would find oil inshore, behind Grand Isle and Barataria Bay. We would provide the coordinates where it was located to DRC, and DRC was supposed to send skimmer boats to those locations. When we would return to those locations the next morning there would be no oil, just foam. To my knowledge, BP and the government were only supposed to spray Corexit offshore, not inshore, but it looked like there was dispersed oil inshore. The foamy water would spray the other workers and me in the face. I would come home with my shirt covered in brown spots from

where the water splashed me. Shorty after those experiences - within the first month on the job - I started to feel abnormal, as if had a bad cold.

2. HEALTH PROBLEMS

Before I began working on the cleanup I took a physical, including urine samples and x-rays. There was nothing wrong with me at that time. I also felt like I was in good health. However, after the first month on the job I felt like I had a cold and it got worse as I continued to work. I went to Jefferson Medical Clinic, and they told me I had an upper respiratory infection. After a month into the job my ears started bleeding and I developed a sore throat. My eyes began to hurt and itch real bad, as if they had blisters. I didn't know the cause of my sudden health problems. My eye problems will not go away. The oncologist said he couldn't determine what was wrong with them. He prescribed me eye drops that cost $125 and they didn't last long. When I ran out, my eyes went back to burning and itching. My throat irritates me and is sore every day, and I often have bad headaches.

Since working on the cleanup I have developed a rash all over my chest and thyroids. I put the antibiotic cream on it for months and months. The rash consists of little bumps that spread from the bottom of my rib cage to my shoulders and under my chest and arms. It gets itchy when I don't have the cream. I must purchase the cream and anything else that the hospitals or clinics prescribe for my symptoms. I have noticed that the rash comes back the most when I go out on the water, and I feel worse when I get overheated.

I have become intolerant of chemical smells that have never affected me before. For instance, I cannot stand the smell of perfumes, air fresheners, cleaning products or anything that comes out of aerosol cans; I have to remove myself from the smells. I can no longer wear cologne or even burn a scented candle, because anything that releases a strong smell repulses me, as if my body is rejecting it. I never had those reactions before I worked on the cleanup.

I have also noticed myself forgetting a lot. It includes simple things, such as forgetting whether or not I have washed my hair in the shower. I put my shirt on and I can't remember if I put on deodorant. At times when I am driving I forget where I am momentarily, and then I suddenly remember. I don't forget how to drive, however. I did not have memory problems before the spill, but now I have good days and bad days. I went to Ohio for a week in the summer of 2013, and I felt much better; my symptoms began to subside. When I returned home I felt the way that I had felt when I left; the symptoms began to come back.

I don't know what is wrong with me. I feel like I have been poisoned, almost as if I'm dying. It is one thing to have symptoms for a week or a month, but I have been through years of ineffective treatment. It's as if the doctors are treating me for something that I don't actually have. I only feel better for a few days until I run out of antibiotics, eye drops and cream. When I go to different doctors they don't want to hear anything about the spill or being infected with oil and toxins. They don't want to look at the cause of these reoccurring problems or discuss their possible connection to the spill. They only treat the individual symptoms. Where is the doctor's concern for the patient? It is not right; I feel a doctor should try to help the patient no matter what.

In early December I went to one of the health clinics run by the Kennedy Center for Justice that is located on the bayou, and I saw a doctor who specializes in chemical exposure. He took a blood test and urine sample and checked my heart and gave me a complete examination. The results recently came back. He told me that I had an upper respiratory infection, but he did not explain what had caused it. My blood work came back fine, but the exam did not test for the chemicals found in the oil and dispersant.

I am not the only person who has had health problems since the spill, but it seems to affect people in different ways. When I was a captain, I had a deckhand in his mid-thirties. He would bag the oil and unload it onto other boats. Since working on the spill he has developed heart problems. People who I've known for years and were in fine health prior to the spill are now using breathing apparatuses. One of my friends now has brain cancer. One man who I used to go trolling with for years is now breathing out of his throat through a breathing tube, and the doctors don't know what is wrong with him. He never smoked.

Despite this onslaught of health problems in my community since the spill, over three years later no one is explaining what is the cause. Is it because of my old age, or due to chemical exposure? We live on a bayou, which is 100 yards from my backdoor where I keep my boat. Is my proximity to the water making me sick? We only hear about the health problems in other parts of the Gulf through Facebook, not on the news, because we are sharing what we know with one another. We also share what we are experiencing with our neighbors and fellow fishermen.

I am a commercial fisherman, so I'm on a boat during the summer. It's difficult now, because when I am outside in the sun and it starts to get hot, I feel like I am going to pass out or have a heat stroke. Before the spill I used to go trolling on my own without a problem, but I no longer go out alone or make as many trips. I used to go out for 20 days in a row. Now I can only go out for five days, and then I have to come in for five days to rest before I go back out. When I went trolling in the summer of 2013 the heat really affected my rash and depleted my energy. Sometimes the other fishermen and I saw oil in the current line – where the current makes a line and debris settles. In August and September 2013 I was not out that much because there were not a lot of shrimp.

3. SEAFOOD DEFORMITIES

When the season first opens in early May there is a rush of shrimpers. It usually lasts a few weeks. However, after the first week into the 2013 season ninety percent of the boats were tied up on the bayou. There are fewer shrimp where there used to be an abundance of shrimp before the spill. What do we do now? Worse yet, since 2011 we have been catching shrimp that are deformed. I have worked in these bayous and canals my whole life and I never saw shrimp like this before the spill, especially inshore where the shrimp are born and raised. Some look like they had acid dropped on their shell, or they have black gills and tar. Some of the shrimp have sores and tumors on both sides of their heads and discoloration, as if they are rotten but still alive. I only come across a few shrimp without eyes, but some shrimp have eyes that are clear and not fully developed. If you take the heads off the shrimp often look fine, but if you take the heads off and put them in a bag and let the gook ooze out then it turns your stomach.

Most people, including many of the fishermen, don't want to hear about the oil spill because they want the shrimp to be safe and to make a living. They don't want to stop doing what has been in

their family for generations. For decades Barataria Bay has been known for having some of the best shrimp in the world. We don't have other work; we live on the bayou, and fishing is what we do. Everything we have is tied up in the bay, because that is our living. Now I have to go to different locations then where I normally fish. Places that used to have shrimp, such as Barataria Bay and Little Lake, which is 20 miles west of Barataria Bay, are no longer as plentiful. I have noticed about a 60 percent decline in catch. At first most of the deformed shrimp were in Bay Jimmy and Barataria Bay, but now the impact appears to be spreading. I am catching them further up in Lafitte as well.

We are looking at thousands of shrimp, so it is difficult to go through every shrimp and pick out those with deformities. However, if I'm catching deformed shrimp, then other fishermen are catching them as well. We are selling the shrimp, and the idea of it making someone sick really hurts me. The seafood may be safe, I'm not saying it's not, but something is wrong. After the spill President Obama said that the seafood was safe and the beaches were clean. It hurts me to now see the kids digging in the sand, because in many cases the beach cleanup workers covered up the oil with sand. The workers made videos of this practice and posted them online, and I also saw reports of it on the news. Just like the beaches, I don't know if the shrimp are safe. The government said it has tested the public beaches and seafood for chemicals, but how am I supposed to feed the shrimp to people when I am catching deformed shrimp?

4. CONCLUSION

We felt good about our lives and communities prior to the spill. But after it occurred, people have been out of work and their health is declining. At that point it is easy to become depressed. Fortunately I own my boat and my house, and I have excellent credit. I don't have an education, but I have always known how to make money. I have been selling seafood all of my life. I lay in bed now and ask myself, what am I going to do? I do a lot of pacing from the back door to the front door. I am 55 years old; I am too old to start looking for a new career. I had a part-time job in the winter at a bait shop, but now it is gone. Since the oil spill there aren't too many people fishing, and not a lot of people want to buy shrimp now. I used to sell shrimp to local establishments that would then re-sell the shrimp, but as consumer demand went down so did my sales.

I think that everyone needs to know what really happened during the oil spill cleanup and what the impact has been on our communities. In the future, oil spill cleanup workers should receive HAZMAT training and be fully informed of the potential health risks associated with the chemicals that they will be exposed to, before they begin working. Further, our communities and the public should not have to question whether or not government seafood testing is reliable or how much seafood we can safely consume. We have a right to know what we are being exposed to.

I have read the foregoing four page statement, and declare that it is true, accurate and complete to the best of my knowledge and belief.

Executed on December 16, 2013.

Subscribed and sworn to before me
this 10 day of March, 2014

Vicky L Pollard

Notary Public
My Commission expires on: Dec 4

VICKY L. POLLARD
LBN 24606
STATE OF LOUISIANA
UNION · JUSTICE · CONFIDENCE
Attorney Notary
Lifetime Commission

AFFIDAVIT

My name is [redacted]. I am submitting this statement confidentially, without any threats, inducements or coercion, to Shanna Devine, who has identified herself to me as an investigator with the Government Accountability Project. I am providing this statement because I am concerned about the health of everyone who consumes Gulf seafood contaminated by the BP oil spill. I have lived in [redacted], Louisiana my whole life. Until recently, I helped run a seafood restaurant in Louisiana. [redacted] and I decided to close the restaurant after we realized that the seafood we served was contaminated by oil. I could not bear to serve other people's children and grandchildren a product that I did not want my own children to eat. Gulf seafood is being shipped all over the world. Who is going to take care of those made ill by contaminated seafood?

My family has worked in the seafood business for generations. [redacted]. [redacted] owns a seafood processing plant, and I worked for it from age 15 to 20. At the time it was called a platform. At the plant we would buy, boil, clean, package and sell shrimp. I later became a truck driver and for approximately three years I transported seafood for [redacted], located in Louisiana. The plant would buy crabs, peel them and sell the crab meat. I then began my own seafood transportation company called [redacted] and distributed different processed food to wholesalers in Louisiana. I closed it after I received a better job opportunity to become a [redacted]. However, that work slowed down in the years before the oil spill and when the offshore drilling moratorium took effect.

After the Deepwater Horizon explosion, [redacted]. Later, in October 2011 [redacted] offered me a position in his seafood restaurant. I was going to become a co-owner, but before we could do the paperwork we decided to shut down due to food safety concerns.

[redacted] We specialized in boiled seafood, and offered boiled crabs, shrimp and seafood platters. [redacted] One night in June 2012 when we were serving boiled crabs, a patron was eating the crabs and said that she couldn't get a black substance off of her hands, even when she scrubbed it with a napkin. She showed me that when she opened the back side of the crab and squeezed it, a black oil-like substance came out of it. I asked if she would mind if I documented it, in the event that she got sick. She agreed and we took photos of the crab and her hand. I proceeded to give her a wet paper towel with Dawn dish washing liquid and the black substance on her hand came off right away. She then proceeded to keep eating the crabs, at which point I panicked and said, "Let me get you some fresh crabs." I had never seen anything like that before the oil spill; I was shocked.

We were also having problems with soft shell crabs. [redacted] had frozen soft shell crabs from before the spill. We initially sold those, and they were very popular. However, we ran out and began serving soft shell crabs from catch that was collected after the Deepwater Horizon explosion. Customers repeatedly complained that they tasted bad, as if there were old. However, they were fresh catch. [redacted] owns a seafood plant, and he would buy the seafood for the restaurant directly from the fishermen and we would take them to the restaurant. They were as fresh as they could be. After the patrons complained about the soft shell crab we decided to stop selling them; we were scared of someone getting poisoned. Folks weren't complaining about hard shelled crabs at that time, but we started findings problems with them as well. After the first oiled crab incident we started paying closer attention and noticed more crabs that looked like they were contaminated with oil. We also started looking more closely at the shrimp; to our surprise, they frequently had no eyes and their heads contained a thick black substance. I didn't know what it was but [redacted] explained that it must be oil.

After these events, [redacted] and I had a long discussion and decided that we should close the restaurant before someone sick, or before we got sued for serving a contaminated product. After we closed the restaurant, on [redacted] I sent the photos to BP and asked about filing a business loss claim. The following week, a BP representative called me three times in one night, asking me questions and providing instructions on how to file my claim. He said, "I'm really glad you sent it to us. We can work together and it will be beneficial." I had not shared the photos publically yet and he said, "We appreciate you contacting us and not going public." He said that BP would help us out as much as it could. He told me to file as an individual for a claim for a business economical loss and to send the photos with my claim. He assured me not to worry, and said that BP would help. He didn't tell me how to contact him but instructed me to call the number 1-800-333-3991 and submit information by email. We decided to see what would happen with our claim before going public. One month ago – nine months after I had filed the claim - BP said I should have filed as an individual economical loss and denied my claim.

[redacted] wanted to figure out what was wrong with the crabs. He put them in a tank and placed 10 gallons on cooking oil into the tank. Within days, the cooking oil had disappeared. I believe that the crabs were exposed to Corexit and the Corexit is responsible for this. If the Corexit is going to eat the oil that fast, what is it going to do to a person? [redacted] processing plant was peeling crabs and he wanted to make sure they weren't contaminated. He contacted the Louisiana Department of Health and Hospitals, and it told him to get a black light to identify any contamination. [redacted] has photos of the crab under a black light that identifies chemicals, and the crab meat and shrimp are a neon blue color under the black light. Those photos as included in this affidavit as Exhibit 1.

I don't have a future anymore, because I don't have a restaurant; my dream was to oversee the restaurant and now I can't. [redacted] shared that dream. After we decided to close the restaurant, he had a stroke. He had invested all of his savings - $200,000 - into opening the restaurant. He was worried sick about closing it. Since the restaurant closed, I have been on

higher and higher doses of antidepressant pills. We are really struggling financially. My husband works as a [redacted], and we are trying to survive on his income. However, he makes in a month what he used to make in a week as a [redacted]. I am aggravated, because I was very active and always working, yet I have had no work since we closed the restaurant. After we decided to open the restaurant, I got rid of my truck. I cannot afford to start over or risk reinvesting in my previous company under the current conditions.

There is not a demand for distributing Gulf seafood. Since the spill seafood catch has declined dramatically and there is almost no seafood for commerce. Fishermen are having problems trying to find seafood, and its cost has skyrocketed since catch is scarce. This is usually the time of the year when crabs come out and the catch is so plentiful. However, this year there are virtually no crabs. A friend of mine went skimming – a method of collecting shrimp & crabs from the seafloor - all night and only caught three crabs. Normally he would come back with several bushels. Usually he would have a crab boil but this year he has to have a shrimp boil instead, and even then the shrimp were smaller than normal. Shrimpers going trolling are also noticing a significant decline in their catch. Each year since the spill the crab catch has declined and 2013 is the worst year yet.

My hope is that no one gets sick from contaminated seafood, and if they do then BP should take responsibility. BP should develop a fund for any health problems connected with this oil spill. I have lost almost half a dozen friends from cancer since the spill. What will happen to us? Prior to the spill, my friend had cancer of the stomach but the doctors had removed it all. After the spill he developed it again and passed away. Another friend found out that he had cancer six months ago and they will bury him today. There are so many people on our bayou dying from cancer. A 40 year-old mother who is a neighbor of mine developed rare cancer of the appendix after the spill. The doctors told her that the cancer is ongoing and there is no cure. She goes into remission and then the cancer comes right back. In addition to rising cancer rates, we have so any allergy problems. Every neighbor I speak with is living on antihistamines. Most people in our community are also living with awful sinus problems and migraines now. These problems were not common during previous oil spills or prior to the Deepwater Horizon disaster; they became widespread in the aftermath of the BP oil spill.

As part of the long-term GULF STUDY, the National Institute of Environmental Health and Sciences came into my house and took samples from my urine, fingernails, toe nails and hair, and swabbed the inside of my mouth. They said I would receive the results in two to three weeks, but it has been several months and I have not received anything.

I have read the foregoing three page statement, and declare that it is true, accurate and complete to the best of my knowledge and belief.

Executed on May 30, 2013.

_____

Subscribed and sworn to before me
this _____ day of _____, 2013

_____

Notary Public
My Commission expires on: _____

To: Wilson, Gregory[Wilson.Gregory@epa.gov]; Principe, Vanessa[Principe.Vanessa@epa.gov]
Cc: Conmy, Robyn[Conmy.Robyn@epa.gov]
From: Barron, Mace
Sent: Fri 1/20/2017 6:03:11 PM
Subject: completion of ACCELL tox tests....

Just fyi that we got the contractor report of ACCELL Clean DWD.

The acute tox results were very similar to the reported values on the EPA website

https://www.epa.gov/emergency-response/accell-cleanr-dwd

have a great weekend all,

Mace

To: Loring, Joseph B CAPT[Joseph.B.Loring@uscg.mil]; Weaver, James (USCG)[James.D.Weaver@uscg.mil]; Scott.A.Stoermer@uscg.mil[Scott.A.Stoermer@uscg.mil]; Ottenwaelder, Thomas A CDR[Thomas.A.Ottenwaelder@uscg.mil]; Sligh, Kevin M CIV[Kevin.M.Sligh@uscg.mil]; Carnegie, Tammie R LT[Tammie.R.Carnegie@uscg.mil]; Crecy, Stacey L LCDR[Stacey.L.Crecy@uscg.mil]; Platt, Jeffrey R LCDR[Jeffrey.R.Platt@uscg.mil]; Brooks, Rebecca J LT[Rebecca.J.Brooks@uscg.mil]; Maghini, Monica K CIV[Monica.K.Maghini@uscg.mil]; Hall, Gregory CDR (EDU)[Gregory.Hall@USCGA.EDU]; Fletcher, James E CIV[James.E.Fletcher@uscg.mil]; kurt.a.hansen@uscg.mil[kurt.a.hansen@uscg.mil]; Balsley, Alexander CIV[Alexander.Balsley@uscg.mil]; DiRenzo, Joseph CIV[Joseph.DiRenzo@uscg.mil]; mark.g.vanhaverbeke@uscg.mil[mark.g.vanhaverbeke@uscg.mil]; Catanach, Curtis P CIV[Curtis.P.Catanach@uscg.mil]; Chaves, Wendy[Wendy.G.Chaves@uscg.mil]; Jenkins, Shannon R CIV[Shannon.R.Jenkins@uscg.mil]; dave.westerholm@noaa.gov[dave.westerholm@noaa.gov]; scott.lundgren@noaa.gov[scott.lundgren@noaa.gov]; steve.lehmann@noaa.gov[steve.lehmann@noaa.gov]; john.kucklick@nist.gov[john.kucklick@nist.gov]; jason.boehm@nist.gov[jason.boehm@nist.gov]; Elena.Melchert@hq.doe.gov[Elena.Melchert@hq.doe.gov]; Erica.Folio@Hq.Doe.Gov[Erica.Folio@Hq.Doe.Gov]; kevin.easley@hq.doe.gov[kevin.easley@hq.doe.gov]; david.moore@bsee.gov[david.moore@bsee.gov]; Lori.Medley@bsee.gov[Lori.Medley@bsee.gov]; william.vocke@bsee.gov[william.vocke@bsee.gov]; joseph.levine@bsee.gov[joseph.levine@bsee.gov]; Walter.Johnson@boem.gov[Walter.Johnson@boem.gov]; brian.zelenke@boem.gov[brian.zelenke@boem.gov]; Jeff.Ji@boem.gov[Jeff.Ji@boem.gov]; barry_Forsythe@fws.gov[barry_Forsythe@fws.gov]; holly_herod@fws.gov[holly_herod@fws.gov]; christina_kravitz@fws.gov[christina_kravitz@fws.gov]; michael.carter@dot.gov[michael.carter@dot.gov]; tom.thompson@dot.gov[tom.thompson@dot.gov]; robert.w.smith@dot.gov[robert.w.smith@dot.gov]; james.merritt@dot.gov[james.merritt@dot.gov]; David.Lehman@dot.gov[David.Lehman@dot.gov]; Steven.V.Cary@usace.army.mil[Steven.V.Cary@usace.army.mil]; Andrew.J.Bruzewicz@usace.army.mil[Andrew.J.Bruzewicz@usace.army.mil]; Nathan.J.Lamie@usace.army.mil[Nathan.J.Lamie@usace.army.mil]; Kemp.skudin@navy.mil[Kemp.skudin@navy.mil]; frank.stone@navy.mil[frank.stone@navy.mil]; abe.nachabe@navy.mil[abe.nachabe@navy.mil]; michael.s.dean@navy.mil[michael.s.dean@navy.mil]; daniel.eldredge@navy.mil[daniel.eldredge@navy.mil]; Stephanie A. Brown[stephanie.a.brown@navy.mil]; Conmy, Robyn[Conmy.Robyn@epa.gov]; Principe, Vanessa[Principe.Vanessa@epa.gov]; Wilson, Gregory[Wilson.Gregory@epa.gov]; michael.j.green-1@nasa.gov[michael.j.green-1@nasa.gov]; wayne.yoder@dhs.gov[wayne.yoder@dhs.gov]; jfarrell@arctic.gov[jfarrell@arctic.gov]; Sarah.Helinek@csra.com[Sarah.Helinek@csra.com]; Rebecca.Weissman@csra.com[Rebecca.Weissman@csra.com]
From: Brooks, Rebecca J LT
Sent: Thur 6/2/2016 12:04:09 PM
Subject: ICCOPR 2014-2015 Biennial Report to Congress
2016.06.01.ICCOPR Oil Pollution Research.pdf

Good morning ICCOPR members and colleagues,

We are pleased to provide you all with the approved and signed 2014-2015 Biennial Report to Congress, enclosed. Thank you for all the time and effort each of you put into the Report. Have a great day!

Very respectfully,

LT Becca Brooks
U.S. Coast Guard Headquarters STOP 7516
Office of Marine Environmental Response Policy (CG-MER-3)
2703 Martin Luther King Jr. Ave SE
Washington, DC 20593-7516
Phone: 202-372-2259

Interagency Coordinating Committee on Oil Pollution Research: FY 2014-2015 Activities

Biennial Report to Congress

June 01, 2016

U.S. Coast Guard

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Message from the U.S. Coast Guard Chief, Office of Marine Environmental Response Policy

The *Oil Pollution Act of 1990* requires the Chairman of the Interagency Coordinating Committee on Oil Pollution Research to submit biennial reports on the Interagency Committee's activities. The U.S. Coast Guard chairs the Interagency Committee, and has done so since its inception. The Interagency Committee first reported to Congress in 1994 and this report responds to the latest Congressional requirements.

The Interagency Committee released its updated Oil Pollution Research and Technology Plan for Fiscal Years 2015-2021 on September 29, 2015, the first revision to the Plan since 1997. Release of the Plan marked the culmination of a comprehensive multi-year effort to document the current state of oil pollution research, establish current Federal oil pollution research priorities, and initiate a six-year revision cycle for the Plan.

The Interagency Committee and its 15 member agencies continued its high level of activity over the past two years including conducting and sponsoring more than 212 oil pollution related research projects and publishing more than 378 reports, papers, and other documents. It continued to conduct outreach to industry, academia, research institutions, state governments, and other nations to promote coordinated and collaborative research.

Pursuant to Congressional requirements, this report is being provided to the following members of Congress:

The Honorable John Thune
Chairman, Senate Committee on Commerce, Science, and Transportation

The Honorable Bill Nelson
Ranking Member, Senate Committee on Commerce, Science, and Transportation

The Honorable Bill Shuster
Chairman, House Committee on Transportation and Infrastructure

The Honorable Peter DeFazio
Ranking Member, House Committee on Transportation and Infrastructure

I am happy to answer any further questions you may have, or your staff may contact the Coast Guard's Senate Liaison Office at (202) 224-2913 or House Liaison Office at (202) 225-4775.

Sincerely,

Joseph B. Loring
Captain, U.S. Coast Guard
Chairman, Interagency Coordinating Committee
on Oil Pollution Research

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Interagency Coordinating Committee on Oil Pollution Research: FY 2014-2015 Activities

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I. Executive Summary

Title VII of the *Oil Pollution Act of 1990* (OPA 90) (Pub. L. No. 101-380) established the Interagency Coordinating Committee on Oil Pollution Research (referred to as the "Interagency Committee") to "coordinate a comprehensive program of oil pollution research, technology development, and demonstration among the federal agencies, in cooperation and coordination with industry, universities, research institutions, state governments, and other nations, as appropriate" and to "foster cost-effective research mechanisms, including the joint funding of research." This report discusses Interagency Committee activities carried out in fiscal years (FY) 2014 and 2015, as well as activities proposed for FY 2016 and 2017.

The Interagency Committee released its FY 2015 - 2021 Oil Pollution Research and Technology Plan (OPRTP) in September 2015. This multi-year effort included a detailed analysis of more than 900 research needs, evaluations of the needs using surveys of 280 subject matter experts, and extensive internal reviews. This effort resulted in the Interagency Committee deciding on 150 priority research needs within 25 Standing Research Areas (SRAs), which are common research themes. The Interagency Committee also conducted outreach with several non-federal entities to promote the concepts in the plan and encourage these entities to also focus on the priority needs.

Federal Agencies of the Interagency Committee continued to oversee an increasing number of research projects related to prevention of, preparedness for, and response to oil spills. Chapter IV lists some of the member research initiatives and collaborations. Appendix A lists 378 publications that were generated from member agencies and their funded research, while Appendix B describes 211 member projects that were active during the reporting period.

Interagency Committee members participated in numerous workshops and conferences that have included both international and domestic subject matter experts working on various oil pollution issues. Most notably, several member agencies sponsored and took leadership roles in planning and conducting major conferences including the International Oil Spill Conference, the Clean Gulf and Clean Pacific Conferences, and the Offshore Technology Conference. These conferences and workshops are a vital component of the Interagency Committee's abilities to stay abreast of the latest research initiatives.

The Interagency Committee has substantial plans for future initiatives during the FY2016-2017 period. Most prominent will be conducting outreach to promote use of the OPRTP within federal agencies, state and non-governmental organizations, industry, academia, other research organizations, and international partners. The Interagency Committee will establish a mechanism to track research toward the research priorities as a tool to facilitate future updates of the OPRTP. The Interagency Committee members will also continue sponsorship and planning responsibilities for the next International Oil Spill Conference in 2017. In addition, the Interagency Committee will continue working with the National Academy of Sciences and other research programs to support restoration from the BP *Deepwater Horizon* oil spill; identify and promote Arctic research; and continue outreach to non-federal stakeholders.

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II. Legislative Requirement

This report responds to the language set forth in Section 7001(e) of the *Oil Pollution Act of 1990* (Pub. L. No. 101-380), as per the following:

> **SEC. 7001. OIL POLLUTION RESEARCH AND DEVELOPMENT PROGRAM.**
>
> "(e) BIENNIAL REPORTS - The Chairman of the Interagency Committee shall submit to Congress every 2 years on October 30 a report on the activities carried out under this section in the preceding 2 fiscal years, and on activities proposed to be carried out under this section in the current 2 fiscal year period."

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III. Background and Legacy Obligations

Purpose of the Interagency Committee

Section 7001(a) of OPA 90 established the Interagency Coordinating Committee on Oil Pollution Research (Interagency Committee). The purpose of the Interagency Committee is twofold: (1) to prepare a comprehensive, coordinated federal OPRTP; and (2) to promote cooperation with industry, universities, research institutions, state governments, and other nations through information sharing, coordinated planning, and joint funding of projects.

Membership

The 15 Interagency Committee members, representing independent agencies, departments, and department components, include:

Department of Commerce (DOC) represented by:

- National Oceanic and Atmospheric Administration (NOAA)
- National Institute of Standards and Technology (NIST)

Department of Energy (DOE)

Department of the Interior (DOI) represented by:

- Bureau of Safety and Environmental Enforcement (BSEE)
- Bureau of Ocean Energy Management (BOEM)
- U.S. Fish and Wildlife Service (USFWS)

Department of Transportation (DOT) represented by:

- Maritime Administration (MARAD)
- Pipeline and Hazardous Materials Safety Administration (PHMSA)

Department of Defense (DoD) represented by:

- U.S. Army Corps of Engineers (USACE)
- U.S. Navy (USN)

Environmental Protection Agency (EPA)

National Aeronautics and Space Administration (NASA)

Department of Homeland Security (DHS) represented by:

- U.S. Coast Guard (USCG)
- Federal Emergency Management Agency (FEMA)
    - U.S. Fire Administration (USFA)

U.S. Arctic Research Commission (USARC)

Oil Pollution Research and Technology Plan Revision

The Interagency Committee made a major stride in addressing oil pollution research needs with the release of its revised OPRTP in September 2015. This revision marks the first coordinated federal OPRTP since the Interagency Committee released the 1997 OPRTP. Its release also

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established a new baseline on the nation's research needs. This document will be used by federal agencies to inform their research funding decisions. It will also serve as a valuable reference tool for agencies and organizations involved in oil pollution research.

OPRTP Background: Section 7001(b) of OPA 90 required the Interagency Committee to prepare an OPRTP. The Interagency Committee prepared the original OPRTP to define the roles of each federal agency involved in oil spill research and development and to identify subject areas that needed attention. The original OPRTP was submitted to Congress in April 1992 and revised in April 1997 based on an OPA 90 mandated review by the National Research Council's Marine Board. The 1997 version of the OPRTP identified 21 research areas divided into three levels of priority and served as a strategic planning document for the Interagency Committee to communicate and coordinate research needs.

Updated OPRTP Process: Although OPA 90 did not explicitly require successive updates to the original plan, the Interagency Committee reexamined the 1997 OPRTP Plan in late 2009 and decided that an update was necessary to address changing technologies and new oil pollution risks. Consequently, the Interagency Committee began a comprehensive examination of the current state of the science for oil pollution research to formulate a new version of the OPRTP. The revision process concluded during the reporting period with a detailed analysis of research needs, establishing research priorities, and documenting the plan.

During the reporting period, the Interagency Committee conducted a systematic and thorough review of more than 900 identified oil pollution research needs and consolidated the list into approximately 570 needs. These needs were categorized using the new "Oil Pollution Research Categorization Framework" into 25 SRAs within four research Classes- (1) Prevention, (2) Preparedness, (3) Response, and (4) Injury Assessment and Restoration. The Interagency Committee organized an R&T Workgroup that conducted the following activities during the reporting period to complete the planning process:

- Recruited 280 subject matter experts covering all 25 SRAs and surveyed them to evaluate the relative merits of the research needs in their areas of expertise.
- Analyzed and evaluated the relative merits of the research needs using input from the survey of subject matter experts.
- Identified the three highest priority research needs for each SRA, or subcategory of an SRA and presented the list to the full Interagency Committee, which approved the research priorities.
- Developed a comprehensive listing of key organizations involved in oil pollution research and their roles. This documentation included Interagency Committee member agencies as well as entities from federal agencies, state agencies, academic organizations, non-governmental organizations, industry, and international entities.
- Compiled the formal OPRTP, which was reviewed and unanimously approved by the full Interagency Committee.

Future Revisions: Publication of the updated OPRTP initiates a new cycle of research planning for the Interagency Committee. In the future, the OPRTP will be revised every six years to include a retrospective analysis of completed research and accomplishments over the previous six years and a forecast of new research needs for the upcoming six-year period. The Interagency Committee chose a six-year revision period to provide time that is realistically needed by the global research community to make measureable strides in oil pollution research

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or to identify new research needs. This timeframe was also chosen to align updates of the OPRTP with future submissions of Interagency Committee Biennial Reports to Congress.
Oil Pollution Research and Development Program.

Guided by Section 7001(c) of OPA 90, the Interagency Committee monitors, supports, and publicizes a variety of oil pollution research and development initiatives with industry, universities, research institutions, state governments, and other entities. Several ventures were completed in the first decade of the Interagency Committee's existence, while others continue to progress through the current reporting period. The status of several key initiatives listed in Section 7001(c) is discussed below:

1) *Oil pollution technology research* – The cornerstone of the Interagency Committee's role and activities is the research funded, monitored, conducted, and coordinated by its members. Chapter IV of this report includes highlights of several research initiatives of Interagency Committee member agencies. The selected initiatives illustrate a small sample of the diverse research coordinated by the Interagency Committee. Appendix A lists some of the numerous papers, reports, and other publications by the members and researchers funded by the member agencies. Appendix B describes specific projects overseen by member organizations on the Interagency Committee during FY 2014 and FY 2015 or planned through FY 2017.

2) *Demonstration Projects* - Section 7001(c)(6) directed that Port Oil Pollution Minimization Demonstration Projects be conducted in New York, New Orleans, and Los Angeles/Long Beach. The *Great Lakes Oil Pollution Research and Development Act of 1990* (Pub. L. No. 101- 380) amended OPA 90 to include a fourth demonstration in ports of the Great Lakes. Demonstration Projects were held in New Orleans (December 1994) and New York (October 1995). After the first two projects were completed, the USCG determined that they were cost prohibitive and the Interagency Committee agreed that the objectives for the Demonstration Projects requirement could be met through other means.[1] Since 1995, the objectives have been addressed through interagency participation in and support for regularly scheduled domestic and international oil spill conferences including: the International Oil Spill Conference (triennial), Interspill (triennial), Spillcon (triennial), and the Clean Pacific and Clean Gulf Conferences (biennial and annual). These domestic and international conferences present both technical programs and equipment tradeshows that present the latest issues, products, and technologies available for oil spill and hazardous materials response, spill prevention, marine salvage, cleanup and remediation, professional services, and regulatory compliance.

   The Interagency Committee conducted the following activities during the reporting period to maintain its commitment to meet the requirement of section 7001(c)(6):

   - The USCG, BSEE, EPA, and NOAA served as key members of the 2014International Oil Spill Conference (IOSC) Executive Committee and Program Committee. These Committees delivered a robust conference program that included 45 sessions with papers selected through a peer review process from 299 submitted abstracts. Authors from member agencies delivered more than 70 papers and posters at the conference.

[1] Interagency Committee Biennial Report to Congress for FY 2001 & 2002

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- BSEE managed planning for on-water demonstrations of oil pollution prevention and cleanup systems including UAV surveillance and cutting edge response technology.
- NOAA organized a series of 12 short courses to provide attendees with opportunities to improve their knowledge.
- The Executive Committee and Program Committee are currently organizing the 2017 IOSC, which will include an additional on-water demonstration if site conditions and budgets allow.

3) *Simulated Environmental Testing* – Section 7001(c)(7) directed agencies of the Interagency Committee to ensure the long-term use and operation of Ohmsett - the National Oil Spill Response Research & Renewable Energy Test Facility. BSEE continues to operate and maintain Ohmsett, which is located an hour south of New York City, in Leonardo, New Jersey. Ohmsett provides independent and objective performance testing of full-scale oil spill response equipment and marine renewable energy systems (wave energy conversion devices), and improves technologies through research and development. It is the largest outdoor saltwater wave/tow tank facility in North America and is the only facility where full-scale oil spill response equipment testing, research, and training can be conducted in a simulated marine environment using real oil under controlled environmental conditions (waves and oil types).

   Ohmsett is used for two primary and essential functions related to national oil spill response planning:

   - *Full-scale equipment testing* - It is estimated that 95 percent of the quantitative performance data on mechanical equipment used by the USCG, EPA, USN and private industry (both domestic and international) is obtained through Ohmsett.

   - *Responder training* - Ohmsett is one of the few facilities in the world where oil spill responders can be trained under various controlled environmental conditions using real oil. Training provided at Ohmsett ensures responders are educated about oil pollution operations in advance of an incident.

   Ohmsett experienced significant damage during 2012's Hurricane/Super-storm Sandy. One storage building was completely destroyed, and a second building was heavily damaged. Significant amounts of testing and training materials that were stored in the destroyed buildings were lost. Salt water infiltrated many electrical components requiring repair or replacement of those items. Limited tank operations resumed a month after the storm and within a year, the tank was fully operational and most of the damaged equipment was replaced or repaired. BSEE used supplemental funding for both a replacement warehouse, which is being built by the National Park Service, and for the Naval Facilities Engineering Command (NAVFAC) to harden the facility against future storms by raising assets damaged during Sandy and using barriers in front of critical assets to protect against future storm surge.

   BSEE has undertaken several projects to enhance the scientific data collection capabilities of Ohmsett. During FY 2014 new sensor systems were added that allow for near-real-time data interpretation in regard to the thickness of oil on the surface of the tank water, and the quantification of the ice coverage within an ice field. During FY 2015, studies were conducted to enhance the capabilities of the facility's wave maker to produce breaking waves at a specified location, translate the energy produced by

breaking waves within the tank to the ocean environment, and understand the impact of the chemicals in the tank water (chlorine, zinc, etc.) upon dispersant effectiveness testing and how that might translate to open ocean dispersant application.

4) *Regional Research Grant Program* - Section 7001(c)(8) authorized a Regional Research Program. The objective of the Regional Research Program is to "coordinate a program of competitive grants to universities or other research institutions, or groups of universities or research institutions, for the purposes of conducting a coordinated research program related to the regional aspects of oil pollution, such as prevention, removal, mitigation, and the effects of discharged oil on regional environments." Funding for the program was authorized for each of the FYs from 1991 through 1995. The last reports prepared by the universities and institutions selected under this program were published in 1997.[2]

[2] U.S. Coast Guard 1995 Oil Pollution Research Grant Publications: Parts 1 &2. Final Report. John A. Volpe National Transportation Systems Center, Cambridge, Massachusetts. August 1997.

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IV. Interagency Committee Activities

The Interagency Committee pursued several different activities during this reporting period. These activities addressed Government Accountability Office (GAO) recommendations[3,4] and emerging and continuing oil pollution research needs.

Organizational Changes

Expanding Membership – The Interagency Committee membership remains at 15 independent agencies, departments, and department components. In FY2015, the Interagency Committee reached out to the U.S. Geological Survey (USGS) to explore the Survey's interest in participating in the Interagency Committee's activities. The USGS is currently participating in an observer role. The Interagency Committee is also reaching out to other agencies that could provide expanded capabilities related to human health effects of oil pollution. In addition, the Interagency Committee is also reaching out to Environment Canada and Transport Canada to explore opportunities for these agencies to participate on an ad hoc basis.

Leadership Changes – In June 2015, the Interagency Committee welcomed CAPT Joseph Loring as the new Chair replacing CAPT Claudia Gelzer. During the reporting period, Ms. Lori Medley of BSEE served as the Vice Chair in accordance with the Interagency Committee's rotating Vice Chair position. Dr. Robyn Conmy of EPA will assume the role of Vice Chair during the FY2016-2017 reporting period.

Workgroups – The Interagency Committee's R&T Plan Workgroup operated throughout the reporting period to guide development of the OPRTP. The R&T Plan Workgroup met frequently to evaluate research needs and provide recommendations to the full Interagency Committee on proposed priorities and content of the OPRTP. In June 2015, the Interagency Committee established an Intentional Release Permitting Workgroup to evaluate issues related to obtaining permits for release of small amounts of oil into the environment for research purposes.

Staff Resources – The USCG, as Interagency Committee Chair, continued to support a full-time Executive Director position to provide the Interagency Committee with expanded organizational, coordination, and outreach capabilities.

Interagency Committee Meetings

The Interagency Committee formally met 11 times during FYs 2014 and 2015. These gatherings included quarterly and special meetings of the membership and engagements with the Prince William Sound Regional Citizen's Advisory Council (PWSRCAC) and the International Tanker Owners Pollution Federation (ITOPF):

- December 11, 2013 – Washington, DC: Quarterly Meeting
- March 12, 2014 – Washington, DC: Quarterly Meeting
- March 27, 2014 – Washington, DC: Meeting with PWSRCAC
- May 21, 2014 – Washington, DC: Meeting with ITOPF

[3] Government Accountability Office, Federal Oil and Gas: Interagency Needs to Better Coordinate Research on Oil Pollution Prevention and Response. GAO-11-319, March 2011

[4] Government Accountability Office, Oil Dispersants: Additional Research Needed, Particularly on Subsurface and Arctic Applications. GAO-12-585. May 2012

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- June 18, 2014 – Washington, DC: Quarterly Meeting
- September 17, 2014 – Washington, DC: Quarterly Meeting
- January 21-22, 2015 – Washington, DC: Quarterly Meeting
- April 1, 2015 – Washington, DC: Quarterly Meeting
- April 26, 2015 – Washington, DC: Meeting with PWSRCAC
- June 10, 2015 – Washington, DC: Quarterly Meeting; and
- September 29, 2015 – Washington, DC: Quarterly Meeting

The agendas for these meetings are available on the Interagency Committee's website, www.uscg.mil/iccopr. During the quarterly meetings, the Interagency Committee shared information on recent research projects, identified new research issues, listened to presentations from other government agencies, industry, and academia, and developed strategies for future initiatives. The meetings with PWSRCAC and ITOPF provided opportunities for Interagency Committee members to share information with these organizations and to hear their issues and perspectives on research needs.

Internal Collaboration

A standing agenda item in each quarterly meeting is a research update from each of the 15 member organizations. These updates prompted increased collaboration within the membership. The updates foster new ideas and opportunities for joint agency projects or suggestions on new initiatives.

The USCG Research, Development, Test and Evaluation (RDT&E) Program collaborated over the past two years with BSEE by holding yearly meetings to identify priorities and coordinate research. The RDT&E Program supported the BSEE contracting process by assisting in the evaluation of White Papers and Broad Agency Announcements (BAA) in multiple spill response topic areas. Funds were transferred from BSEE to the RDT&E Program to support oil spill surveillance and response topics and these projects are provided in Appendix B of this report. BSEE also provided an unmanned underwater vehicle for demonstrations in the Great Lakes and the Arctic Circle off of the Coast Guard Cutter HEALY.

BSEE collaborated with NOAA on several projects to enhance computer software's ability to support oil spill responders. One project that has become fully-functional during this reporting period is the enhancement of the Environmental Response Management Application (ERMA) for the Arctic region. Reconfiguring this application to meet the needs of responders in the remote marine Arctic environment will be a critical tool in effectively preparing for, responding to, and mitigating situations where limited assets, personnel, and facilities exist. Arctic ERMA contains information such as the extent and concentration of sea ice, locations of ports and pipelines, and vulnerable environmental resources for spill responders to make rapid, science-informed response decisions. ERMA facilitates the display of real-time data feeds such as weather, ship locations/movements, and other oceanographic information. In FY 2015, BSEE began work on another collaborative effort that will assist in the ingestion of existing Geographic Response Plan (GRP) and/or Area Contingency Plan resource protection data into GIS systems such as ERMA. Additionally, BSEE is developing models to more accurately represent spills in a cold weather/arctic environment from potential well blowouts as well as shipping and oil transport accidents. The focus is on spills in cold waters where sea ice may be present, and blowouts in the U.S. Arctic region.

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During this reporting period, the Interagency Committee continued to engage in discussions on the potential benefits of, and concerns associated with intentional oil discharges into U.S. waters for testing purposes. An intentional release of oil in U.S. waters, particularly a subsea discharge test, may provide useful research data when clear research needs, methods, and goals, combined with responsible cleanup and monitoring plans, have been established. Field tests may be justified when laboratory or other simulated settings (e.g., test tanks) cannot address specific research needs and no other open water research projects have addressed them. Experiments in large test tanks (i.e., Ohmsett) provide opportunities to simulate real environmental conditions and bridge the gap between laboratory and actual field experiments; however, they cannot completely replicate actual field conditions. The Interagency Committee will continue working with policy makers and permitting authorities to explore field testing opportunities.

Examples of formal collaborations between member agencies include:

DOE/BSEE Memorandum of Collaboration (MOC) - The DOE Office of Fossil Energy and BSEE continue to operate under a MOC signed on August 22, 2013 that coordinates the ongoing efforts of the two agencies on offshore research and technological improvement projects. Through this collaboration, BSEE and DOE work together to develop technology that ensures safe, sustainable offshore production of oil and natural gas. The group established a Steering Committee and three Subcommittees: Cementing Subcommittee, Materials Subcommittee and Arctic Subcommittee. These Subcommittees bring together experts from DOE and BSEE to coordinate their research and explore synergies.

Federal Multiagency Collaboration on Unconventional Oil and Gas Research - In response to the President's *Blueprint for a Secure Energy Future,* the DOE, DOI, and the EPA signed a memorandum of agreement in April 2012 to formalize the collaboration. Under the agreement, the three agencies are working together to address the highest priority challenges and research questions associated with safely and prudently developing unconventional shale gas and tight oil reserves. The topic areas of collaboration include Resource Base, Water Availability, Ecological Effects, Air Quality, Induced Seismicity, Water Quality, and Human Health. In these areas, each agency has individual expertise and core competencies that can influence the effective implementation of R&D. In this collaboration, emphasis is placed on a complementary approach that avoids duplication and takes advantage of these inherent strengths. On July 18th, 2014 the Steering Committee finalized and released the "Federal Multiagency Collaboration on Unconventional Oil and Gas Research - A Strategy for Research and Development."

DOE/PHMSA Collaboration on Crude Oil Properties - The DOE Office of Fossil Energy and DOT-PHMSA collaborated on a study to identify the actions needed to obtain a science-based understanding of outstanding questions associated with the production, treatment, and transportation of various types of crude oil, including Bakken crude oil. The agencies asked Sandia National Laboratories to prepare the March 2015 report entitled *Literature Survey of Crude Oil Properties Relevant to Handling and Fire Safety in Transport.* The Sandia report was an important step in developing a more complete understanding of outstanding scientific questions associated with the properties of various types of crude oil. It identified gaps in important crude oil characterization data; uncertainty and a lack of uniformity regarding how best to sample, test and analyze crude oil to ensure that its properties are accurately determined; and deficiencies in the understanding of how crude oil properties affect its potential for accidental ignition, combustion, and explosion.

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DOE and DOT-PHMSA also asked Sandia to prepare recommendations to address these gaps. Sandia prepared a comprehensive *Crude Oil Characterization Research Sampling, Analysis, and Experiment (SAE) Plan,* which contains recommendations on research needed to improve understanding of transport-critical crude oil and especially tight crude oil properties, including identifying the most appropriate sampling and testing methods for crude oils; sampling, testing and compilation of data on different crude oils using those methods; initial combustion testing to identify relationships between a particular chemical or physical property of crude oil, or combination of such properties, and combustion properties; and possible full-scale combustion tests. After considering this Plan, DOE and DOT have decided to support selected portions of the effort described in the Sampling, Analysis and Experiment (SAE) Plan.

External Collaboration

The Interagency Committee did not limit itself to internal collaboration among the membership. It pursued coordination and collaboration with several external oil spill related programs, particularly in the Gulf of Mexico and Arctic regions, through participation in joint meetings, forums, and workgroups.

The Interagency Committee continued working with the National Academy of Science's Gulf Research Program (GRP) as they developed their strategy for implementation of the 30-year oil system safety research program funded by a $500 million endowment from BP and Transocean criminal settlements stemming from the BP *Deepwater Horizon* oil spill. The settlement agreements require NAS to seek the recommendations of the Interagency Committee, including members BOEM and BSEE, at least annually on administration of the program.

The Interagency Committee external collaboration activities also included presentations at the following meetings of key organizations with research programs:

- January 6, 2014 – Via Conference Call: The Vice-Chair, Executive Director, and an Interagency Committee member participated in a Pacific States/British Columbia Task Force meeting to provide an annual update on oil pollution research activities. The USCG and BSEE were represented.

- April 2, 2014 – Conference Call: Presented an overview of Interagency Committee activities and research planning efforts to a USCG and Florida Institute of Oceanography forum on incorporating research into spill response.

- May 5-8, 2014 – Savannah, GA: The Executive Director presented a paper on the history and current activities of the Interagency Committee during the International Oil Spill Conference. Several other members of the Interagency Committee also presented papers and posters on research topics at the conference.

- June 5, 2014 – Washington, DC: The Executive Director met with the National Response Team (NRT) and made a presentation on the National Research Council's report "Responding to Oil Spills in the U.S. Arctic Marine Environment."

- June 30, 2014 – Conference call: Interagency Committee members from the USCG and NOAA participated in an informal information exchange with Norwegian representatives regarding oil pollution research.

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- July 8, 2014 – Via Conference Call: Presented an overview of Interagency Committee activities and research planning concepts to the PWSRCAC's Science Advisory Committee.

- September 3-4, 2014 – New Orleans, LA: The Executive Director and representatives from six other Interagency Committee agencies participated in the NAS Gulf Research Program workshop on environmental monitoring opportunities for the GRP.

- September 22, 2014 – New Orleans, LA: The Executive Director participated in the NAS Gulf Research Program workshop on human health and community resilience opportunities for the GRP.

- September 23, 2014 – New Orleans, LA: The Executive Director presented an update on Interagency Committee research and technology planning activities to the annual meeting of the Industry Technical Advisory Committee (ITAC). The Interagency Committee Chair presented an update on USCG oil spill response activities.

- November 4, 2014 – Stavanger, Norway: The Executive Director presented information on Interagency Committee member research and development activities and Interagency Committee R&T Plan development to a Norwegian interagency committee organized to enhance Norwegian oil pollution response capabilities and research.

- November 12-13, 2014 – Washington, DC: The Interagency Committee Chair, Executive Director, and members from NOAA participated in a two-day workshop between the USCG, NOAA, and the Norwegian Coastal Administration and Norwegian Ministry of Transport to share information on oil pollution research and response. The Executive Director presented information on Interagency Committee member research and development activities and Interagency Committee R&T Plan development.

- January 6, 2015 – Conference Call: The Executive Director and representatives of EPA, BSEE, and NOAA participated in the Pacific States-British Columbia Oil Spill Task Force meeting. The Executive Director presented information on the Interagency Committee activities.

- February 20, 2015 – Houston, TX: The Interagency Committee Executive Director and EPA representative presented information on Interagency Committee activities and met with the GoMRI Board of Directors to discuss the R&T planning process and opportunities for the Interagency Committee and GoMRI to work together to promote research.

- February 26, 2015 – Alameda, CA: The Interagency Committee Executive Director participated in the California Office of Spill Prevention and Response (CA OSPR) and Chevron Technology Conference and presented information on Interagency Committee and the R&T planning process.

- March 24-26, 2015 – Amsterdam, Netherlands: Representatives of the USCG, BSEE, and NOAA presented six papers at the Interspill Conference.

- April 30, 2015 – Webinar: Representatives of the Interagency Committee participated in the Federal Interagency Preparedness Initiatives in Crude by Rail Transport webinar.

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- June 19, 2015 – Conference Call: The Interagency Committee Executive Director participated in the first meeting of the Canada-United States Working Group on Maritime Transportation of Hydrocarbons and Their By-Products to provide information on Interagency Committee activities.

- July 8, 2015 – Alexandria, VA: The Interagency Committee Executive Director participated in a USCG and American Salvage Association meeting to discuss oil pollution issues related to marine salvage.

- August 11-12, 2015 – Anchorage, AK. Representatives of the USCG and BSEE participated in an Oil Spill Technology Adoption Workshop sponsored by OSRI to better understand how oil spill response technologies advance from the research and development phase to widespread adoption and application to improve oil spill response.

- September 15-17, 2015 – Washington, DC. Representatives of the USCG, BSEE, MARAD, and EPA participated in the Arctic Council Emergency Preparedness, Prevention and Response (EPPR) MOSPA 2015 Exercise Workshop to discuss research activities and make plans for an Arctic response exercise.

Individual members of the Interagency Committee serve on different committees, forums, and teams with a nexus to oil spill research. Their participation in these other committees brings an increased awareness of the Interagency Committee and provides the other committees with a wider perspective on oil spill research interests. Examples of the Interagency Committee participation in outside activities include:

National Response Team (NRT) and its Science and Technology (S&T) Committee – Eight of the Interagency Committee agencies, and several individual representatives, are also members of the NRT, which provides opportunities for the two organizations to share information and perspectives on common issues. This joint participation enables these Interagency Committee members to also collaborate with the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH), which are not Interagency Committee members, but serve important roles during oil spill response and recovery.

The NRT's S&T Committee, a forum for the NRT to fulfill its research and development responsibilities, is chaired by an Interagency Committee member from NOAA. Other representatives serving on both committees are from the USCG, EPA, and BSEE. This joint membership has enabled the Interagency Committee and the S&T Committee to share research information and leverage their resources to address critical needs.

Gulf Coast Ecosystem Restoration Council – The Chair of the Interagency Committee also serves as the DHS representative on the Gulf Coast Ecosystem Restoration Council. The Interagency Committee interests are represented in the Council by senior official representatives from the EPA, the Departments of Commerce (Chair) and the Interior, and USCG.

Gulf Restoration Science Programs Ad Hoc Coordination Forum – This Forum was established by NOAA and the Gulf of Mexico University Research Collaborative (GOMURC) to promote communication between and integration of restoration science programs. The Team conducts bi-monthly webinars to exchange information on programs and activities. The Interagency Committee Executive Director represents the Interagency Committee on the Forum.

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Federal Oil Spill Team for Emergency Response Remote Sensing (FOSTERRS) – NOAA, NASA, and USGS organized and formed FOSTERRS in 2015 as an interagency working group to facilitate the sharing of remote sensing capabilities and to discuss improvements in disaster response using remote sensing. Specifically, FOSTERRS seeks to connect agency information on airborne and space borne asset's availability, limitations, capabilities and performance, and ancillary data needs to stakeholders and responders. It also reaches out to the larger community involved in marine disaster response and the development and implementation of remote sensing best practices.

Environmental Committee on Offshore Energy Resources - In June 2015, BOEM announced an agreement to have the National Academies establish a new standing committee on environmental science and assessment for offshore energy and mineral resources. The committee will provide independent information on issues relevant to BOEM's environmental studies and assessment activities and support discussions on relevant issues. The committee's services will be provided under a three-year contract with the National Research Council (NRC), the operating arm of the National Academy of Sciences (NAS) and the National Academy of Engineering (NAE). Topics and activities the committee or sub-committees may explore include: strategic approaches to environmental monitoring to assess ecosystem health and mitigation effectiveness; stakeholder discussions on controversial issues; reviews of proposed BOEM studies; high level reviews and expert advice on gaps and priorities for research; technical input related to BOEM's environmental programs; enhancing understanding of innovation in science and technology; and if warranted, NRC studies on specific topics.

Joint Industry Task Forces – During this reporting period, three different domestic and international Joint Industry Task Forces that are focusing on new oil pollution research initiatives were in various stages of progress and are of great interest to the Interagency Committees. These task forces are:

- Joint Industry Oil Spill Preparedness & Response Task Force (OSPR JITF) and resulting API Research Workgroups.
- Arctic Oil Spill Response Technology Joint Industry Programme.
- International Association of Oil and Gas Producers (OGP) - Oil Spill Response Joint Industry Project (OSR-JIP).

These industry-led and industry–financed programs were initiated to tackle numerous research gaps identified from the BP *Deepwater Horizon* oil spill and potential energy exploration in the Arctic. In addition to monitoring the general progress of these organizations, the Interagency Committee has been asked to provide some direct support. For example, the Interagency Committee provided subject matter experts from its member organizations to support several of the API Workgroups formed from the OSPR JITF, including:

- API *In-Situ* Burn Technical Working Group
- API Subsea Dispersant Injection Workgroup
- API Remote Sensing Technical Working Group
- API Alternative Response Technology (ART) Working Group

Other Workgroups and Forums – Individual members of the Interagency Committee participate in a number of other external workgroups and other forums that provide valuable information on different issues related to the oil pollution research. These workgroups include:

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- ASTM F-20 Committee on Hazardous Substances and Oil Spill Response
- International Maritime Organization (IMO) Technical Group under Marine and Environmental Protection Committee (MEPC)
- Prince William Sound Oil Simulants Workgroup
- CRRC Dispersant Workgroup
- CRRC Submerged Oil Workgroup
- Oil Spill Recovery Institute (OSRI) Technology Adoption Workshop

Collaboration on Arctic Issues

The Interagency Committee member agencies have several responsibilities to meet the requirements of the National Strategy for the Arctic Region (NSAR) and the Implementation Plan for the National Strategy for the Arctic Region (NSAR IP). The Interagency Committee member agencies sponsored independent assessments of Arctic research needs, participated in organizations addressing Arctic issues, and incorporated recommendations into the Interagency Committee's research priorities. Examples of the collaboration on Arctic issues are:

Assessment of Arctic Spill Response Capabilities - Interagency Committee members USCG, BSEE, BOEM, NOAA, and USARC, along with three other organizations requested that the National Research Council of the National Academy of Sciences conduct a study of the current capabilities to respond to oil spills in the Arctic. The Council issued their report, "Responding to Oil Spills in the Arctic Marine Environment" in July 2014. The report had four main sections: 1) Environmental Conditions and Natural Resources in the U.S. Arctic; 2) Arctic Oil Spill Response Research; 3) Operations, Logistics, and Coordination in an Arctic Oil Spill; and, 4) Strategies for Response and Mitigation. Each section described the current state of knowledge or capabilities of the U.S. response organizations and made recommendations for an effective prevention, preparedness, and response system.

NPC Arctic Potential Report – In 2013, the Secretary of Energy commissioned the National Petroleum Council (NPC) to conduct a comprehensive study considering the research and technology opportunities to enable prudent development of U.S. Arctic oil and gas resources. Subject matter experts from the Interagency Committee and its member agencies provided input and reviews of portions of the products from the study. The NPC in July 2015 released the report, "Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources." The Executive Summary was released in March 2015. The report includes extensive information on the state of knowledge on Arctic technologies and operations, spill prevention and response capabilities, and the ecological and human environment.

Plan for Incorporation of National Academy of Sciences Arctic Spill Response Assessment – In November 2014, the Interagency Committee in collaboration with the National Response Team, issued a plan to incorporate the recommendations of the National Research Council into federal activities. The Plan addressed each applicable recommendation and described the activities member agencies were conducting to address the recommendations.

State of the Science for Dispersant Use in Arctic Waters Workshop - The December 2013 Spill of National Significance (SONS) exercise for the Arctic senior federal agency leadership identified the need for a definitive evaluation of the state of the science of dispersants and dispersed oil (DDO).Workgroup formation and project scoping occurred throughout 2014 and a workshop was held in January 2015 to evaluate the state of science and remaining uncertainties for dispersant use in

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Arctic waters. . The workshop was organized into five groups: Efficacy and Effectiveness, Physical Transport and Chemical Behavior, Degradation and Fate, Toxicity, and Public Health and Food Security. Follow-on meetings and work continues to finalize the workshop's summary report.

Arctic Executive Steering Committee (AESC) Participation – The White House formed the AESC in 2015 by Executive Order 13689 to provide guidance to executive departments and agencies and enhance coordination of Federal Arctic activities, including research activities. Representatives from Interagency Committee member agencies USACE, USARC, USCG, BSEE, BOEM, DOE, EPA, MARAD, NASA, USN, and, NOAA contribute to the AESC activities through their agency or department official on the AESC.

Arctic Research and Technology Evaluations – The USCG continued to provide opportunities for Arctic and cold water research. As part of the annual Arctic Shield Exercises, USCG researchers collaborate with researchers from other federal agencies, academia, industry, and international organizations to evaluate technology under Arctic field conditions. Arctic Shield evaluations were conducted in 2014 and 2015. The USCG also conducts technology evaluations in the Great Lakes where conditions approximate those of the Arctic. In addition, the USACE's Cold Regions Research and Engineering Laboratory (CRREL) conducts research both in their laboratory facilities and field tests in Alaska and other cold regions.

Arctic Council Emergency Preparedness, Prevention, and Response (EPPR) Working Group – Interagency Committee member agencies NOAA, USCG, BSEE, BOEM, and EPA are active participants in oil spill and emergency prevention, preparedness, and response initiatives in the EPPR Working Group, which is currently chaired by a NOAA representative. A recent project led by NOAA, the Arctic Environmental Response Management Application (ERMA), is a GIS mapping platform to assist in oil spill response by providing information on all response assets and threatened environmental resources. BSEE is leading a project to develop an inventory of spill response assets throughout the Arctic. The USCG is leading an effort to develop an EPPR Arctic oil spill exercise in 2016 and hosted a planning workshop in 2015. Other projects include updating the Operational Guidelines in support of the Agreement on Marine Oil Pollution Preparedness and Response, and finalizing the Guide to Oil Spill Response in Snow and Ice Conditions" (https://oaarchive.arctic-council.org/handle/11374/403).

Interagency Arctic Research Policy Committee (IARPC) – The U.S. Interagency Arctic Research Policy Committee (IARPC) consists of 15-plus agencies, departments, and offices across the Federal government. Established by Congress through the Arctic Research and Policy Act, IARPC is chaired by the National Science Foundation. Representatives of the USCG, BOEM, BSEE, DOE, NASA, and NOAA participate as part of the IARPC staff.

Coast Guard Arctic Strategy Initiatives – The USCG has developed a series of initiatives to implement its Arctic Strategy, which was released in May 2013. Four of these initiatives have direct bearing on the interests of the Interagency Committee:

- *Initiative 1: Enhance Arctic Operations and Exercises* – The USCG has been conducting Operation Arctic Shield annually since 2010 as a tactical activity that includes the deployment of aircraft, cutters, and personnel to the Arctic region to improve operational capabilities. It also serves as a platform for conducting oil pollution-related research in the Arctic.
- *Initiative 9: Support a Center for Arctic Study and Policy (CASP)* – The USCG opened the CASP on September 19, 2014 as a center for thought leaders on Arctic policy and operations. Research products from CASP will be used by national Arctic policy makers.

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- *Initiative 13: Strengthen Marine Environmental Response in the Arctic* – Under this initiative, the USCG is conducting programmatic reviews of area planning in Alaska and working with international partners to improve response capabilities.

Member Research and Technology Initiatives

Member organizations of the Interagency Committee managed and funded a number of new and on-going research projects during this reporting period: Appendix (A) lists 378 publications and Appendix (B) summarizes 212 research projects. The publications include scientific papers, journal articles, and reports by member agencies, their staff, or funded researchers. The research projects are categorized according to the SRAs identified in the OPRTP's Oil Pollution Research Categorization Framework. While the appendices detail research projects funded and managed by Interagency Committee members, the Interagency Committee also monitors a variety of oil spill research projects conducted or funded by other non-Committee entities.

In addition to the specific research projects and publications described in the appendices, some of the member organizations have prepared broad research strategies and initiatives that are being coordinated with the Interagency Committee.

1) *NOAA Environmental Response Management Applications (ERMA)* – NOAA continued its updating and improvements to the Environmental Response Management Application (ERMA®), an online mapping tool that integrates both static and real-time data, such as Environmental Sensitivity Index (ESI) maps, ship locations, weather, and ocean currents, in a centralized, easy-to-use format for environmental responders and decision makers. Developed by NOAA and the University of New Hampshire with the EPA, USCG, and DOI, ERMA provides environmental resource managers with the data necessary to make informed decisions for environmental response. NOAA has developed ERMA tools for the following regions: Atlantic, Gulf of Mexico, Deepwater Horizon Response, Caribbean, Great Lakes, New England, Pacific Northwest, Pacific Islands, and Southwest. Through funding from BSEE, NOAA also developed an ERMA for the Arctic, with separate software interfaces for first responders and the public.

2) *PHMSA/NAS Diluted Bitumen Studies* – PHMSA commissioned the National Academy of Sciences to conduct two separate studies of diluted bitumen (dilbit) transport by pipeline. The first study, "Effects of Diluted Bitumen on Crude Oil Transmission Pipelines" provided an analysis of whether any increase in the risk of a release exists for pipeline facilities transporting diluted bitumen. The results of the first study were released in 2014. The second study, "Effects of Diluted Bitumen on the Environment: A Comparative Study," is evaluating whether the spill properties of diluted bitumen differ sufficiently from those of other liquid petroleum products to warrant modifications of spill response plans, spill preparedness, or clean-up regulations. The completion of the second study is anticipated for early in FY 2016.

3) *DOE/BSEE Memorandum of Collaboration* - The DOE Office of Fossil Energy and BSEE continue to operate under a MOC signed on August 22, 2013 that coordinates the ongoing efforts of the two agencies on offshore research and technological improvement projects. Through this collaboration, BSEE and DOE work together to develop technology that ensures safe, sustainable offshore production of oil and natural gas. The group established a Steering Committee and three Subcommittees: Cementing Subcommittee, Materials Subcommittee and Arctic Subcommittee. These Subcommittees bring together experts from DOE and BSEE to coordinate their research and explore synergies.

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4) *Federal Multiagency Collaboration on Unconventional Oil and Gas Research* - In response to the President's *Blueprint for a Secure Energy Future*, the DOE, DOI, and the EPA signed a memorandum of agreement in April 2012 to formalize their collaboration. Under the agreement, the three agencies are working to address the highest priority challenges and research questions associated with safely and prudently developing unconventional shale gas and tight oil reserves. The topic areas of collaboration include Resource Base, Water Availability, Ecological Effects, Air Quality, Induced Seismicity, Water Quality, and Human Health. In these areas, each agency has individual expertise and core competencies that can influence the effective implementation of R&D. In this collaboration, emphasis is placed on a complementary approach that avoids duplication and takes advantage of these inherent strengths. On July 18th, 2014 the Steering Committee finalized and released the "Federal Multiagency Collaboration on Unconventional Oil and Gas Research - A Strategy for Research and Development."

5) *DOE/PHMSA Collaboration on Crude Oil Properties* - The DOE Office of Fossil Energy and DOT-PHMSA collaborated on a study to identify the actions needed to obtain a science-based understanding of outstanding questions associated with the production, treatment, and transportation of various types of crude oil, including Bakken crude oil. The agencies asked Sandia National Laboratories to prepare the March 2015 report entitled *Literature Survey of Crude Oil Properties Relevant to Handling and Fire Safety in Transport.* The Sandia report was an important step in developing a more complete understanding of outstanding scientific questions associated with the properties of various types of crude oil. It identified gaps in important crude oil characterization data; uncertainty and a lack of uniformity regarding how best to sample, test and analyze crude oil to ensure that its properties are accurately determined; and deficiencies in the understanding of how crude oil properties affect its potential for accidental ignition, combustion, and explosion.

   DOE and DOT-PHMSA also asked Sandia to prepare recommendations to address these gaps. Sandia prepared a comprehensive *Crude Oil Characterization Research Sampling, Analysis, and Experiment (SAE) Plan*, which contains recommendations on research needed to improve understanding of transport-critical crude oil and especially tight crude oil properties, including identifying the most appropriate sampling and testing methods for crude oils; sampling, testing and compilation of data on different crude oils using those methods; initial combustion testing to identify relationships between a particular chemical or physical property of crude oil, or combination of such properties, and combustion properties; and possible full-scale combustion tests. After considering this Plan, DOE and DOT have decided to support selected portions of the effort described in the Sampling, Analysis and Experiment (SAE) Plan.

6) *BSEE Oil Spill Response Research (OSRR) Program* – For more than 25 years, BSEE (and former organizations) has aggressively maintained a comprehensive, long-term research program dedicated to improving oil spill response options. The major focus of the program is to improve the methods and technologies used for oil spill detection, containment, treatment, recovery and cleanup. The OSRR program is a cooperative effort bringing together funding and expertise from research partners in government agencies, industry and the international community. BSEE's Oil Spill Response Division's Response Research Branch (RRB) manages the funding for numerous research projects chosen to meet selected major topics each year.

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7) *BSEE's preparation for an oil spill response in the Alaskan Arctic* – BSEE's research program continues to focus on enhancing the technology, processes, and procedures employed in responding to a marine oil spill. With the increase in interest and activities related to oil and gas exploration and production in the Alaskan Arctic, BSEE placed an increased emphasis on the ability to launch an expedient, efficient, and effective response in arctic conditions. BSEE conducted a comparison of commercially available dispersants in February 2014 to evaluate the efficacy of chemical dispersants in arctic environments. Additionally, recognizing the restricted logistical support in the Alaskan Arctic, BSEE continues to work on a project designed to assess the temporary storage options for oil recovered during a spill. As a result, new projects were initiated with the goal of reducing the amount of hazardous waste generated by an offshore oil response. BSEE is exploring options to enhance response operations during periods of low light, such as those encountered in the Arctic winter, and new methods to detect and map oil in and under ice. Finally, BSEE continues to study the impact of ice mechanics on the ability to conduct *in situ* burns of oil, and develop new technology that will burn crude oil more efficiently and result in less residual particulate matter in the air and on the surface of the water. The capability will be especially important in the Arctic because recent research has indicated that *in situ* burning of oil is the most practical response technique on a year-around basis due to the harsh operating conditions.

8) *BSEE's Technology Readiness Level (TRL) initiative* – During this reporting period BSEE implemented a project to define the TRLs for oil spill response technologies. TRLs have been in use for many years by agencies such as NASA and DOE. Once they are established within the oil spill response community they will not only define stage-gates for the development of new technologies, but also provide a metric to determine the readiness of these technologies to be deployed during an actual spill response. These TRLs would have been a valuable tool to assist with verifying the potential contributions of the hundreds of un-proven technologies that proposed to assist in the Deepwater Horizon response.

9) *Effective Recovery System Potential (ERSP) Calculator* - BSEE continued to develop and refine the ERSP calculator, which uses a systems approach to compute a reasonable response standard based on an operator's entire system (pumps, storage capacity, transit time, etc). BSEE developed the ERSP as a planning tool for estimating the potential for mechanical recovery of spilled oil by an advancing skimming system. In November 2013, the National Research Council completed an independent review of the ERSP and made several recommendations to improve the calculator.

10) *Department of Energy's Upstream Research* – The DOE works to ensure America's energy security and prosperity by addressing energy and environmental challenges with research and technology solutions. This includes ensuring the responsible development of America's oil and natural gas resources through research and development that improves the safety and environmental performance of oil and natural gas exploration and production.

    In its research program, DOE works toward developing technology that addresses the risks and environmental impacts/challenges associated with onshore and offshore oil and gas resource development. The offshore research portfolio is primarily dedicated to oil spill prevention, while the onshore research portfolio is focused on reducing the environmental footprint of oil and gas exploration and production activities. The

offshore research portfolio has focused on the areas of (1) geologic uncertainty; (2) subsea systems reliability; (3) surface systems and umbilicals; and (4) drilling and completions. Areas of focus for the onshore research portfolio include (1) resource characterization, (2) water quality and availability, (3) air quality, and (4) induced seismicity.

Through its National Energy Technology Laboratory, DOE continues to conduct laboratory, field, and modeling-based research on offshore oil spill prevention and onshore unconventional oil and gas, focusing on more fundamental research questions in these areas. DOE's offshore and onshore research activities are working to build the scientific understanding and assessment tools necessary to develop confidence in the safe and environmentally sustainable development of domestic oil and gas resources.

11) *Enhanced BOEM Environmental Information Systems* – BOEM, in collaboration with NOAA's Office for Coastal Management, used the latest geospatial science and database technology to reinvent the Environmental Studies Program Information System (ESPIS) to streamline the search, discovery, and retrieval of more than 40 years of environmental science. This enhanced system enables BOEM and others who are preparing NEPA environmental reviews to find study reports with more precision by searching expanded metadata of BOEM-funded ocean research. Regional Planning Bodies can geo-reference study data more easily. Industry, academia and the NGO community will find archived study results from past decades to compare with the latest BOEM research. This enhancement built upon the success of the BOEM/NOAA collaboration on MarineCadastre.gov, an integrated marine information website that includes a national viewer, a data registry, planning tools, a map gallery, example uses, and technical support products.

12) *The DOE Quadrennial Technology Review* - In FY 15, DOE prepared and released the 2015 Quadrennial Technology Review (QTR 2015). The QTR 2015 examines the most promising research, development, demonstration, and deployment (RDD&D) opportunities across energy technologies to effectively address the nation's energy needs. Specifically, this analysis identifies the important technology RDD&D opportunities across energy supply and end use in working toward a clean energy economy in the United States. The insight gained from this analysis provides essential information for decision makers as they develop funding decisions, approaches to public-private partnerships, and other strategic actions over the next five years. The QTR 2015 is supported by technology assessments, which provide a more in-depth discussion of a technology area. Four of these technology assessments were focused on "Offshore Safety and Spill Prevention" "Unconventional Oil and Gas," "Gas Hydrates Research and Development," and "Natural Gas Delivery Infrastructure." Please visit http://energy.gov/quadrennial-technology-review-2015-omnibus to access all the QTR 2015 materials.

13) *DOE SubTER* - SubTER (Subsurface Technology and Engineering Research, Development, & Demonstration) is an integrated platform across the DOE offices involved in subsurface activities to address crosscutting and grand challenges associated with the use of the subsurface for energy extraction and storage purposes. This initiative is about next generation approaches to engineering subsurface reservoirs with improved safety and efficiency. The involved DOE Offices include: Fossil Energy; Energy Efficiency and Renewable Energy/Geothermal Technologies; Advanced Research Projects Agency- Energy; Nuclear Energy; Electricity; Environmental Management; Energy Policy and Systems Analysis;

Energy Information Administration; Congressional and Intergovernmental Affairs; and Science. The SubTER Crosscut identifies common research, development, and demonstration (RD&D) and policy challenges across DOE and enables programs to work together toward solutions through effective funding leverage and collaborative structure. The SubTER effort is primarily focused on four topic areas: (1) wellbore integrity; (2) subsurface stress and induced seismicity; (3) permeability manipulation; and (4) new subsurface signals (including identification and correction of problems for effective well control). Please visit http://energy.gov/sites/prod/files/2016/04/f30/Ch.7-SI-Subsurface-Science-Technology-Engineering.pdf for additional information on Subsurface Science, Technology, and Engineering.

14) *DOT/PHMSA's Pipeline Research* - PHMSA's Pipeline Safety Research Program is rather unique within the Interagency Committee as the sole agency charged with conducting "Pipeline Systems" research. During this reporting period, DOT/PHMSA registered commercialization into the market on one technology development research project addressing hazardous liquid pipeline challenges. This is reported below with further information about the net improvement available from the public project page.

- Subsurface Multi-Utility Asset Location Tool
  https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=490
- A Quantitative Non-destructive Residual Stress Assessment Tool for Pipelines
  https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=441

New research projects awarded by PHMSA in 2014 and 2015 are developing needed technology and expanding the knowledge base on several critical hazardous liquid pipeline challenges including leak detection, threat prevention and anomaly detection/characterization. These initiatives are reported in the appendix to this biennial report.

Finally, late in 2013, PHMSA launched a new facet of its overall research program focused on university research. The Competitive Academic Agreement Program (CAAP) is intended to spur innovation through enabling an academic research focus on high risk and high pay-off solutions for wide ranging pipeline safety challenges. The CAAP is different in focus, execution and reporting than PHMSA's core program on Pipeline Safety Research. It is intended to potentially deliver desired solutions that can be a "handed-off" to further investigations in CAAP or in PHMSA's core research program that employs partnerships with a variety of public/private organizations. One goal in this strategy would be to validate proof of concept of a thesis or theory potentially all the way to commercial penetration into the market.

Another goal for CAAP is to expose graduate and PhD research students to subject matter common to pipeline safety challenges for illustrating how their engineering or technical discipline is highly desired and needed in the pipeline field. The pipeline industry and federal/state regulators are all experiencing low numbers of entry level applications to positions that are engineering or technically focused. Public conferences, meetings and journals have identified similar shortfalls. The ultimate benefits from this goal would be to reflect new talent in all aspects of pipelining similar to how programs at other Federal Agencies and non-profit organizations have provided talent to other industries over time. Initiatives related to hazardous liquids are reported in the appendix to this biennial report.

Program Website: https://primis.phmsa.dot.gov/rd/index.htm
CAAP Website: https://primis.phmsa.dot.gov/rd/universitypartners.htm

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15) *BOEM's Environmental Studies Program* – BOEM continued to conduct its Environmental Studies Program, which was authorized under the Outer Continental Shelf Lands Act. BOEM and its predecessors collected much of the available baseline environmental information on the Outer Continental Shelf (OCS) for the past 40 years. Working cooperatively with NOAA, USFWS, and other agencies, the Environmental Studies Program (ESP) provides critical environmental data to support responsible oil and gas production decisions and provides pre-spill baseline data that can be used in the event of oil spills. The breadth of information collected stretches from the composition of the seafloor and below, to the birds that fly over the water and almost everything in between. Beyond the basic understanding of the environment, information to determine the important social and economic effects of OCS energy development is also collected.

    BOEM's Hanna Shoal Ecosystem Study is a five-year investigation of the biological, chemical, and physical properties that define this unique ecosystem. Resulting data will help inform decision makers about future policies and activities that could potentially affect the region. This study extends to 2008-2011 Chukchi Sea Offshore Monitoring in Drilling Area (Chemical and Benthos) (COMIDA CAB) study.

    BOEM continued other environmental studies reported in the FY2012-2013 Biennial Report to Congress. These studies include:

    - The Aerial Surveys of Arctic Marine Mammals (ASAMM) study, a partnership with NOAA
    - Atlantic Marine Assessment Program for Protected Species (AMAPPS)
    - Gulf of Mexico ESP includes studies of sperm whales, chemosynthetic communities, and deepwater corals susceptible to damage due to oil and gas exploration
    - The Flower Garden Banks (FGB) Long-Term Monitoring Program at the FGB National Marine Sanctuary
    - The Multi-Agency Rocky Inter-tidal Network, or MARINe, monitors more than 100 sites along the Pacific coast from Canada to Mexico and 32 rocky inter-tidal sites on the mainland shore adjacent to OCS production facilities.

16) *Marine Arctic Ecosystem Study (MARES)* – MARES is an integrated ecosystem research initiative coordinated and planned by BOEM in conjunction with its federal and private sector research partners: USARC, USCG, USGS, U.S. Integrated Ocean Observing System, Marine Mammal Commission, National Science Foundation, NOAA, Office of Naval Research, and Shell Oil Company. The MARES study is taking place under the National Ocean Partnership Program (NOPP), which brings together federal agencies, academia, industry, and non-governmental organizations to support ocean research. The MARES stems from increased attention in the Arctic region to climate change, energy development, and sustainability. Information gained will aid government, industry, and communities in making decisions related to regulations, resource management, economic development and environmental protection issues.

17) *NOAA/CRRC Training and Workshops* – The CRRC is a partnership between NOAA's Office of Response and Restoration (ORR) and the University of New Hampshire (UNH) and its Environmental Research Group. The Center was created in 2004 by a Memorandum of Agreement between NOAA and UNH when NOAA ORR wanted to partner with a research-oriented university to create a center to address its research needs in spill response, recovery and restoration. Through the partnership, NOAA and CRRC

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have accomplished a number of oil pollution and environmental disaster response research coordination objectives. Together, NOAA and CRRC sponsored or hosted several oil spill workshops and training during the reporting period, including:

- Data Management Strategy Workshop. (December 10-11, 2013, Seattle, WA)
- An Information Exchange & Collaboration on Data Management for Environmental Disasters. (January 29, 2014, Mobile, AL)
- Environmental Disasters Data Management Workshop (EDDM). (September 16-17, 2014, Shepherdstown, WV)
- State-of-Science for Dispersant Use in Arctic Waters (January 5-9, 2015, Seattle, WA); this is ongoing with regular web meetings until each of the five topic papers are finalized.
- CAMEO Stakeholder's Workshop. (April 15-16, 2015, Mobile, AL)

The CRRC also coordinates three working groups that have met at least once per year during this reporting period. The Dispersant Working Group, Submerged Oil Working Group, and Environmental Disasters Data Management (EDDM) Working Groups are comprised of representatives from several of the Interagency Committee agencies (USCG, EPA, NOAA, BSEE, and BOEM) as well as State agencies, international organizations, industry, and academia.

18) *Oil-in-Ice Recovery Demonstration Exercises* – The USCG Research and Development Center (RDC) is conducting an on-going series of demonstrations and exercises to develop and validate equipment and techniques that can be used successfully to detect, track, and recover oil in ice-filled waters under all conditions. The demonstrations and exercises involve deployment of small unmanned aerial vehicle (UAV) systems, unmanned underwater vehicles (UUVs), remotely operated vehicles, tethered observation balloons, ice radar systems, and different skimmer systems. Key activities of an oil spill response in the Arctic that were tested included: ability to search above and below an ice floe; ability to detect spilled oil; ability to produce data to be used to plot the safest course to the spilled oil; ability to deploy a brush skimmer to recover the spilled oil; and ability to monitor the recovery operation (above and below the ice) to ensure complete recovery. In 2014, the CGC HEALY suppored a Technology Demonstration cruise focused on the ice conditions well off the North Slope of Alaska. As this project has been ongoing for several years, the exercises and demonstrations of technology undertaken in 2014 built upon findings and lessons learned from a similar cruise which took place in 2013. Results have been recorded through videos as well as conference papers. The following Interagency Committee agencies have participated in one or more of the exercises: USCG, NOAA, BSEE, and USN.

19) *Remote Sensing Spills of Opportunity* – The USCG RDC, in collaboration with BSEE, conducted remote sensing tests over the Santa Barbara, California, oil seeps in May 2015. The on-going seeps in the Santa Barbara Channel were used to test various remote sensing equipment, mostly focused on inherent USCG radar, infrared and visual capabilities. Before the tests began, the Refugio Oil Spill occurred in the Channel, which provided additional opportunities to test remote sensing equipment. BSEE provided some funding and NOAA, US Army's Night Vision and Electronic Sensors Directorate, and the state of California also provided assistance with personnel.

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20) *BP Deepwater Horizon Natural Resource Damage Assessment (NRDA)* - NOAA, EPA, USDA and the DOI, along with other State resource agencies, are natural resource trustees for the Deepwater Horizon NRDA. (On April 4, 2016, a consent decree resolving civil claims, including NRDA, against BP was entered in Federal court.) Over the course of the NRDA process, the trustees assessed and quantified the nature and extent of the injuries to natural resources (and the services they provide) caused by the release of the oil and other substances, and associated response actions for the purpose of restoring injured resources and impacts of lost public use. The trustees developed a comprehensive, integrated, ecosystem restoration plan based upon their conduct of over 200 studies on natural resources within the Gulf of Mexico that were affected by the oil spill, including the categories of marine mammals, turtles, birds, benthic resources, water column including fish and invertebrates, nearshore marine ecosystem, and human use. On October 5, 2015, immediately after the close of this biennial reporting period, the Deepwater Horizon Trustees released the Deepwater Horizon Oil Spill Draft Programmatic Damage Assessment and Restoration Plan (PDARP) and Draft Programmatic Environmental Impact Statement (PEIS), which allocates funds from a proposed settlement with BP of up to $8.8 billion for natural resource injuries stemming from the spill. The draft plan, now final , allocates funds to meet five restoration goals, and across 13 restoration types designed to meet these goals. The restoration types address a broad range of ecosystem level impacts, with funds being allocated across restoration areas, including coastal and nearshore habitats and in open waters. Together, these efforts will restore wildlife and habitat and increase recreational opportunities in the Gulf. For additional information please visit http://www.gulfspillrestoration.noaa.gov/.

21) *BP Deepwater Horizon NRDA Data Sharing* – NOAA developed the Data Integration Visualization Exploration and Reporting (DIVER) tool to integrate and make available data primarily generated during the Deepwater Horizon NRDA into a centralized data warehouse and query tool. NRDA data in DIVER are available to the general public and are accessed through a query and mapping interface called DIVER Explorer (https://dwhdiver.orr.noaa.gov/). Data currently available include validated information such as sampling locations and concentrations of contaminants in tissue, sediment, oil, and water, visual observations, photographs, telemetry and oceanographic data. To provide additional context to the NRDA data, the site also includes historical (pre-2010) contaminant chemistry data for the onshore area of the Gulf of Mexico, as well as contaminant chemistry data collected during the Response efforts. Data can be viewed onscreen or downloaded in a variety of formats. NOAA is incorporating additional field and laboratory data into the DIVER tool as it is collected, analyzed, and validated. Substantial additional information was made available in DIVER following the release of the Draft Programmatic Damage Assessment and Restoration Plan (PDARP), and the DIVER data collectively represents approximately over 20,000 trips to the field to collect data, more than 100,000 environmental samples collected, with a sum total of 13 million publically available records. The DIVER application has the capacity to bring in and standardize environmental data from across the Gulf of Mexico to provide an on-line ecosystem-wide environmental data repository.

22) *Science Partnerships Enabling Rapid Response (SPERR)*. Representatives of the USCG, NOAA, and EPA served as Core Advisors to the SPERR project. The project is a collaboration between the Center for Ocean Solutions and ChangeLabs at Stanford University funded by the Packard Foundation. The goal of the project is to promote effective scientific collaboration and enable rapid information exchange between government agency responders and non-governmental scientists from multiple relevant

disciplines. The project resulted in a proposal to create a Science Action Network (SAN) designed as a network of 13 Regional Academic Hubs, each associated with a Federal emergency response region. Through the Hubs, non- governmental scientists from academic institutions, professional societies, and scientific NGOs can develop and fund disaster-relevant collaborative research initiatives. During a disaster response effort, government agencies can access Hub members' scientific expertise in a rapid, streamlined manner. At the close of the biennium, the Stanford centers were collaborating with the Coastal Response Research Center in seeking partners and funding to conduct a regional pilot of the SAN.

23) Arctic Waterways Safety Committee (AWSC). The USCG is providing a framework for this maritime committee. The committee is established based solely on the collective group of stakeholders to include representatives from local and tribal governments, subsistence hunter co-management groups, advocacy organizations, the maritime industry, and community members. - See more at: www.arcticwaterways.org.

24) *NIST's Marine Environmental Specimen Bank* – NIST continued to maintain the biological specimens it has since 1979 when it established the National Biomonitoring Specimen Bank (NBSB) in Gaithersburg, MD. In 2001, NIST established the Marine Environmental Specimen Bank (Marine ESB) facility in Charleston, SC, and continues to cryogenically bank well-documented environmental specimens collected as part of other agency marine research and monitoring programs. Other agency programs collaborating with NIST and providing specimens include: the NOAA National Marine Mammal Tissue Bank (NMMTB), the NOAA National Status and Trends Mussel Watch Project, the USFWS Seabird Tissue Archival and Monitoring Project (with supplemental funding from the North Pacific Research Board), and the USFWS American Peregrine Falcon Monitoring Plan. Specimens in the collection include marine mammal tissues, mussels and oysters, fish tissues, seabird eggs, and peregrine falcon eggs and feathers. The Marine ESB is an important resource of research materials that are used to document geographic and temporal trends in "new" pollutants, changes in transport and accumulation of "old" pollutants in the environment, and study temporal changes in marine animal health through application of future new analytical and biochemical techniques.

25) *NOAA Airborne Chemical Measurements Quantifying Blowout Leak Rates* – NOAA research used airborne hydrocarbon measurements from chemically-instrumented aircraft to calculate accurate offshore blowout leak rates and environmental distributions in the *Deepwater Horizon* disaster in the U.S. Gulf of Mexico in 2010, and in the 2012 *Elgin* rig blowout in the UK North Sea in 2012. This capability was briefed to the ICCOPR Committee at the Quarterly Meeting in September 2014. NOAA continues to evaluate the feasibility of a future operational quick-response airborne chemical measurement capability for incident response, with applications to both offshore and onshore blowout leak rate assessment as recently demonstrated by quantifying the Aliso Canyon underground storage facility leak rate in near-real time. – See more at: http://esrl.noaa.gov/csd/projects/alisocanyon.html.

Member Participation in Workshops and Conferences

Each year a variety of workshops and conferences are held that address various facets of the petroleum industry and oil pollution research. The Interagency Committee monitors these to stay abreast of the latest topics and issues that support on-going and future research initiatives. The

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Interagency Committee's member organizations participate in or directly sponsor many of these workshops and conferences. To increase the communication and networking benefits across the oil pollution research community, the Interagency Committee has devoted a specific area of its website to tracking and publicizing these conferences and workshops, including their associated website links and basic support documents.

In this reporting period, several workshops, conferences, and other forums addressed oil spill research needs or provided participants with opportunities to expand their capabilities to address oil spills. The Interagency Committee maintained a visible presence in several of these events by sponsoring, planning, and participating in the events. Key forums in which the Interagency Committee participated include:

1) *2014 International Oil Spill Conference (IOSC)* – During the reporting period, the USCG, EPA, NOAA, and BSEE, with staff on the Executive Committee, played key roles in planning for the 2014 IOSC in partnership with the API. The USCG chaired the Program Committee, which solicited and evaluated a record number of 399 abstracts for papers and posters in 38 topic areas covering diverse topics such as oil spill modeling, dispersant use policies and applications, arctic issues, and cutting-edge response technologies. BSEE managed planning for on-water demonstrations of oil pollution prevention and cleanup systems including UAV surveillance and cutting edge response technology. NOAA designed a suite of 12 short courses on oil pollution issues. EPA organized a film festival and photography contest to garner additional interest from conference participants.

   Since 1973, the USCG and EPA have managed the IOSC alongside the API. NOAA and BSEE joined later and the current IOSC permanent sponsorship team consists of seven domestic and international organizations, four of whom are members of the Interagency Committee. The goals of the IOSC are: "To promote an international exchange of information and ideas dealing with spill prevention, planning, response and restoration processes, protocols and technology" and "To promote international sharing of best practice as it relates to management of the varied impacts of oil spills and their aftermath."

   The IOSC is part of the "triennial conference series," which is also comprised of its European and Australian counterparts known as Interspill and Spillcon, respectively. All three conferences are major venues for hosting the latest oil pollution research communications and technology displays. In 2005, the conference organizers agreed to work on a three-year cycle to avoid overlap and reduce the travel/financial burden of government and industry participants.

2) *2015 Interspill Conference* – On March 24-26, 2015, representatives of the USCG, BSEE, EPA, and NOAA participated in this conference, which is one of the three primary international oil spill conferences.

3) *Offshore Technology Conference 2015* – On May 4-7, 2015, the DOE participated in the Offshore Technology Conference (OTC), the largest oil and gas sector trade show in the world. DOE spill prevention research was presented during the technical sessions and at the DOE-National Energy Technology Laboratory (NETL) exhibit booth. DOE leadership participated in a panel titled "Global Energy Outlook: North America Challenges and Opportunities."

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4) *Offshore Technology Conference 2014* – On May 5-8, 2014, the DOE and BSEE participated in the Offshore Technology Conference (OTC), the largest oil and gas sector trade show in the world. DOE research was presented during the technical sessions and at the DOE-NETL exhibit booth. During the conference, DOE organized and led a 2-panel forum on spill prevention. This forum was titled "Energy Security and Economic Prosperity: Oil Spill Prevention." The first panel focused on Federal efforts to prevent oil spills. During this panel, DOE presented from a technical perspective and BSEE presented from a regulatory viewpoint. The second panel was focused on industry efforts, including future technology, for spill prevention. The speakers on the second panel included representatives from a domestic producer, an international producer, a service company, and an equipment manufacturing company.

5) *Federal Multiagency Collaboration on Unconventional Oil and Natural Gas Research Workshop* - On January 28-29th, 2015, a workshop on Federal Multiagency Collaboration on Unconventional Oil and Natural Gas Research was held at the U.S. Geological Survey National Center in Reston, Virginia. The workshop was held to discuss joint collaborative research of the Federal Multiagency Collaboration on Unconventional Oil and Natural Gas, a group that includes DOE, DOI, and the EPA. This workshop was successful in sharing research results and identifying potential areas of coordination on future research efforts. More specifically, the workshop participants addressed individual agency accomplishments, direction for collaborative research, and the progress or modifications of objectives to particular collaborative projects. This workshop enhanced the coordination and collaboration of DOE, DOI, and EPA research on topics including Resource Base, Water Availability, Ecological Effects, Air Quality, Induced Seismicity, Water Quality, and Human Health.

6) *RPSEA 2015 Ultra-Deepwater (UDW) Technology Conference* – On September 9-10, 2015, DOE participated in the RPSEA Ultra-Deepwater Technology Conference. This year, it was co-hosted by RPSEA and Society of Petroleum Engineers' Gulf Coast Section Technology Transfer Committee. On the first day of this conference, a DOE-NETL representative gave a keynote speech on *Technologies for The Age of Offshore Risk Reduction*, highlighting the contributions of the DOE offshore spill prevention research portfolio. Throughout the conference, presentations on DOE research communicated progress and results of projects that are working towards assessing and mitigating the risks associated with offshore drilling and production operations.

7) *2014 Clean Gulf Conference* – BSEE, USCG, and NOAA participated in this conference on December 2-4, 2014 in San Antonio, Texas.

8) *2013 Clean Gulf Conference* –BSEE and the Gulf States, in association with the USCG, co-hosted this conference conducted on November 12-14, 2013 in Tampa, Florida. BSEE, USCG, and NOAA participated in the conference.

9) *2015 Clean Pacific Conference* – In Vancouver, British Columbia, Canada on June 16-18, 2015, representatives of the USCG, BSEE, and NOAA participated in this conference wide range of prevention, preparedness and response topics, with a focus on the growth in crude transportation across the West.

10) *2014 Gulf of Mexico Oil Spill and Ecosystem Sciences Conference* – On January 26-29, 2014, the USCG, EPA, BSEE, BOEM, NOAA, NASA, USN, and USFWS participated in this annual conference organized by the Gulf of Mexico Research Initiative (GoMRI),

which included more than 900 registrants. Participants from Interagency Committee agencies were included as authors of 19 papers and 20 posters. Representatives of NOAA and EPA serve on the Executive Committee. Partners and sponsors include Interagency Committee member agencies NOAA and EPA. The conference included "An Information Exchange and Collaboration on Data Management for Environmental Disasters: Kick-Off Meeting" to initiate a working group to consider data management issues.

11) *2015 Gulf of Mexico Oil Spill and Ecosystem Sciences Conference* – In February 2015, the USCG, EPA, BSEE, BOEM, NOAA, and USFWS participated in an annual GoMRI conference, which included more than 1,000 registrants. Partners and sponsors include Interagency Committee member agencies NOAA, BOEM, and EPA. The representatives participated in these associated workshops:

- State-of-Science on Dispersants and Dispersed Oil; Environmental Disasters Data Management Working Group;
- Gulf Science and Restoration Programs Update and Panel Discussion;
- Science Partnerships Enabling Rapid Response (SPERR):
- Design Session for Improving Scientific Collaboration during Oil Spill Crises

12) *Government/Industry Pipeline R&D Forum* – On August 6-7, 2014, PHMSA sponsored the Government/Industry Pipeline R&D Forum in Arlington, VA. This two-day event occurs periodically to generate a national research agenda that fosters solutions for the many challenges with pipeline safety and protecting the environment. The forum allows public, government, and industry pipeline stakeholders to develop a consensus on the technical gaps and challenges for future research. It also reduces duplication of programs, factors on-going research efforts, leverages resources and broadens synergies. The national research agenda coming out of these events aligns with the needs of the pipeline safety mission, makes use of the best available knowledge and expertise, and considers stakeholder perspectives.

13) *Hazardous Materials R&D Forum* – On April 16, 2015, PHMSA hosted the 2015 R&D forum with three goals in mind: inform the public and industry of our proposed research projects and projects that have recently begun; provide an opportunity for interested industry representatives to present their recommendations to PHMSA; and provide a forum where research projects and the overall program can be discussed and prioritized. Participants provided input into seven projects addressing Safe Transportation of Energy Products, including crude oils and other hazardous liquids.

14) *2014 International Oil Spill Response Seminar and Exercise* – A BSEE representative participated in the seminar in Bergen, Norway to describe oil spill planning and preparedness in U.S. territorial waters. The representative highlighted current BSEE research and explained BSEE and operator requirements for oil spill planning and preparedness. The representative observed the Oil on Water Exercise offshore at the Frigg oil field in the North Sea where various oil spill response equipment operated during a field release of oil. The exercise is conducted annually.

15) 2015 International Oil Spill Response Seminar and Exercise – A representative from the USCG participated in the 2015 International Oil Spill Response Seminar and Exercise conducted in the former Frigg oil field approximately 100 nautical miles northwest of

Stavanger, Norway. As with the 2014 event, the representative explained current U.S. oil pollution activities. NASA also used this exercise as an opportunity to test its Unmanned Aerial Vehicle Synthetic Aperture Radar (UAVSAR) remote sensing capabilities with calibrated discharges of petroleum and vegetable oil.

16) *International Forum on Group V (Non-buoyant) Heavy Oils* – USCG, NOAA, and EPA representatives participated in this forum conducted September 9-10, 2014 in Detroit, Michigan.

17) *The 6th Symposium on the Impacts of an Ice-Diminishing Arctic on Naval and Maritime Operations* – This symposium, conducted on July 14-15, 2015 in Washington, DC, was co-hosted by USARC and the National Ice Center, a multi-agency operational center operated by the USCG, NOAA, and the USN. The symposium addressed the changing Arctic sea ice environment and the current and future implications on maritime operations, including how the changes could affect oil spill risks.

18) *Washington Best Achievable Protection Conference* – On May 20-21, 2015, representatives of NOAA, BSEE, and the USCG participated in this conference to discuss technologies available for oil spill response.

19) *Pacific States/British Columbia Oil Spill Task Force Oil Spill R&D Project Workgroup* – On January 6, 2014, and January 6, 2015, representatives of the USCG, BSEE, EPA, and NOAA participated in a workgroup conference call with representatives from oil spill programs in Canada, Alaska, California, Oregon, and Washington. These meetings enabled the participants to share information on their oil spill research and development projects.

20) *PHMSA Pipeline Risk Modeling Methodologies Public Workshop* - On September 9-10, 2015, PHMSA, partnering with the National Association of Pipeline Safety Representatives (NAPSR), held a public workshop to discuss risk modeling methodologies of gas transmission and hazardous liquid pipelines and non-pipeline systems. It focused on improving risk modeling approaches and techniques for pipeline and non-pipeline systems to advance pipeline risk models.

21) *PHMSA Emergency Response to Bakken Crude Oil Stakeholder Engagement Meeting* – On February 10, 2014, PHMSA held a meeting to get input on the level of interaction between crude oil shippers and local emergency planning agencies and the level of capabilities of these agencies for response to a rail incident.

22) *PHMSA Lessons Learned Roundtable* - On May 29, 2014, PHMSA and the Virginia Department of Fire Programs conducted a Roundtable where representatives from Alabama, North Dakota, and Virginia presented lessons learned from the response, aftermath, and actions subsequent to the incidents in those states. They identified key factors having a direct effect on the successful outcome of managing a crude oil transportation incident.

23) *FEMA/USFA Coffee Break Training: Hazardous Materials Series* – To promote improved human response capabilities, the USFA provides one-page training bulletins for busy fire and emergency medical services personnel with busy daily schedules who often do not have time to attend valuable skill-enhancing training sessions. These one-page training notices provide technical training and administrative tips on a variety of topics.

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Each notice includes a photograph or drawing that illustrates the point of the training lesson. They also include links to additional information on the topic. Coffee Break Bulletins specific to hazardous materials issued during the reporting period were:

- Bakken Crude in Transportation (June 23, 2014)
- Petroleum Crude Oil Transportation and Response Considerations (October 27, 2014)
- Petroleum Crude Oil: Preincident Planning (November 3, 2014)
- Petroleum Crude Oil: Principles of Successful Incident Management (November 10, 2014)
- Petroleum Crude Oil: Railroad Safety Procedures (November 17, 2014)
- Petroleum Crude Oil: Hazard Assessment and Risk Evaluation (November 24, 2014)
- Petroleum Crude Oil: Implementing Response Objectives (December 1, 2014)

24) *Oil Spill Recovery Institute (OSRI) Technology Adoption Workshop* - August 11-12, 2015. Representatives of BSEE, NOAA, and the USCG participated in this workshop in Anchorage, AK. This workshop focused on identifying the impediments of bringing new technology into oil spill responses. The workshop sought to elicit different perspectives on challenges associated with the advancement of oil spill response technologies from research and development through commercialization. All locations for spills were addressed with the Arctic regions given the higher priority. Participants included federal and state government, oil production and oil response industry and academics.

25) *American Geophysical Union Fall Meeting 2013* – On December 9-13, 2013, representative of BSEE conducted a town hall forum that described BOEM's Environmental Studies Program and addressed funding opportunities of applied science at BOEM. An EPA representative presented a poster on ocean science.

26) *2014 NRT Worker Safety and Health (WS&H) Technical Conference* – On October 28-29, 2014, EPA hosted this National Response Team Technical Conference to provide a forum to discuss current trends and topics, share information, and improve the safety and health for workers related to oil and hazardous material response and recovery. EPA, USACE, and USCG personnel participated.

27) *Industry Quality Partnership Meetings* – Several Interagency Committee agencies regularly participate in quality partnership meetings with industry groups including: American Petroleum Institute's Spill Advisory Group, the Association of Petroleum Industry Cooperative Managers (APICOM), the Spill Control Association of America (SCAA), and the American Salvage Association (ASA).

Website and Other Outreach

The Interagency Committee continued to provide information through its website. During the reporting period, the Interagency Committee migrated the content to a new URL location at: www.uscg.mil/iccopr. The USCG hosts and updates the content to provide up-to-date announcements of research news, meetings and conferences, and links to documents or sources of information useful to the research community. Member agencies continued using their websites as tools to convey information on research initiatives to partners and the public. The Interagency Committee website contains links to these member sites.

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Several member agencies have newsletters that highlight agency activities, including oil spill-related research. Examples include the BOEM Ocean Science quarterly newsletter, BSEE's semi-annual Ohmsett Gazette, USARC Arctic Daily Update by e-mail, the USFWS Fish & Wildlife News, and several NOAA programmatic newsletters.

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V. Future Activities

The Interagency Committee recognizes that oil spills will continue to be a hazard as long as oil is used as a fuel and feedstock source. The United States continues to recover from major spills such as the BP *Deepwater Horizon* and Enbridge Pipeline oil spills, as well as other spills around the country. Although great strides were made in oil spill research during the FY 2014 and 2015 period, there is still much work to be done to address lessons learned from these spills and meet the challenges of emerging hazards. Therefore, the Interagency Committee will continue to move forward to promote research and development in the four research classes: Preparedness, Prevention, Response, and Injury Assessment & Recovery. Future initiatives include:

1) *Oil Pollution Research and Technology Plan Maintenance* –The Interagency Committee will use its Oil Pollution Research Categorization Framework as a tool to track and measure research progress within the government, academia and industry. The Interagency Committee will release revised versions of the OPRTP every six years to reflect conditions and needs at that time. Should significant changes occur in research needs between revisions, the Interagency Committee will consider issuing a supplement or other interim document.

2) *Intentional Release Permitting* – The Interagency Committee's Intentional Release Permitting Workgroup will continue working with policy makers and permitting authorities to explore field testing opportunities. Field tests may be justified when laboratory or other simulated settings (e.g., test tanks) cannot address specific Research Needs and no other open water research projects have addressed the need.

3) *National Academy of Sciences Gulf Research Program* – The Interagency Committee will continue to work closely with NAS as it implements the 30-year NAS Gulf Research Program (GRP) "focused on human health and environmental protection including issues relating to offshore oil and hydrocarbon production and transportation in the Gulf of Mexico and on the United States' outer continental shelf." The NAS GRP was established under Guilty Plea Agreements reached by the U.S. Department of Justice with BP Exploration & Production, Inc. and Transocean Deepwater Inc. to settle criminal charges stemming from the BP *Deepwater Horizon* oil spill. A key provision in both agreements is that, at least once a year, NAS must seek the recommendations of the Interagency Committee, BSEE, and BOEM concerning the administration of the NAS GRP. The Interagency Committee will continue working closely with the NAS GRP as they implement their research program.

4) *Support the 2017 International Oil Spill Conference (IOSC)* – The Interagency Committee will continue to support development of the 2017 IOSC to be held in Long Beach, CA on May 15-18, 2017 and future IOSC events. Four Interagency Committee members - USCG, EPA, BSEE, and NOAA - are permanent members of the Conference's Managing Executive Committee. The IOSC has a 45-year proven track record for maximizing communications within the oil spill research community. Therefore, the Interagency Committee leverages the IOSC to meet many of its Title VII obligations and use it as a communications hub for international and domestic researchers.

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5) *Arctic Research Needs* – The release of reports or Arctic issues by the National Research Council and the National Petroleum Council provide the Interagency Committee with valuable information on current Arctic Research needs. The priority research needs in the OPRTP cover many of the research needs identified in these studies. Member organizations of the Interagency Committee will continue addressing their own issues and responsibilities associated with activities in the arctic using these priority research needs as a guide. Consequently, the perspectives of the member organizations will help shape the Interagency Committee's continuing understanding of, and communications related to, cold weather research.

6) *Continued Outreach to Non-Federal Stakeholders* – The Interagency Committee will continue to proactively reach out to non-federal stakeholders to gain insights into additional research needs, share research results and ideas, and to promote advancements in the state of oil pollution research and technology. The Interagency Committee will continue its practice of inviting speakers from state industry programs, industry and academia to present information on their research during quarterly meetings. In addition, many members of the Interagency Committee will continue participating in IOSC, other conferences, workshops, and other forums as a means to reach out to industry and academic experts from around the world.

7) *Addressing Emerging Issues and Challenges* – The Interagency Committee will continue to monitor the state of the art in oil spill prevention and response and in the conditions that create oil spills risks. Offshore drilling operations are moving into deeper waters on the OCS, which poses additional challenges for responding to a subsea release. Oil production and shipping in the Arctic Ocean is increasing as the levels of sea ice diminish thereby increasing the risk of spills in remote areas where response efforts could be challenging. Oil production patterns are also changing as technology has enabled greater production from tar sands and from shale source rock. Inland spill risks may also be increasing as the transport of crude oil via pipeline and railcars has increased.

   The Interagency Committee members will continue to monitor these and any other emerging trend to consider their effects and make appropriate recommendations for research to address the associated challenges. The Oil Pollution Research Categorization Framework will provide a tool to facilitate tracking of research progress and help identify emerging trends in research needs. In any event, the 15 member organizations have the breadth of skills and expertise needed to identify and coordinate the needed research to address the associated oil spill risks.

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VI. List of Acronyms

ADIOS	Automated Data Inquiry for Oil Spills
AR	Augmented Reality
AMAPPS	Atlantic Marine Assessment Program for Protected Species
API	American Petroleum Institute
ART	Alternative Response Technology
ARTES	Alternative Response Tool Evaluation System
ASAMM	Aerial Surveys of Arctic Marine Mammals
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATON	Aids to navigation
AUV	Autonomous Underwater Vehicle
AWSC	Arctic Waterways Safety Committee
BAA	Broad Agency Announcement
BFT	Baffled Flask Test
BOEM	Bureau of Ocean Energy Management
BOEMRE	the former Bureau of Ocean Energy Management, Regulation and Enforcement
BOP	Blowout Preventer
BOEM	Bureau of Ocean Energy Management
BP	British Petroleum
BSEE	Bureau of Safety and Environmental Enforcement
BTFM	Bacti-Twist Filter Media
BTEX	Benzene, toluene, ethyl benzene, and xylenes
CAFE	Chemical Aquatic Fate and Effects
CAAP	Competitive Academic Agreement Program
CCoast Guard	Canadian Coast Guard
CEDRE	Center of Documentation, Research and Experimentation on Accidental Water Pollution
CETAP	Cetacean and Turtle Assessment Program
CNT	Carbon Nanotubes
CORN	Coordinated Oil-spill Response Network
CRRC	Coastal Response Research Center
CRREL	US Army Cold Regions Environmental Laboratory
CT	Coil Tubing
DE	Dispersant Effectiveness
DFO	Department of Fisheries and Oceans Canada
DHIC	Digital Holographic Imagery Camera
DHS	U.S. Department of Homeland Security
DIVER	Data Integration Visualization Exploration and Reporting
DMAC	Data Management and Access Committee
DOC	U.S. Department of Commerce
DoD	Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DOR	Dispersant-to-Oil Ratio
DOT	U.S. Department of Transportation
DTox	Dispersant and Chemically Dispersed Oil Toxicity Database
DWH	Deepwater Horizon
DWH-IR	Deepwater Horizon Institutional Repository

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EA	Effervescent Atomizers
EDRC	Effective Daily Recovery Capacity
EEMS	Excitation Emission Matrix Spectroscopy
EPA	U.S. Environmental Protection Agency
ERD	Environmental Research Division
ERMA®	Environmental Response Management Application
ERSP	Estimated Recovery System Potential
ERW	Electrical resistance weld
ESB	Environmental Specimen Bank
ESP	Environmental Studies Program
EVOS	Exxon Valdez oil spill
FAME	Fatty Acid Methyl Ester
FEMA	Federal Emergency Management Agency
FBA	Flow-Blurring Atomizers
FFA	Free Fatty Acids
FGB	Flower Garden Banks
FIT	Florida Institute of Technology
FOIA	Freedom of Information Act
FPSO	Floating, Production, Storage and Offloading
FY	Fiscal Year
GAO	U.S. Government Accountability Office
GNOME	General NOAA Operational Modeling
GOM	Gulf of Mexico
GoMRI	Gulf of Mexico Research Initiative
GOMURC	Gulf of Mexico University Research Consortium
GOODS	GNOME Online Oceanographic Data Server
HIPPS	High-integrity pressure protection system
HPHT	High Pressure High Temperature
IATAP	Interagency Alternative Technology Assessment Program
ICIFT	Intelligent Casing-Intelligent Formation Telemetry
IMO	International Maritime Organization
IOSC	International Oil Spill Conference
ISB	In situ burning
IWG-OP	Interagency Working Group on Ocean Partnerships
JIP	Joint Industry Project
JITF	Joint Industry Task Force
LISST	Laser In-Situ Scattering Transmissometry
MAOP	Maximum Allowable Operating Pressure
MARAD	Maritime Administration
MARINe	Multi-Agency Rocky Inter-tidal Network
MEPC	IMO Marine and Environmental Protection Committee
MMHSRP	Marine Mammal Health and Stranding Response Program
MMS	the former Minerals Management Service
MSDC	Modular Stacked Direct Current
MSP	Maximum Source Pressure
NAS	National Academy of Sciences
NASA	National Aeronautical and Space Administration
NBSB	National Biological Specimen Bank
NCP	National Contingency Plan
NESDI	Navy Environmental Sustainability Development to Integration Program
NIOSH	National Institute for Occupational Safety and Health

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NIST	National Institute of Standards and Technology
NMFS	NOAA's National Marine Fisheries Service
NMMTB	National Marine Mammal Tissue Bank
MWM	Meandering Winding Magnetometer
NOAA	National Oceanic and Atmospheric Administration
NOPP	National Oceanographic Partnership Program
NRC	U.S. National Research Council
NRDA	Natural Resource Damage Assessment
NRMRL	National Risk Management Research Laboratory
NRT	National Response Team
NSWCCD	Naval Surface Warfare Center Carderock
NTIS	National Technical Information Service
NVESD	Night Vision and Electronic Sensors Directorate
OCIO	Office of Chief Information Officer
OCS	Outer Continental Shelf
OEM	Office of Emergency Management
OMA	Oil Mineral Aggregate
OPA 90	Oil Pollution Act of 1990 (Public Law 101-380)
OPeNDAP	Open-source Project for a Network Data Access Protocol
OPRTP	Oil Pollution Research and Technology Plan
ORD	EPA's Office of Research and Development
ORR	NOAA's Office of Response and Restoration
OSHA	Occupational Safety and Health Administration
OSPR JITF	Oil Spill Preparedness and Response Joint Industry Task Force
OSRO	Oil Spill Removal Organizations
OSSE	Observing System Simulation Experiment
OSTP	White House Office of Science and Technology Policy
OWS	Oil/Water Separators
PAHs	Polycyclic aromatic hydrocarbons
PBC	Prudhoe Bay Crude
PDI	Phase Doppler Interferometry
PHMSA	Pipeline and Hazardous Materials Safety Administration
PIGPEN	Proactive Infrasonic Gas Pipeline Evaluation Network
PNU	Polymer Nanotube Umbilical
PWSRCAC	Prince William Sound Regional Citizen's Advisory Council
R&D	Research and Development
RCPC	Reverse-Circulation Primary Cementing
RDC	U.S. Coast Guard Research & Development Center
RDT&E	Research, Development, Test & Evaluation
ROV	Remotely Operated Vehicle
RULET	Remediation of Underwater Legacy Environmental Threats
S&T	Science and Technology
SAB	EPA's Science Advisory Board
SAG	API's Spill Advisory Group
SERDP	Navy Strategic Environmental Research and Development Program
SLARP	Slug Loading & Response in Pipelines, Risers and Jumpers
SLC	South Louisiana Crude Oil
SRA	Standing Research Area
SWA	Surface Washing Agent
TAC	Technical Advisory Committee
THP	Thermal Hydrate Preventer

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TRL	Technology Readiness Level
UAV	Unmanned Aerial Vehicle
UAVSAR	Unmanned Aerial Vehicle Synthetic Aperture Radar
UMCES	University of Maryland Center For Environmental Science
UME	Unusual Mortality Event
UNH	University of New Hampshire
USACE	U.S. Army Corps of Engineers
USARC	U.S. Arctic Research Commission
USCG	U.S. Coast Guard
USFA	U.S. Fire Administration
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Service
USN	U.S. Navy
VOC	Volatile Organic Compounds

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VII. Appendices

(A) Interagency Committee Member Publications

(B) Interagency Committee Member Projects

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Interagency Committee Member Publications

Adams, J., J. Felis, J. W. Mason, and J. Y. Takekawa. 2014. Pacific Continental Shelf Environmental Assessment (PaCSEA): aerial seabird and marine mammal surveys off northern California, Oregon, and Washington, 2011-2012. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2014-003. 266 pages. March 2014

Allik, Toomas H., Roberta E. Dixon, Lenard V. Ramboyong, Mark Roberts, Thomas J. Soyka, George Trifon, and Lori Medley. 2014. *Novel Electro-Optic Imaging Technologies for Day/Night Oil Spill Detection*. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 299609.
doi: http://dx.doi.org/10.7901/2169-3358-2014-1-299609.1

Ambrose, R. 2015. *Robotic Solutions for Exploration, Earth and Space*. Offshore Technology Conference 2015, May 2015

Andarawis, Emad. 2014. 11121-5503-01, PHASE 1 FINAL PRESENTATION: Intelligent BOP RAM Actuation Sensor Systems; Ultra-Deepwater Drilling, Completions and Interventions TAC meeting June 4, 2014, Greater Fort Bend Economic Development Council Boardroom, Sugar Land, TX

Andarawis, Emad. 2014. "Phase 1 Final Report, 11121-5503-01, Intelligent BOP RAM Actuation Sensor System," 25 Sep, 2014

Antony, A., V. Vinayan, S. Holmes, D. Spernjak, S. J. Kim, and J. Halkyard, "VIM Study for Deep Draft Column Stabilized Floaters," OTC-25837-MS, Offshore Technology Conference, Houston, Texas, USA, 4–7 May, 2015

Antony, Arun, "Phase 1 Study Final Report: Vortex Induced Motion Study for Deep Draft Column Stabilized Floaters, RPSEA 11121-5404-03," 29 May, 2015

Antony, Arun, "Vortex Induced Motion Study for Deep Draft Column Stabilized Floaters Phase 1 Final Presentation Materials, 11121-5404-03, RPSEA TAC Meeting, 6 Apr., 2015

Antony, A., V. Vinayan, S. Holmes, D. Spernjak, S.J. Kim, and J. Halkyard. 2015. *VIM Study for Deep Draft Column Stabilized Floaters*. Offshore Technology Conference 2015. May 2015

Aten, Brandon. 2015. *Oil Sampling Policy*. Interspill 2015 Conference Proceedings March 25, 2015

Athie, G., J. Sheinbaum, A. Romero, J. Candela, and J. Ochoa. 2014. Measurements in the Yucatan-Campeche area in support of the Loop Current dynamics study. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2014-669. 159 pp. November 2014

Austin, Diane, B. Marks, K. McClain, T. McGuire, B. McMahan, V. Phaneuf, P. Prakash, B. Rogers, C. Ware, and J. Whalen. 2014. Offshore oil and *Deepwater Horizon*: Social Effects on Gulf Coast Communities, Volume I. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2014-617. 266 pp. June 24, 2014

ED_001324_00007486-00046

Austin, Diane, S. Dosemagen, B. Marks, T. McGuire, P. Prakash, and B. Rogers. 2014. Offshore oil and *Deepwater Horizon*: Social Effects on Gulf Coast Communities, Volume II. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2014-618. 205 pp. June 2014

Ayers, Ray R., and Cesar J. Del Vecchio, Paul V. Devlin, and William Head, "Effects of Fiber Rope - Seabed Contact On Subsequent Rope Integrity," OTC 25136-MS, Offshore Technology Conference, Houston, TX, 5-8 May, 2014 [do not release to public]

Ayers, Ray R., Cesar Del Vecchio, and Charles A. Miller, "Final Report: Effects of Fiber-Rope/Seabed Contact on Subsequent Rope Integrity," RPSEA Doc. No.: 10121.4406.01.Final, Doc. No.: 1751572-EN-RP-01 (Rev B)10121-4406-01, 30 Oct., 2014

Bachman MJ, JM Keller, KL West, and BA Jensen. 2014. Persistent organic pollutant concentrations in blubber of 16 species of cetaceans stranded in the Pacific Islands from 1997 through 2011. Science of the Total Environment 488:115-123.

Baled, O. H., D. Xing, H. Katz, D. Tapriyal, I. K. Gamwo, Y. Soong, B. A. Bamgbade, Y. Wu, K. Liu, M. McHugh, and R. M. Enick. 2014. Viscosity of n-Hexadecane, n-Octadecane and n-Eicosane at Pressures up to 243 MPa and Temperatures up to 534 K. Journal of Chemical Thermodynamics 2014, 72, 108–116.

Baguley, J.G., P. A. Montagna, C. Cooksey, J. L. Hyland, H.W. Bang, C. Morrison, A. Kamikawa1, P. Bennetts, G. Saiyo, E. Parsons, M. Herdener, and M. Ricci. 2015. Community response of deep-sea soft-sediment metazoan meiofauna to the Deepwater Horizon blowout and oil spill. Marine Ecology Progress Series, 528: 127–140. doi:10.3354/meps11290. May 28.

Balmer, B.C., et al. 2015. Persistent organic pollutants (POPs) in blubber of common bottlenose dolphins (Tursiops truncatus) along the northern Gulf of Mexico coast, USA.. The Total Environment, 527: 306-312. doi:10.1016/j.scitotenv.2015.05.016. May 14.

Balsley, Alexander, Kurt Hansen, and Michele Fitzpatrick. 2014. Detection of Oil within the Water Column. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 2206-2217. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.2206

Balsley, Alexander, 2015. Evaluation of Rutter Sigma S6 Ice Navigation Radar on USCGC Healy during Arctic Shield 2014.,(CG-D-13-15), US Coast Guard Research and Development Center, March, 2015.

Bamgbade, A. B.; Wu, Y.; Burgess, A. W.; Tapriyal, D.; Gamwo, I.; Baled, O. H.; Enick, M. R.; McHugh, A. M. HighTemperature, High-Pressure Volumetric Properties of Propane, Squalane, and Their Mixtures: Measurement and PCSAFT Modeling. Ind. Eng. Chem. Res. 2015, 54, 6804–6811.

Bamgbade, A. B., Y. Wu, A. W. Burgess, D. Tapriyal, I. Gamwo, O. H. Baled, M. R. Enick, and A. M. McHugh, 2015. Measurements and Modeling of High-Temperature, High-Pressure Density for Binary Mixtures of Propane with NDecane and Propane with N-Eicosane. J. Chem. Thermodynamics 2015, 84, 108–117.

Barker, Christopher H. 2014. Subsurface Oil and Waves in The Coastal Zone. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 300025. **doi:** http://dx.doi.org/10.7901/2169-3358-2014-1-300025.1

Barker, Chris. 2015. *New Developments in the General NOAA Operational Modelling Environment (GNOME).* Interspill 2015 Conference Proceedings March 24, 2015.

Bauer, Jennifer R., and Kelly Rose. 2015. Variable Grid Method: an Intuitive Approach for Simultaneously Quantifying and Visualizing Spatial Data and Uncertainty. Transactions in GIS 2015, 19, 377–397.

Bejarano, A. and A. Mearns. 2015. Improving environmental assessments by integrating Species Sensitivity Distributions into environmental modeling: Examples with two hypothetical oil spills. DOI:10.1016/j.marpolbul.2015.01.022

Bejarano, Adriana C., Valerie Chu, Jeff Dahlin, and Jim Farr. 2014. Development and Application of DTox: A Quantitative Database of the Toxicity of Dispersants and Chemically Dispersed Oi. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 733-746.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.733

Belore, R., S.L. Ross Environmental Research Ltd. 2014. *Dispersant Effectiveness Testing at Ohmsett Using Aircraft Application Dosages*. Herndon, VA: Bureau of Safety and Environmental Enforcement.

Bemis, B. E., R.B. Spies, D.D. Hardin and J.A. Johnson. 2014. Determining the Potential Release of Contaminants into the Marine Environment from Pacific OCS Shell Mounds. Prepared by Applied Marine Sciences, Inc. for the U.S. Department of the Interior, Bureau of Ocean Energy Management. Camarillo, CA. OCS Study BOEM 2013P208. 33 pages + Appxs. March 24, 2014

Benggio, Bradford, Debra Scholz, Dave Anderson, Joseph Dillon, Greg Masson, Lindy Nelson, Daniel Odess, and Elizabeth Petras. 2014. Addressing the Uncertainty and Requirements for Oil Spill Response Consultations. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1881-1898.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.1881

Benggio, Bradford, LCDR Kimberly Chesteen, Jason DeSantis, Richard Knudsen, and CAPT John Slaughter. 2014. Tidal Inlet Protection Strategies for Oil Spill Response; Concepts, Testing, and Considerations. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 287225.
doi: http://dx.doi.org/10.7901/2169-3358-2014-1-287225.1

Bodnar, Jill, Michele Jacobi, Ed Bock, Eric Doucette, Judd Muskat, and Todd Barr. 2014. Understanding the Keys to Effective Information Management and Situation Display During a Pollution Response. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1596-1606. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.1596

Booth, Sara, and Rhianna Macon. 2014. *Action, not Alarm: Preparing for Oil Sands Response at the Local Level.* International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 417-425.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.417

Boswell, Ray, DOE-NETL. 2014. Developments in Marine Gas Hydrate Exploration. Offshore Technology Conference. doi:10.4043/25192-MS

Bouvier-Brown NC, Carrasco E, Karz J, Chang K, Nguyen T, Ruiz D, Okonta V, Gilman JB, Kuster WC, de Gouw JA. 2014. A portable and inexpensive method for quantifying ambient intermediate volatility organic compounds. Atmospheric Environment 94:126-133.

Bowechop, Chad, Andrew Connor, Scott Knutson, Heather A. Parker, and LCDR Lance Lindgren. 2014. Makah Indian Tribe – U.S. Coast Guard Memorandum of Agreement A Model for Meaningful Tribal-Federal Engagement. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 300663. **doi:** http://dx.doi.org/10.7901/2169-3358-2014-1-300663.1

Braund, Stephen R., Braund & Associates. 2013. Aggregate Effects Research and Environmental Mitigation Monitoring of Oil Industry Operation in the Vicinity of Nuiqsut: History and Analysis of Mitigation Measures, Final Report. Prepared for the U.S. Department of the Interior, Alaska OCS Region, Anchorage, AK. Technical Report No. BOEM 2013-212. December 2013

Braund, Stephen R. & Associates. 2013. COMIDA: Impact Monitoring for Offshore Subsistence Hunting, Wainwright and Point Lay, Alaska. US Dept. of the Interior, Bureau of Ocean Energy Management, Alaska OCS Region. Anchorage, Alaska. OCS Study BOEM 2013-211. 298pp. December 31, 2013

Breslow SJ. 2014. A Complex Tool for a Complex Problem: Political Ecology in the Service of Ecosystem Recovery. Coastal Management 42(4):308-331.

Brette F, Machado B, Cros C, Incardona JP, Scholz NL, Block BA. 2014. Crude Oil Impairs Cardiac Excitation-Contraction Coupling in Fish. Science 343(6172):772-776.

Brewton, Rachel Aileen, Richard Fulford, and Robert J. Griffitt. 2014. Gene Expression and Growth as Indicators of Effects of the BP Deepwater Horizon Oil Spill on Spotted Seatrout (Cynoscion nebulosus). Journal of Toxicology and Environmental Health, Part A: Current Issues Volume 76, Issue 21, 2013 pages 1198-1209 DOI:10.1080/15287394.2013.848394

Brooks, J.M., C. Fisher, H. Roberts, B. Bernard, I. McDonald, R. Carney, S. Joye, E. Cordes, G. olff, E. Goehring. 2014. Investigations of chemosynthetic communities on the lower continental slope of the Gulf of Mexico: Volume I: Final report. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2014-650. 560 pp.

Brooks, J.M., C. Fisher, H. Roberts, B. Bernard, I. McDonald, R. Carney, S. Joye, E. Cordes, G. Wolff, E. Goehring. 2014. Investigations of chemosynthetic communities on the lower continental slope of the Gulf of Mexico: Volume II: Appendices. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2014-651. 442 pp.

Bureau of Ocean Energy Management (BOEM) Alaska Outer Continental Shelf Region. 2014. *Alaska Annual Studies Plan FY 2015*. October 2014.

Bureau of Safety and Environmental Enforcement and Genwest Systems, Inc. 2015. ERSP Calculator User Manual. February 2015

Burgess, W. A.; Tapriyal, D.; Gamwo, I. K.; Wu, Y.; McHugh, M. A.; Enick, R. M. New Group-Contribution Parameters for the Calculation of PC-SAFT Parameters for Use at Pressures to 276 MPa and Temperatures to 533 K. Ind. Eng. Chem. Res. 2014, 53, 2520–2528.

Campbell, Seth, Kevin L. Haskins, Benjamin Winn, Jesse Stanley, Leonard J. Zabilansky. 2014. Testing of Oil Skimmer Equipment Components for use in Arctic Environments. Bureau of Safety and Environmental Enforcement, Project #1026, http://www.bsee.gov/Technology-and-Research/Oil-Spill-Response-Research/Projects/Project1026/

Capo, Rosemary C., Brian W. Stewart, Elisabeth L. Rowan, Courtney A. Kolesar Kohl, Andrew J. Wall, Elizabeth C. Chapman, Richard W. Hammack, Karl T. Schroeder, "The strontium isotopic evolution of Marcellus Formation produced waters, southwestern Pennsylvania" International Journal of Coal Geology 126 (2014) 57–63

Casey, LCDR Drew and John Caplis. 2014. Improving Planning Standards for the Mechanical Recovery of Oil Spills on Water. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1772-1783.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.1772

Chanton JP et al. . 2014. The rise and fall of methanotrophy following a deepwater oil-well blowout. Nature Geoscience 7(6):423-427.

Chapman, Elizabeth C. , Rosemary C. Capo, Brian W. Stewart, Robert S. Hedin, Theodore J. Weaver, Harry M. Edenborn,. 2013. "Strontium isotope quantification of siderite, brine and acid mine drainage contributions to abandoned gas well discharges in the Appalachian Plateau", Applied Geochemistry 31 (2013) 109–118.

Chassignet E.P., and A. Srinivasan, 2015. Data Assimilative Hindcast for the Gulf of Mexico. US Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Sterling, VA. OCS Study BOEM 2015-035. 46 pp.

Chen, Qin, "Subsea HVDC Connectors Technical Requirements Final Report: Subsea DC Connectors for Environmentally Safe and Reliable Powering of UDW Subsea Processing, 12121-6302-01," Document No. 12121.6302.01.01, RPSEA, 17 Feb., 2015

Chen, T.; Nutter, J.; Hawk, J. A.; Liu, X. Corrosion Fatigue Crack Propagation of Oil-grade Nickel-base Alloy 718. Part 2: Effect of Aging Treatment. Corros. Sci. 2015, 98, 280–290.

Chen, T.; Nutter, J.; Hawk, J. A.; Liu, X. Influence of Surface Modification on Pitting Corrosion Behavior of Oil-Grade Alloy 718, Part 2: Effects of Aging Treatment. Submitted to Corros. Sci., in review.

Chen, T.; Nutter, J.; Hawk, J.; Liu, X. Corrosion Fatigue Crack Propagation of Oil-grade Nickel-base Alloy 718. Part 1: Effect of Corrosive Environment. Corros. Sci. 2014, 89, 146-153.

Cherrier, J., J. Sarkodee-Adoo, T. P. Guilderson, and J. P. Chanton. 2014. Fossil Carbon in Particulate Organic Matter in the Gulf of Mexico following the Deepwater Horizon Event. *Environ. Sci. Technol. Lett.*, 2014, *1* (1), pp 108–112.
Doi: 10.1021/ez400149c.Publication Date (Web): December 3, 2013

Claisse J.T., D. J. Pondella, M. Love, and A. S. Bull. 2014. Biological productivity of fish associated with offshore oil and gas structures on the Pacific OCS. Vantuna Research Group, Occidental College, Los Angeles, California. BOEM Cooperative Agreement No. M12AC00003. April 2014

Composite Technology Development, Inc. 2013.. *Rapidly Deployable Thermal Hydrate Preventer for Oil Spill Mitigation*. Herndon, VA: Bureau of Safety and Environmental Enforcement.

Conley, S., G. Franco, I. Faloona, D.R. Blake, J. Peischl, and T.B. Ryerson (2016): Methane emissions from the 2015 Aliso Canyon blowout in Los Angeles, CA, Science, 351, 1317-1320, doi: 10.1126/science.aaf2348.

Conmy, Robyn N., Paula G. Coble, James Farr, A. Michelle Wood, Kenneth Lee, W. Scott Pegau, Ian D. Walsh, Corey R. Koch, Mary I. Abercrombie, M. Scott Miles, Marlon R. Lewis, Scott A. Ryan, J. Robinson, Thomas L. King, Christopher, R. Kelble, and

Jordanna Lacoste. Submersible Optical Sensors Exposed to Chemically Dispersed Crude Oil: Wave Tank Simulations for Improved Oil Spill Monitoring. Environmental Science & Technology 2014 48(3). 1903-1810

Conmy, R.N., P.G. Coble, J. Farr, A.M. Wood, R. Parsons, K. Lee, S. Pegau, I. Walsh, C. Koch, M. I. Abercrombie, M.S. Miles, M.R. Lewis, S. Ryan, B. Robinson, T. King, and J. Lacoste. 2014. Submersible Optical Sensors Exposed to Chemically-Dispersed Crude Oil: Wave Tank Simulations for Improved Oil Spill Monitoring. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 300156. **doi:** http://dx.doi.org/10.7901/2169-3358-2014-1-300156.1

Contreras, Elizabeth, Jin Huang, Roger S. Posusta, Deepak K. Sharma, Chao Yan, Paula Guraieb, Mason B. Thomson, and Ross C, Tomson, "Optical measurtement of uniform and localized corrosion of C1018, SS410, and Onconel 825 alloys using white light interferometry," Corrosion Science 87 (2014), pp383-91

Cormier, LT Annjea M. 2014. Crisis Response and Management Following Hurricane Sandy. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 299895. **doi:** http://dx.doi.org/10.7901/2169-3358-2014-1-299895.1

Davis, Scott, "Roadmap to Close the Technology Gaps: 12121-6403-01; Development of Advanced CFD Tools for the Enhanced Prediction of Explosion Pressure Development and Deflagration Risk on Drilling and Production Facilities," RPSEA, 19 Aug., 2015

Detweiler, George and Rand D. LeBouvier. 2015. *The Age of Unmanned Shipping.* The Coast Guard Journal of Safety & Security at Sea – Proceedings of the Marine Safety & Security Council. Summer 2015.

Dilmore, Robert, James I. Sams, Deborah Glosser, Kristin M. Carter, and Daniel J. Bain. 2015. Spatial and temporal characteristics of historical oil and gas wells in Pennsylvania: implications for new shale gas resources", Environ. Sci. Technol., Aug 2015.

Disenhof, C., M. Mark-Moser, and K. Rose. 2014. The Gulf of Mexico Petroleum System Foundation for Science-Based Decision Making. Journal of Sustainable Energy Engineering. 2014, 2, 225–236.

Dismukes, D. 2014. Onshore oil and gas infrastructure to support development in the Mid-Atlantic OCS Region. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2014-657. 360 pp.

Dollhopf, Ralph H., Faith A. Fitzpatrick, Jeffrey W. Kimble, Daniel M. Capone, Thomas P. Graan, Ronald B. Zelt, and Rex Johnson. 2014. Response to Heavy, Non-Floating Oil Spilled in a Great Lakes River Environment: A Multiple-Lines-Of-Evidence Approach for Submerged Oil Assessment and Recovery. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 434-448. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.434

Doris, Inc. "Preliminary Design and Analysis of Topsides Report-FINAL, Low Cost Flexible Production System for Remote Ultra Deepwater Gulf of Mexico (GOM) Field Development: 10121-4404-03," Document No.: 10121-4404-03.10, 9 Jul., 2014

Doughty CL, AM Quattrini, and EE Cordes. 2013. Insights into the population dynamics of the deep-sea coral genus Paramuricea in the Gulf of Mexico **doi:** http://dx.doi.org/10.1016/j.dsr2.2013.05.023

Drury, LTJG Alice, Gary Shigenaka, and Mark Toy. 2014. Washington State Case Study and Guidance Developed on the Closing and Re-Opening of a Shellfishery Due to Oil

Contamination. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 2273-2287.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.2273

Dyke, C., "Ultrahigh Conductivity Imbilicals: Polymer Nanotube Umbilicals," OTC 25340, 2014 Offshore Technology Conference, 5-8 May, 2014, Houston, TX

Dyke, Christopher, "Phase II Final Technical Report: 10121-4302-01, Ultra-High Conductivity Umbilicals: Polymer Nanotube Umbilicals," 17 Jul., 2014

Eastern Research Group, Inc. 2014. Measuring county-level tourism and recreation in the Gulf of Mexico region: Data, methods, and estimates. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2014-660. 58 pp. September 24, 2014

Eiler, J. H., Masuda, M. M., Spencer, T. R., Driscoll, R. J., & Schreck, C. B. 2014. Distribution, Stock Composition and Timing, and Tagging Response of Wild Chinook Salmon Returning to a Large, Free-Flowing River Basin. Transactions of the American Fisheries Society, 143(6), 1476-1507. doi:10.1080/00028487.2014.959997

Ellisor D, McLellan W, Koopman H, Schwacke L, McFee W, Kucklick J. 2013. The distribution and stratification of persistent organic pollutants and fatty acids in bottlenose dolphin (Tursiops truncatus) blubber. Science of the Total Environment 463:581-588.

Embry, Carl and 3D at Depth. 2014. High Resolution 3D Laser Imaging for Inspection, Inspection, Maintenance, Repair, and Operations: 09121.3300.06.Final. December 12, 2014

Fannin, J.M., M. Schafer, and W. Keithly. 2015. Assessing Impacts of OCS Activities on Public Infrastructure, Services, and Population in Coastal Communities Following Hurricanes Katrina and Rita. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study 2015-003. 268 pp. January 2015

Federici, C. & Mintz, J., CNA. 2014. *Literature Synthesis of Oil Properties and Their Impact on Spill Response Options*. Herndon, VA: Bureau of Safety and Environmental Enforcement

Feng, R.; Beck, J.; Lvov, S. N.; Ziomek-Moroz, M. Effects of Hydrogen Sulfide on the Corrosion Behavior of High Strength Steel in Alkaline Solutions. Electrochemical Society Transactions 2014, 61, 97–114.

Ferguson, Scott. 2014. Response V = Response Victory. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 284386.
doi: http://dx.doi.org/10.7901/2169-3358-2014-1-284386.1

Ferguson, Tracy, Steve Hanewich, Leonard Rich, and LT Danielle Shupe. 2014. Geographic Response Planning in the Chesapeake Bay. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 299452.
doi: http://dx.doi.org/10.7901/2169-3358-2014-1-299452.1

Fisher, C.R., P-Y Hsing, C.L. Kaiser, D.R. Yoerger, H.H. Roberts, W.W. Shedd, E.E. Cordes, T.M. Shank, S.P. Berlet, M.G. Saunders, E.A. Larcom, and J.M. Brooks. 2014. Footprint of Deepwater Horizon blowout impact to deep-water coral communities. Proceedings of the National Academy of Science. doi:10.1073/pnas.1403492111. July 28.

Fisher, Charles R., Amanda W.J. Demopoulos, Erik E. Cordes, Iliana B. Baums, Helen K. White, Jill R. 2014. Bourque Coral communities as indicators of ecosystem-level impacts of the Deepwater Horizon spill BioScience DOI: 10.1093/biosci/biu129

ED_001324_00007486-00052

Fitzpatrick, Michele and Scott Fields. 2013.. Institutionalizing Emerging Technology Assessment Process into National Incident Response (CG-D-11-13). U.S. Coast Guard Research and Development Center. May 2012 - Updated October 2013

Fletcher, James. 2015. *21st Century Waterways Navigation: A Research and Development Center Initiative*. The Coast Guard Journal of Safety & Security at Sea – Proceedings of the Marine Safety & Security Council. Summer 2015.

Fukuyama AK, Shigenaka G, Coats DA. 2014. Status of intertidal infaunal communities following the Exxon Valdez oil spill in Prince William Sound, Alaska. Marine Pollution Bulletin 84(1-2):56-69.

Galginaitis, M. 2014. Monitoring Cross Island Whaling Activities, Beaufort Sea, Alaska: 2008-2012 Final Report, Incorporating ANIMIDA and cANIMIDA (2001-2007). U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Alaska Region, Anchorage, AK. OCS Study BOEM 2013-212. 208 pp. March 2014

Gamwo, I. K.; Tapriyal, D.; Enick, R. M.; McHugh, M. A.; Morreale, B. D. High Temperature, High Pressure Equation of State: Solidification of Hydrocarbons and Measurement of Krytox Oil Using Rolling-Ball Viscometer Validation; NETL-TRS5-2014; EPAct Technical Report Series; U.S. Department of Energy, National Energy Technology Laboratory: Morgantown, WV, 2014; p 48.

Garcia-Pineda O, MacDonald IR, Li XF, Jackson CR, Pichel WG. 2013. Oil Spill Mapping and Measurement in the Gulf of Mexico With Textural Classifier Neural Network Algorithm (TCNNA). Ieee Journal of Selected Topics in Applied Earth Observations and Remote Sensing 6(6):2517-2525.

Gelzer, CAPT Claudia C. 2015. *Marine Environmental Response Program.* Soundings, the Official Publication of the American Salvage Association. Spring 2015 edition. April 2015.

Gleason, Joseph J. 2014. Getting Big Results by Going Small - The Importance of Tabletop Exercises. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 114-123.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.114

Goodman, Benjamin T., Ross A. Davidson, Eric S. Sievert, Leslie Wood, and Vincent H. Homer. 2014. Initiating *In Situ* Burning of Difficult-to-Ignite Oil Spills via an Aircraft-Deployable Igniter System. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1821-1833.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.1821

Gordon, Robert, and Reza Mostofi, "Ultra-Deepwater Dry Tree System for Drilling and Production in the Gulf of Mexico, Final Technical Report," 10121-4405-02, RPSEA - Research Partnership to Secure Energy for America, Report No.: 15U502I-11, Rev. 2, Document No.: 15U5O2I-11, 31 Dec., 2014

Gorman, D., J. Farr, R. Bellair, W. Freeman, D. Frurip, A. Hielscher, H. Johnstone, M. Linke, P. Murphy, M. Sheng, K. van Gelder, and D. Viveros. 2013. Enhanced NOAA chemical reactivity worksheet for determining chemical compatibility. Proc. Safety Prog. doi: 10.1002/prs.11613.

Gray JL, Kanagy LK, Furlong ET, Kanagy CJ, McCoy JW, Mason A, Lauenstein G. 2014. Presence of the Corexit component dioctyl sodium sulfosuccinate in Gulf of Mexico waters after the 2010 Deepwater Horizon oil spill. Chemosphere 95:124-130.

ED_001324_00007486-00053

Griffin, Weston, "Phase 1 Final Presentation: Statement of Requirements/Basis of Design," 28 Feb., 2014

Griffin, Weston, "Statement of Requirements/Basis of Design Final Report," 7 Mar., 2014

Guidon, Samantha and Celeste Leroux. 2014. Implementing U.S. Arctic Policy: An Analysis of Federal Recommendations. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1497-1511.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.1497

Gunter, CDR Tim. 2014. Potential Impacts from a Worst Case Discharge from an United States Offshore Wind Farm. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 869-877.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.869

Guraieb, P, et. al., "Validation of the Activity Coefficients for Carbonates at Various High Pressure High Temperature (HPHT) and Total Dissolved Solids (TDS)," 2014 NACE Corrosion Conference, 9-12 Mar., 2014

Guraieb, P, et. al., "Validation of the Activity Coefficients for Carbonates at Various High Pressure High Temperature (HPHT) and Total Dissolved Solids (TDS)," 2014 NACE Corrosion Conference, 9-12 Mar., 2014

Guzzo ,Judith, Jeff Lemonds, Dani, Liu, Carbone, DeRose, Good, Koste, Del'Anno, Guida, Zinser, Almeida, Parodi, Tom Fraser, Bob Judge, Samhita Dasgupta, "Riser Lifecycle Monitoring System (RLMS) for Integrity Management, 11121-5402-01," Floating Facilities and Risers & Systems Engineering UDW TAC Meeting, 5 Jun., 2014, Sugar Land, TX

Guzzo, Judith, Dani, Lemonds, Liu, Carbone, Choudhury, DeRose, Dell'Anno, Good, Guida, Koste, Zinser, Almeida, Parodi, Zhao, Tom Fraser, Bob Judge, Samhita Dasgupta, and Mike Volk, "Riser Lifecycle Monitoring System (RLMS) for Integrity Management , Subcontract: 11121-5402-01," RPSEA Ultra-Deepwater Technology Conference, Norris City Center Conference Center, Houston, Texas, 4 Sep., 2014

Guzzo, Judith, Uttara Dani, Brandon Good, Jeff Lemonds, Shaopeng Liu, John Carbone, and Mike Volk. 2014. Phase I Preliminary Design Report – Final, 11121.5402, Riser Lifecycle Monitoring System for Integrity Management: Contract 11121-5402-01. November 18, 2014

Haines, Seth S., Patrick E. Hart, William W. Shedd, and Matthew Frye. 2013. Seismic Investigation of Gas Hydrates in the Gulf of Mexico: 2013 Multi-component and High-Resolution 2D Acquisition at GC955 and WR313.
doi: http://dx.doi.org/10.4043/25318-MS

Hall, Christopher J. and Leonard Zabilansky. 2014. Responding to Oil Spills Under Ice: Alaska Clean Seas' Cold Regions Research and Engineering Laboratory (CRREL) Training Course. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 300320. **doi:** http://dx.doi.org/10.7901/2169-3358-2014-1-300320.1

Hall, Gregory J., Glenn S. Frysinger, Christoph Aeppli, Catherine A. Carmichael, Jonas Gros, Karin L. Lemkau, Robert K. Nelson, and Christopher M. Reddy. *Oxygenated weathering products of Deepwater Horizon oil come from surprising precursors*. Marine Pollution Bulletin, Volume 75, Issues 1–2, 15 October 2013, Pages 140–149
http://dx.doi.org/10.1016/j.marpolbul.2013.07.048

Halliwell Jr., G.R., A. Srinivasan, V. Kourafalou, H. Yang, D. Willey, M. Le Hénaff, and R. Atlas. 2014: Rigorous Evaluation of a Fraternal Twin Ocean OSSE System for the Open Gulf of Mexico. J. Atmos. Oceanic Technol., 31, 105–130. doi: http://dx.doi.org/10.1175/JTECH-D-13-00011.1

Hamer, T., M. Reed, E. Colclazier, K. Turner and N. Denis. 2014. Nocturnal Surveys for Ashy Storm-Petrels (*Oceanodroma homochroa*) and Scripps's Murrelets (*Synthliboramphus scrippsi*) at Offshore Oil Production Platforms, Southern California. US Dept. of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2014-013. 62 pp.

Hammack, Richard W. William Harbert, Shikha Sharma, Brian W. Stewart, Rosemary C. Capo, Andy J. Wall, Arthur Wells, Rodney Diehl, David Blaushild, James Sams, and Garret Veloski, "An Evaluation of Fracture Growth and Gas/Fluid Migration as Horizontal Marcellus Shale Gas Wells are Hydraulically Fractured in Greene County, Pennsylvania", NETL Final Report, NETL-TRS-3-2014, September 2014.

Hannon, Stephen M., "Underwater Mapping," LiDAR News, Vol. 3, No. 1, 25-31, 2013

Hansen, Kurt, 2014, *Responding to Oil Spills in Ice,* International Oil Spill Conference Proceedings, May 2014, Vol 2014, No 1. Pp 1200-1214, **doi**: http://ioscproceedings.org/doi/pdf/10.7901/2169-3358-2014.1.1200

Hansen, Kurt, 2014, *Sunken Oil Recovery System Recommendations*, 2014 International Oil Spill Conference, Savannah, GA International Oil Spill Conference Proceedings, May 2014, Vol 2014, No 1. Pp 1214-1223, **doi**: http://ioscproceedings.org/doi/pdf/10.7901/2169-3358-2014.1.2014

Hansen, Kurt. 2014. *Evaluating Equipment for responding to oil spills in ice*. In Proceedings of the AMOP Technical Seminar on Environmental Contamination and Response, Environment Canada, Halifax, NS.

Hansen, Kurt. 2015. *Monitoring Oil Spills Near an Ice Edge*. Interspill 2015 Conference Proceedings March 25, 2015

Hansen, Kurt A. *Arctic Technology Evaluation 2014 Oil-in-Ice Demonstration Report*, (CG-D-14-15), US Coast Guard Research and Development Center, March, 2015.

Hansen, Kurt, "Sunken Oil Recovery Systems: Federal Om-Scene Commander (FOSC) Recommendations, Group V Oil Forum, Detroit, MI Sept 9-10, 2014.

Hansen, Kurt, Mike Sprague, John Joeckel and Mark Rockley, *Response to Oil Sands Products Assessment,* (CG-D-X-15) US Coast Guard Research and Development Center, October, 2015

Harbert, W.; Benge, G.; Cunningham, E.; Lawrence, W.; DeBruijn, G.; Gardner, C. Field-Generated Foamed Cement: Initial Collection, Computed Tomography, and Analysis; NETL-TRS-5-2015; EPAct Technical Report Series; U.S. Department of Energy, National Energy Technology Laboratory: Morgantown, WV, 2015; p 48.

Hardy, Mark, and Carl Embry, "High Resolution 3D Laser Imaging for Inspection, Maintenance, Repair, and Operations: FINAL PRESENTATION, RPSEA Project 09121-3300-06," RPSEA Ultra-Deepwater Technology Conference, Norris Conference Center, Houston, Texas, 3-4 Sep., 2014

Harper, J.R., Morrow, K. 2014. *North Slope Coastal Imagery Site*. Herndon, VA: Bureau of Safety and Environmental Enforcement

ED_001324_00007486-00055

Hartmann-Moore C, Lewis S, Morris M, Harper J, Lindeberg M, Saupe S, Stewart D. 2014. ShoreZone Mapping in Alaska and the Pacific Northwest (Poster). Alaska Marine Science Symposium, Anchorage, AK, Jan 2014

Haza, A.C., Özgökmen, T.M., Griffa, A., and Ryan, E. 2014. Implementation of Lagrangian Stochastic Models to Parameterize Submesoscale Transport for Tracking Oil Spills in the Gulf of Mexico, U.S. Department of the Interior, Bureau of Ocean Energy Management, BOEM 2014-053. Herndon, VA, February 2014.

Heffern K, Maselko J, Sreenivasan A, Garvin M. 2014. Effects of Polystyrene Ingestion on Growth of Pink Salmon (Poster). Alaska Marine Science Symposium, Anchorage, AK, Jan 2014

Helton, Doug and Vicki Loe. 2014. How to Better Manage Public Expectations and Information Concerning Oil and Chemical Spill Response. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 300295.
doi: http://dx.doi.org/10.7901/2169-3358-2014-1-300295.1

Holder, E.L, R.N. Conmy, A.D. Venosa (2015) Comparative laboratory-scale testing of dispersant effectiveness of 23 crude oils using four different testing protocols. J. Environ. Protection. 6: 628-639.

Holesinger, Terry, et al., "Carbon Nanotube Composite Cables for Ultra-Deepwater Oil and Gas Fields," OTC 25370, 2014 Offshore Technology Conference, Reliant Center, Houston, TX., 5-8 May, 2014

Holland, Greg, "PHASE 2 FINAL PRESENTATION: Effect of Climate Variability and Change in Hurricane Activity in the North Atlantic, 10121-4802-01," RPSEA Metocean TAC Meeting, 6 May, 2014

Holland, Greg, and James Done, "Phase 2 Final Summary Report and Recommendations: Effect of Climate Variability and Change in Hurricane Activity in the North Atlantic," 10121.4802.01.Final2, RPSEA, 3 Aug., 2015

Houston Offshore Engineering "10121-4405-02 – Final Technical Report Appendix C1 - AIP FOR HOE'S PAIRED COLUMN DRY TREE SEMI, Approval in Principle of HOE's Paired Column Dry Tree Semi," RPSEA, Report No.: 15U5O2I-9, Rev. 2, Document No.: 15U5O2I-9, 30 Dec., 2014

Houston Offshore Engineering "10121-4405-02 – Final Technical Report Appendix C2 - DNV, Approval In Principle, HOE's Paired Column Dry Tree SemiSubmersible," Request by RPSEA, 14 Nov., 2014

Houston Offshore Engineering, "10121-4405-02 – Final Technical Report Appendix B1 - Technology Qualification of Riser Tensioner for Dry Tree Semi Concept," Houston Offshore Engineering, Report No.: 2014-0569, Rev. 0, Document No.: NA, 11 Aug., 2014

Hsing P-Y, B. Fu, E.A. Larcom, S.P. Berlet, T.M. Shank, A.F. Govindarajan, A.J. Lukasiewicz, P.M. Dixon, and C.R. Fisher. 2013. Evidence of lasting impact of the Deepwater Horizon oil spill on a deep Gulf of Mexico coral community. Elementa Science of the Anthropocene. December 4.

Huang, J., et al., "Corrosion Testing of Deepwater Tubing Materials under Extreme Pressure and Temperature Conditions" OTC 25193, 2014 Offshore Technology Conference, 5-8 May, 2014, Houston, TX

ED_001324_00007486-00056

Huang, Jin, et. al., "Corrosion Behavior of Deepwater Oil Production Tubing Materials under Extremely High Temperature and High Pressure," 2014 NACE Corrosion Conference, 9-14 Mar., 2014

Huang, Jin, Paula Guraieb, Chao Yan, and Ross Tomson, "Study of pitting corrosion resistant alloys at extreme high temperature using electrochemical measurements," NACE-5620, NACE International Corrosion 2015 Conference & Expo, Kay Bailey Hutchison Convention Center, Dallas, TX, 15-19 Mar., 2015

ICCOPR. 2014. *Interagency Coordinating Committee on Oil Pollution Research: Fiscal Years 2012-2013 Activities*. June 25, 2014.

ICCOPR. 2015. *Oil Pollution Research and Technology Plan: Fiscal Years 2015-2021*. September 29, 2015.

Incardona J, Gardner L, Linbo T, Brown T, Esbaugh A, Mager E, Stieglitz J, French B, Labenia J, Laetz C, Tagal M, Sloan C, Elizur A, Benetti D, Grosell M, Block B, Scholz N Deepwater Horizon crude oil impacts the developing hearts of large predatory pelagic fish Proceedings of the National Academy of Sciences of the United States of America. 2014 vol: 111 (15) pp: E1510-8. DOI: 10.1073/pnas.1320950111

Incardona JP, Swarts TL, Edmunds RC, Linbo TL, Aquilina-Beck A, Sloan CA, Gardner LD, Block BA, Scholz NL. 2013. Exxon Valdez to Deepwater Horizon: Comparable toxicity of both crude oils to fish early life stages. Aquatic Toxicology 142:303-316.

Jacobson, John, "Final Product Presentation: Autonomous Underwater Inspection Using a 3D Laser," RPSEA DCI TAC Meeting, GFBEDC, Sugar Land, TX, 18 Nov., 2014

Jacobson, John, "Final Report: Autonomous Underwater Inspection Using a 3D Laser," 10121.4903.FINAL, 18 Nov., 2014

Jacobson, John, and Dan McLeod, "AUV Based 3D Laser Imaging," Offshore Engineer, 56-8, Mar. 2014

Jellison, LT Kyle, LCDR Lushan Hannah, and Mr. JB Huyett. 2014. Hurricane Isaac Data Management Lessons Learned and Subsequent Plan Development. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1029-1040. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.1029

Johnston, Michelle A., M.F. Nuttall, R.J. Eckert, J.A. Embesi, N.C. Slowey, E.L. Hickerson, and G.P. Schmahl. **2013**. Long-term monitoring at the East and West Flower Garden Banks National Marine Sanctuary, 2009–2010, volume 1: technical report. U.S. Dept. of Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, Louisiana. OCS Study BOEM 2013-214. 202 pp. December 2013

Johnston, Michelle A., M.F. Nuttall, R.J. Eckert, J.A. Embesi, N.C. Slowey, E.L. Hickerson, and G.P. Schmahl. **2013**. Long-term monitoring at the East and West Flower Garden Banks National Marine Sanctuary, 2009–2010, volume 2: appendices. U.S. Dept. of Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, Louisiana. OCS Study BOEM 2013-215. 372 pp. December 2013

Johnston, M.A., M.F. Nuttall, R.J. Eckert, J.A. Embesi, N.C. Slowey, E.L. Hickerson, and G.P. Schmahl. **2015**. Long-term monitoring at East and West Flower Garden Banks National Marine Sanctuary, 2011–2012, volume 1: technical report. U.S. Dept. of Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, Louisiana. OCS Study BOEM 2015-027. 194 p. June 2015

ED_001324_00007486-00057

Johnston, Michelle A., M.F. Nuttall, R.J. Eckert, J.A. Embesi, N.C. Slowey, E.L. Hickerson, and G.P. Schmahl. 2015. Long-term monitoring at East and West Flower Garden Banks National Marine Sanctuary, 2011–2012, volume II: Appendices. U.S. Dept. of Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, Louisiana. OCS Study BOEM 2015-028. 416 p. June 2015

Jones, R., W. Lehr, D. Simecek-Beatty, R. Michael Reynolds. 2013. ALOHA® (Areal Locations of Hazardous Atmospheres) 5.4.4: Technical Documentation [PDF, 1.3 MB]. U.S. Dept. of Commerce, NOAA Technical Memorandum NOS OR&R 43. Seattle, WA: Emergency Response Division, NOAA. 96 pp.

Jozsef, LTM Aaron L., LT Scott R. Houle, LCDR Tedd B. Hutley, and MST1 Justin M. Sawyer. 2014. KIS Approach to Data Management for Oil and Hazardous Material Response. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 2295-2303.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.2295

Karl T. Schroeder, and Harry M. Edenborn, "Geochemical and Strontium Isotope Characterization of Produced Waters from Marcellus Shale Natural Gas Extraction", Environ. Sci. Technol. 2012, 46, 3545−3553

Keller JM, Balazs GH, Nilsen F, Rice M, Work TM, Jensen BA. 2014. Investigating the Potential Role of Persistent Organic Pollutants in Hawaiian Green Sea Turtle Fibropapillomatosis. Environmental Science & Technology 48(14):7807-7816.

Kelner, Eric, Phase 1 Final Summary Report and Recommendations: More Improvements to Deepwater Subsea Measurement," 28 Feb., 2014

Kimrey, LT Christopher and Mr. Doug Helton. 2014. Abandoned Vessel Authorities and Best Practices Guidance-A Review of NRT Work. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 2053-2063.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.2053

Kimrey, LT Christopher M. and CDR Eric J. Doucette. 2014. Pollution Response in Post Disaster Recover – Best Practices From Hurricane Sandy. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1041-1049.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.1041

Knutson, Scott, Craig Dougans, Gary Reiter, Don Rodden, and Erik Kidd. 2014. Canada-United States (Salish Sea) Spill Response Organizations: A Comparison. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 299-313.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.299

Ko, D. S. and Wang, D-P (2104) Intra-Americas Sea Nowcast/Forecast System Ocean Reanalysis to Support Improvement of Oil-Spill Risk Analysis in the Gulf of Mexico by Multi-Model Approach, Department of the Interior, Bureau of Ocean Energy Management, Herndon, VA. BOEM 2014-1003.

Koh, Carolyn, "Phase I Final Presentation: Hydrate Modeling & Flow Loop Experiments for Water Continuous & Dispersed Systems," 28 May, 2014

Koh, Carolyn, "Phase 1 Final Technical Report: Hydrate Modeling and Flow Loop Experiments for Water Continuous and Partially Dispersed Systems, 10121-4202-01," 15 Jul., 2014

ED_001324_00007486-00058

Kolesar Kohl, Courtney A., Rosemary C. Capo, Brian W. Stewart, Andrew J. Wall, Karl T. Schroeder, Richard W. Hammack, and George D. Guthrie, "Strontium Isotopes Test Long-Term Zonal Isolation of Injected and Marcellus Formation Water after Hydraulic Fracturing", Environ. Sci. Technol. 2014, 48, 9867−9873

Kutchko, B., D. Crandall, J. Moore, C. Gieger, M. Gill, R. Spaulding, I. Haljasmaa, A. Mergaman, E. Rosenbaum, L. Dalton, National Energy Technology Laboratory; D. Mcintyre, W. Harbert, G. Benge, C.C. Buford, and J.M. Shine. 2015. *Assessment of Foamed Cement - Field Generated Pressurized Samples*. Offshore Technology Conference 2015. May 2015

Kutchko, B.; Moore, J.; Crandall, D.; Gill, M.; McIntyre, D.; Spaulding, R.; Strazisar, B.; Rosenbaum, E.; Haljasmaa, I.; Benge, G.; Cunningham, E.; DeBruijn, G.; Shine, J.; Gardner, C. 2014. Addendum 1 to Computed Tomography and Statistical Analysis of Bubble Size Distributions in Atmospheric-Generated Foamed Cement; NETL-TRS-2-2014; EPAct Technical Report Series; U.S. Department of Energy, National Energy Technology Laboratory: Morgantown, WV, 2014; p 20.

Kvaerner Field Development Inc "10121-4405-02 – Final Technical Report Appendix C3 - AIP FOR KVAERNER DEEPWATER DRY TREE SEMI, Approval in Principle of Kvaerner Deepwater Dry Tree Semi," RPSEA, Report No.: 15U5O2I-10, Rev. 2, Document No.: 15U5O2I-10, 30 Dec., 2014

Kvaerner Field Development Inc "10121-4405-02 – Final Technical Report Appendix C4 - DNV, Approval In Principle, Kvaerner's Deepwater Dry Tree SemiSubmersible," Request by RPSEA, 12 Nov., 2014

Kvaerner Field Development Inc., "10121-4405-02 – Final Technical Report Appendix B2 - Ultra-Deepwater Dry Tree System for Drilling and Production in the Gulf of Mexico, Technology Qualification of Riser Tensioner for Dry Tree Semi Concept," Kvaerner Field Development Inc., Document No.:KFD-RP-ZZZ-0002, 30 Dec., 2014

Kvaerner Field Development Inc., "10121-4405-02 – Final Technical Report Appendix A1 - Ultra Deepwater Dry Tree System for Drilling and Production in the Gulf of Mexico, Phase 2, Conceptual Design Report," HOE, H12122-G-RPT-GN-15001, 30 Dec., 2014 "10121-4405-02 – Final Technical Report Appendix A2 - RPSEA Project 10121-4405-02 Ultra-Deepwater Dry Tree System for Drilling and Production in the Gulf of Mexico, Dry Tree Semi Conceptual Design Report," Kvaerner Field Development Inc., KFD-RP-ZZZ-0001, 30 Dec., 2014

Lamendella R, Strutt S, Borglin S, Chakraborty R, Tas N, Mason OU, Hultman J, Prestat E, Hazen TC and Jansson JK. 2014. Assessment of the Deepwater Horizon oil spill impact on Gulf coast microbial communities. *Front. Microbiol.* **5**:130. doi: 10.3389/fmicb.2014.00130

Lehr, William. 2014. Communicating Study Results of Scientific Teams in Large Spills. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1141-1148.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.1141

Leifer, Ira, John Murray, Davida Streett, Timothy Stough, Ellen Ramirez, and Sonia Gallegos. 2015. The Federal Ocean Spill Team for Emergency Response Remote Sensing, FOSTERRS: Enabling remote sensing technology for marine disaster response

Leonard Jr., CDR Joseph J., LCDR Kerry G. Karwan, LCDR John Hahn, and Carl Gibeault. 2014. Exercising the Recovery Phase: Taking the Next Step. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 144-155. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.144

Levine, Ed, John Tarpley, LTJG Alice Drury, LT Kyle Jellison, and LCDR John Lomnicky. 2014. Development of the NOAA Scientific Support Coordinator Training Guidebook. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1899-1909. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.1899

Levine, J. S.; Haljasmaa, I.; Lynn, R.; Shaffer, F.; Warzinski, R. P. Detection of Hydrates on Gas Bubbles during a Subsea Oil/Gas Leak; NETL-TRS-6-2015; EPAct Technical Report Series; U.S. Department of Energy, National Energy Technology Laboratory: Pittsburgh, PA, 2015; p 44.

Li, Chunyan, Lawrence J. Rouse, Jr. 2014. Analysis of ocean current data from Gulf of Mexico oil and gas platforms. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2014-040. 141 pp. April 2014

Li R, Palm BB, Borbon A, Graus M, Warneke C, Ortega AM, Day DA, Brune WH, Jimenez JL, de Gouw JA. 2013. Laboratory Studies on Secondary Organic Aerosol Formation from Crude Oil Vapors. Environmental Science & Technology 47(21):12566-12574.

Lillycrop, Jeff and Brian Tetreault. 2015. *The U.S. Army Corps of Engineers: The future of navigation and 21st century waterways*. The Coast Guard Journal of Safety & Security at Sea – Proceedings of the Marine Safety & Security Council. Summer 2015.

Litz, Jenny A., Melody A. Baran, Sabrina R. Bowen-Stevens, Ruth H. Carmichael, Kathleen M. Colegrove, Lance P. Garrison, Spencer E. Fire, Erin M. Fougeres, Ron Hardy, Secret Holmes, Wanda Jones, Blair E. Mase-Guthrie, Daniel K. Odell, Patricia E. Rosel, Jeremiah T. Saliki, Delphine K. Shannon, Steve F. Shippee, Suzanne M. Smith, Elizabeth M. Stratton, Mandy C. Tumlin, Heidi R. Whitehead, Graham A. J. Worthy, Teresa K. Rowles. 2014. Review of historical unusual mortality events (UMEs) in the Gulf of Mexico (1990−2009): providing context for the multi-year northern Gulf of Mexico cetacean UME declared in 2010, Dis Aquat Org Vol. 112: 161–175, 2014 doi: 10.3354/dao02807

Long, Roy. 2014. Research effort aims to enhance cement integrity in deepwater. Offshore, December 12, 2014

Louisiana State University. 2014. *Development of a Real-time Monitoring Protocol for Assessing VOC Impacts on Response and Cleanup Workers' Safety During Dispersant Operations*. Herndon, VA: Bureau of Safety and Environmental Enforcement

Lu, Jennie, "Ultra-Deepwater Dry Tree System for Drilling and Production in the Gulf of Mexico Phase 1, Final Presentation, 10121-4405-02," RPSEA Ultra-Deepwater Technology Conference, Norris Conference Center, Houston, TX, 2 Sep., 2014

Lynn, R. J.; Haljasmaa, I. V.; Shaffer, F.; Warzinski, R. P.; Levine, J. S. A Pitot tube system for obtaining water velocity profiles with millimeter resolution in devices with limited optical access. Flow Measurement and Instrumentation 2014, 40, 50–57.

ED_001324_00007486-00060

MacFadyen, Amy, Eugene Wei, Christopher Warren, Charlie Henry, and Glen Watabayashi. 2014. Utilization of the Northern Gulf Operational Forecast System to Predict Trajectories of Surface Oil from a Persistent Source Offshore of the Mississippi River Delta. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 531-543.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.531

Macpherson, G.I; R.C. Capo, B. W. Stewart, T. T Phan, K. Schroeder and R.W. Hammack, "Temperature-dependent Li isotope ratios in Appalachian Plateau and Gulf Coast Sedimentary Basin saline water", Geofluids 10.111 (2014)

Mager EM, Esbaugh AJ, Stieglitz JD, Hoenig R, Bodinier C, Incardona JP, Scholz NL, Benetti DD, Grosell M. 2014. Acute Embryonic or Juvenile Exposure to Deepwater Horizon Crude Oil Impairs the Swimming Performance of Mahi-Mahi (Coryphaena hippurus). Environmental Science & Technology 48(12):7053-7061.

Majors, Lee, Susanne Miller, and Shannon Jensen. 2014. Oil Spill Preparedness for Polar Bears in Alaska. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 299530.
doi: http://dx.doi.org/10.7901/2169-3358-2014-1-299530.1

Maksym, T., Singh, H., Bassett, C., Lavery, A., Freitag, L., Sonnichsen, F., Wilkinson, J. 2014. *Oil spill detection and mapping Arctic sea ice using autonomous underwater vehicles*. Herndon, VA: Bureau of Safety and Environmental Enforcement.

MAR, Inc. 2015. Ocean Imaging, TRACS-Ohmsett User Guide. Sterling, VA: Bureau of Safety and Environmental Enforcement

Mark-Moser, M.; Disenhof, C.; Rose, K. Gulf of Mexico Geology and Petroleum System: Overview and Literature Review in Support of Risk and Resource Assessments; NETL-TRS-4-2015; EPAct Technical Report Series; U.S. Department of Energy, National Energy Technology Laboratory: Morgantown, WV, 2015; p 28.

McCanna, Jason, "Coiled Tubing Intervention System using an SSR with a Cost Effective Vessel, Project Number 10121-4505-01," RPSEA Ultra-Deepwater Technology Conference, Norris City Center Conference Center, Houston, Texas, 4 Sep., 2014

McCay, Deborah French, Danielle Reich, Jacqueline Michel, Dagmar Etkin, Lisa Symons, Doug Helton, and John Wagner. 2014. For Response Planning: Predicted Environmental Contamination Resulting from Oil Leakage from Sunken Vessels. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 300108.
doi: http://dx.doi.org/10.7901/2169-3358-2014-1-300108.1

McDonough, M. and J.H. Cowan, Jr. 2013. *Short-term movement, home range, and behavior of red snapper around petroleum platforms in the northern Gulf of Mexico, as determined by high resolution acoustic telemetry*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. October 2013. OCS Study 2013-0123. 71 pp.

McGrath, CDR Gabrielle and Christopher J. Hall. 2014. Standardizing Incident Command System Training Internationally in the Public and Private Sector. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 300322.
doi: http://dx.doi.org/10.7901/2169-3358-2014-1-300322.1

ED_001324_00007486-00061

McKinney, K., DeVitis, D. 2015. ASTM Testing of Skimmers at Ohmsett. Herndon, VA: Bureau of Safety and Environmental Enforcement

McKinney, Kristi and DeVitis, Dave. 2015. *ASTM F2709-08 Testing of Skimmer Systems at Ohmsett Facility*. AMOP 2015 Conference Proceedings June 2015.

McKinnon, Renee V. and Agustus J. Bannan. 2014. Challenges of an NCP Response to the Tsunami of Northern California in 2011. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1019-1028.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.1019

Mearns, Alan J.; Reish, Donald J.; Oshida, Philips.; Ginn, Thomas; Rempel-Hester, Mary Ann; Arthur, Courtney; Rutherford, Nicolle. 2014. Effects of Pollution on Marine Organisms. Source: Water Environment Research, 2014 Literature Review, pp. 1869-1954(86)

Mearns, Alan J., Gary Shigenaka, Buffy Meyer, and LTJG Alice Drury. 2014. Contamination and Recovery of Commercially-Reared Mussels Exposed to Diesel Fuel from a Sunken Fishing Vessel. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1686-1705.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.1686

Merrick, Gary, Debra Scholz, Mike Sprague, Al Allen and Ann Hayward Walker. 2015. *In-Situ Burn Gaps Analysis (CG-D-01-15)*. U.S. Coast Guard Research & Development Center. June 2015

Merten, Amy A., Zachary Winters-Staszak, and Nancy E. Kinner. 2014. Incorporating Traditional Knowledge and Subsistence Mapping into the Arctic Environmental Response Management Application. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1512-1523.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.1512

Michel, Jacqueline and Nicolle Rutherford. 2014. Determining the Need for Treatment of Oiled Marshes: Rates of Recovery and Treatment Options by Oil Type and Degree. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 294746.
doi: http://dx.doi.org/10.7901/2169-3358-2014-1-294746.1

Michel J and Rutherford N. 2014. Impacts, recovery rates, and treatment options for spilled oil in marshes. Marine Pollution Bulletin 82(1-2):19-25.

Michel, Jacqueline, Zachary Nixon, William Holton, Mark White, Scott Zengel, Frank Csulak, Nicolle Rutherford, and Carl Childs. 2014. Three Years of Shoreline Cleanup Assessment Technique (SCAT) for the *Deepwater Horizon* Oil Spill, Gulf of Mexico, USA. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1251-1266.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.1251

Moran P, Bromaghin JF, Masuda M (2014) Use of Genetic Data to Infer Population-Specific Ecological and Phenotypic Traits from Mixed Aggregations. PLoS ONE 9(6): e98470. doi:10.1371/journal.pone.0098470

National Response Team and ICCOPR. 2014. *Plan for Incorporation of National Academy of Sciences Arctic Spill Response Assessmen*t. November 2014

Nayar, H. and J. Hall. 2015. *Field Applications for Advanced Robotics*. Offshore Technology Conference 2015. May 2015

Nelson B, Heintz R. 2014. Enhancing and Expanding Bioenergetics Research Despite Staff Attrition (Poster). Alaska Marine Science Symposium, Anchorage, AK, Jan 2014

Nelson, J. R.; Bauer, J. R.; Rose, K. Assessment of Geographic Setting on Oil Spill Impact Severity in the United States - Insights from Two Key Spill Events in Support of Risk Assessment for Science-Based Decision Making. Journal of Sustainable Energy Engineering 2014, 2, 152–165.

Nelson, J. R.; Grubesic, T. H.; Sim, L.; Rose, K. Geospatial approach for evaluating potential impacts and improving response readiness to hydrocarbon spills in the tourism sector. Submitted to Tourism Management, in review.

Nelson, J. R.; Grubesic, T. H.; Sim, L.; Rose, K.; Graham, J. Approach for Assessing Coastal Vulnerability to Oil Spills for Prevention and Readiness Using GIS and the Blowout and Spill Occurrence Model (BLOSOM). Ocean & Coastal Management 2015, 112, 1–11.

NETL. Adapting the National Energy Technology Laboratory's Offshore Integrated Assessment Modeling Approach for the Offshore Arctic; NETL-TRS-3-2015; EPAct Technical Report Series; U.S. Department of Energy, National Energy Technology Laboratory: Morgantown, WV, 2015; p 40.

NETL. Analyze Broad Risks and Potential Impacts Associated with Uncontrolled Hydrocarbon Release Events in the Offshore Gulf of Mexico; NETL-TRS-2-2015; EPAct Technical Report Series; U.S. Department of Energy, National Energy Technology Laboratory: Morgantown, WV, 2015; p 60.

NETL. NETL Boasts State-of-the-Art Capabilities for Cement Research. E&P Focus 2014, 1.

Niedoroda, A., S. Davis, M. Bowen, E. Nestler, J. Rowe, R. Balouskus, M. Schroeder, B. Gallaway, and R. Fechhelm. 2014. A Method for the Evaluation of the Relative Environmental Sensitivity and Marine Productivity of the Outer Continental Shelf. Prepared by URS Group, Inc., Normandeau Associates, Inc., RPS ASA, and LGL Ecological Research Associates, Inc. for the U.S. Department of the Interior, Bureau of Ocean Energy Management. Herndon, VA OCS Study BOEM 2014-616. 80 pp. + appendices.

Nixon, Zachary and Jacqueline Michel. 2015. Predictive Modeling of Subsurface Shoreline Oil Encounter Probability from the Exxon Valdez Oil Spill in Prince William Sound, Alaska. Environmental Science & Technology 49 (7), 4354−4361 February 26, 2015

Nixon, Zachary, William Holton, Mark White, and Chris Locke. 2014. Shoreline Oiling Data Management for the Deepwater Horizon oil spill, Gulf of Mexico, USA: Implications for Data Management Standards for Future Spills of Significance. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 300040. **doi:** http://dx.doi.org/10.7901/2169-3358-2014-1-300040.1

NOAA. 2014. *NOAA Technical Memorandum NMFS-SEFSC-673 – Common Bottlenose Dolphins (Tursiops Truncatus) in Lake Pontchartrain, Lousiana: 2007 to Mid-2014.*

Nuka Research and Planning Group, LLC. 2014. Estimating an Oil Spill Response Gap Analysis for the U.S. Arctic. Herndon, VA: Bureau of Safety and Environmental Enforcement

Nuka Research and Planning Group, LLC, Coastal and Ocean Resources, and Archipelago Marine Research, Ltd. 2014. *ShoreZone mapping of the North Slope of Alaska: Final report.* US Dept. of the Interior, Bureau of Ocean Energy Management, BOEM Alaska OCS Regional Office, Anchorage. OCS Study BOEM 2014--□657. 324 pp. November 12, 2014

Nuka Research and Planning Group, LLC, 2015. Permitting the Use of Oil Spill Simulants: Identifying Options and Building Consensus Final Report. Herndon, VA: Bureau of Safety and Environmental Enforcement

Packard, Richard, Mike Popovich, and John Stengel. 2014. Massachusetts First Responder Exercises: Preparing Local Communities for Oil Spill Response. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 300125.
doi: http://dx.doi.org/10.7901/2169-3358-2014-1-300125.1

Panetta, P.D., McElhone, D., Carr, L., Winfield, K., Cartwright, G.G., & Friedrichs, C.T. 2014. *Acoustic Assessment of Subsea Chemical Dispersant Efficacy*. Herndon, VA: Bureau of Safety and Environmental Enforcement.

Panetta, P., McElhone, D., Carr, L., & Winfield, K. 2015. Acoustic Tool to Measure Oil Slick Thickness at Ohmsett. Herndon, VA: Bureau of Safety and Environmental Enforcement

Pangman, Peter, Michael Fehler, and Charles Meeder, "Final Report for Geophysical Modeling for Studying Acquisition and Processing Methods in the Deepwater Gulf of Mexico, RFP2007DW2001, Subcontract 07121-2001," 3 Jan., 2014

Parker, Heather A., Josie Clark, Brad H. Martin, Linda Pilkey-Jarvis, and Brian MacDonald. 2014. New Tools for the SCAT Program: An Innovative Approach to Assimilating Newer Responders into the Shoreline Cleanup Assessment Technique Program. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1298-1314.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.1298

Parker, Heather A., Scott R. Knutson, Andy Nicoll, and Tim Wadsworth. 2014. International Offers of Assistance Guidelines – Developing an IMO Tool to "Internationalize" Oil Spill Readiness and Response. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 328-339.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.328

Parker, Heather. 2015. *International Offers of Assistance - Guidelines for Enhancing Multi Agency Response from the International Community*. Interspill 2015 Conference Proceedings March 25, 2015

PCCI Engineering & Emergency Management, Inc. 2015. Emergency Response Exercise Best Practices. Herndon, VA: Bureau of Safety and Environmental Enforcement

PCCI, Inc. 2015. Development of Surrogate Ice Modules for Conducting Expanded Seasonal Testing in Simulated Arctic Environment at Ohmsett. Herndon, VA: Bureau of Safety and Environmental Enforcement

PCCI Marine and Environmental Engineering, Inc. 2014. *Technological assessment of Alaskan Arctic Oil Spill Response Temporary Oil Storage Options*. Herndon, VA: Bureau of Safety and Environmental Enforcement

PCCI Marine and Environmental Engineering, Inc. 2014. *Alaskan Arctic Oil Spill Response Temporary Oil Storage WCD Scenario Tool*. Herndon, VA: Bureau of Safety and Environmental Enforcement

Petron G, Karion A, Sweeney C, Miller BR, Montzka SA, Frost GJ, Trainer M, Tans P, Andrews A, Kofler J et al. . 2014. A new look at methane and nonmethane hydrocarbon emissions from oil and natural gas operations in the Colorado Denver-Julesburg Basin. Journal of Geophysical Research-Atmospheres 119(11):6836-6852.

ED_001324_00007486-00064

Pihl C, Heffern K, Maselko J. 2014. Interannual Variability of Marine Debris on Select Gulf of Alaska Beaches (Poster). Alaska Marine Science Symposium, Anchorage, AK, Jan 2014

Potter, LT Kristen, MSTC Bridgette Brown and Rosiu, Cornell J. 2014. M/V JOHN B. CADDELL: Use of Solidifying Agent in ESF-10 Response. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 299005. doi: http://dx.doi.org/10.7901/2169-3358-2014-1-299005.1

Potter, LT Kristen Potter, MSTC Bridgette Brown, and Cornell Rosiu. 2014. M/V JOHN B. CADDELL. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 299005.
doi: http://dx.doi.org/10.7901/2169-3358-2014-1-299005.1

Preble, Kristen and Bradford Benggio. 2014. Managing the Resource Consultation Process: A Case Study from the JIREH Grounding Response. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 686-696.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.686

Prouty, Nancy G., Charles R. Fisher, Amanda W. Demopoulos, Ellen R. M. Druffel. 2014. Growth rates and ages of deep-sea corals impacted by the Deepwater Horizon oil spill Deep-Sea Research Part II: Topical Studies in Oceanography

Quattrini A, P. Etnoyer, C. Doughty, L. English, R. Falco, N. Remon, M. Rittinghouse, E. Cordes. 2015. *A phylogenetic approach to octocoral community structure in the deep Gulf of Mexico.* DOI:10.1016/j.dsr2.2013.05.027

Ragland JM, Liebert D, Wirth E. 2014. Using Procedural Blanks to Generate Analyte-Specific Limits of Detection for Persistent Organic Pollutants Based on GC-MS Analysis. Analytical Chemistry 86(15):7696-7704.

Reeves, T., J. Jacobson, D. McLeod, C. Embry, and B. Nickerson, "AUV-Based 3D Laser Inspection for Structural Integrity Management in Deepwater Fields," OTC 25381, Offshore Technology Conference, Reliant Center, Houston, TX, 6 May, 2014

Roberts, H.H. 2013. Improving the Predictive Capability of 3-D Seismic Surface Amplitude Data For Identifying Chemosynthetic Communities. US Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico Region, New Orleans, LA. OCS Study BOEM 2013-222. 190 pp. December 2013

Robertson A, Heintz R, Boswell K, Moran J, Vollenweider J, Barton M. 2014. Short Term Variation in Nearshore Fish Communities in Barrow, Alaska (Poster). Alaska Marine Science Symposium, Anchorage, AK, Jan 2014

Robertson, T.L., Campbell, L. K., Pearson, L., and Higman, B. 2013.. Oil spill occurrence rates for Alaska North Slope crude and refined oil spills. Report to Bureau of Ocean and Energy Management. Contract M11PS00021. October 2013

Rooker JR, Kitchens LL, Dance MA, Wells RJD, Falterman B, et al. 2013. Spatial, Temporal, and Habitat-Related Variation in Abundance of Pelagic Fishes in the Gulf of Mexico: Potential Implications of the Deepwater Horizon Oil Spill. Published October 10, 2013. PLoS ONE 8(10): e76080. doi:10.1371/journal.pone.0076080

Rooker JR, Kitchens LL, Dance MA, Wells RJD, Falterman B, et al. 2013. Spatial, Temporal, and Habitat-Related Variation in Abundance of Pelagic Fishes in the Gulf of Mexico: Potential Implications of the Deepwater Horizon Oil Spill. Published October 10, 2013

Rose, K.; Aminzadeh, F.; Ghanem, R. G.; Thimmisetty, C.; Jabbari, N.; Khodabakhshnejad, A.; Disenhof, C. Risks and Impact Assessment for Deepwater and Ultra-Deepwater Gulf of Mexico Resources. Offshore Technology Conference, Houston, TX, May 5–8, 2014; p 17. DOI:10.4043/25364-MS.

Rose, K.; Guthrie, G. Deepwater and Ultra-Deepwater Annual Report; NETL-TRS-UDW-2013; NETL Technical Report Series, U.S. Department of Energy, National Energy Technology Laboratory: Albany, OR, 2013; p 37.

Rosiu, Cornell J., S. Lehmann, D. Sherry, W. Brigg and P. Blanchard 2014. When Oil is the Lesser of Two Evils: Comparative Risk of the Shipwreck EMPIRE KNIGHT. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 299468. doi: http://dx.doi.org/10.7901/2169-3358-2014-1-299468.1

Royer, Brian, "Riser Concepts Recommendation Final Report," 11 Apr., 2014

Rozman, K. A.; Ziomek-Moroz, M.; Bullard, S.; Kruzic, J. J.; Hawk, J. A. Localized Corrosion and Fatigue Behavior of UltraDeep Drilling Alloys; NETL-TRS-1-2014; EPAct Technical Report Series; U.S. Department of Energy, National Energy Technology Laboratory: Morgantown, WV, 2014; p 28.

RPSEA. 2014. Maintenance, Repair, and Operations; Project 09121-3300-06", 09121.3300.06.Final, 12 Dec., 2014

Ryerson, T.B, K.C. Aikin, W.M. Angevine, E.L. Atlas, D.R. Blake, C.A. Brock, F.C. Fehsenfeld, R.-S. Gao, J.A. de Gouw, D.W. Fahey, J.S. Holloway, D.A. Lack, R.A. Lueb, S. Meinardi, A.M. Middlebrook, D.M. Murphy, J. A. Neuman, J.B. Nowak, D.D. Parrish, J. Peischl, A.E. Perring, I.B. Pollack, A.R. Ravishankara, J.M. Roberts, J.P. Schwarz, J.R. Spackman, H. Stark, C. Warneke, and L.A. Watts (2011): Atmospheric emissions from the *Deepwater Horizon* spill constrain air□water partitioning, hydrocarbon fate, and leak rate, Geophysical Research Letters, 38, L07803, doi:10.1029/2011GL046726.

Ryerson, Thomas B., Richard Camilli, John D. Kessler, Elizabeth B. Kujawinski, Christopher M. Reddy, David L. Valentine, Elliot Atlas, Donald R. Blake, Joost de Gouw, Simone Meinardi, David D. Parrish, Jeff Peischla, Jeffrey S. Seewald, and Carsten Warneke (2012): Chemical data quantify *Deepwater Horizon* hydrocarbon flow rate and environmental distribution, Proceedings of the National Academy of Sciences, 109(50), p. 20246-20253, doi: 10.1073/pnas.1110564109.

Saad, Merna, Benjamin Silliman, Nathan Qian, Denise Lawn, Frederick Aulwes. 2014. *Will it Sink?: Predicting the Submergence of Diluted Bitumen.* NASA DEVELOP, NASA Langley Research Center, Hampton, Virginia.

Sack ,Andrea L. and Shikha Sharma, "A multi-isotope approach for understanding sources of water, carbon and sulfur in natural springs of the Central Appalachian Region, Environ Earth Sci (2014) 71:4715–4724.

Salimi, Amir, Mark Kalman, and Liang Yu, "Flexible Hybrid Reinforced Pipe Bend Stiffener Interface Design With Optimized Thermal Performance," OMAE 24267, 10121-4402-02, 33rd International Conference on Ocean, Offshore and Arctic Engineering (OMAE 2014), San Francisco, CA, 8 Jun., 2014

Salimit, Amir, "Phase 1 Final Report, Qualification of Flexible Fiber-Reinforced Pipe for 10000 ft WD," 10121.4402.02.10, RPSEA, 10 Dec., 2013

Sammarco, Paul W. 2013. Corals on oil and gas platforms near the Flower Garden Banks: population characteristics, recruitment, and genetic affinity. U.S. Dept. of the Interior,

Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2013-216. pp. 106. December 2013

Sammarco, Paul W. 2013. Deepwater coral distribution and abundance on active offshore oil and gas platforms and decommissioned Rigs-to-Reefs platforms. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2013-217. 45 pp. December 2013

Sammarco, Paul W. 2014. Determining the geographical distribution and genetic affinities of corals on offshore platforms, Northern Gulf of Mexico. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2014-011. 75 pp. March 2014

Sammarco, Paul W. 2014. New Invasive Marine Species Colonizing Energy Platforms in the Northern Gulf of Mexico: Verification, and Examination of Spread. US Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2015-005. 72 pp. January 2015

Sandia National Laboratories. 2015. *Literature Survey of Crude Oil Properties Relevant to Handling and Fire Safety in Transport.* March 2015.

Schmidt, Bill, Paul Meyer, and Steve Potter. 2014. Testing of Oil Recovery Skimmers in Ice at Ohmsett The National Oil Spill Response Research & Renewable Energy Test Facility. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 618-633.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.618

Schnapp, Kelly Lynn, Joseph Leonard, Michael Drieu, and Bryan Rogers. 2014. Incorporating Well Control Support Functions into a Broader Oil Spill Response Organization. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 2098-2111.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.2098

Schwacke, Lori H. , Cynthia R. Smith, Forrest I. Townsend, Randall S. Wells, Leslie B. Hart, Brian C. Balmer, Tracy K. Collier, Sylvain De Guise, Michael M. Fry, Louis J. Guillette ,Jr., Stephen V. Lamb, Suzanne M. Lane, Wayne E. McFee, Ned J. Place, Mandy C. Tumlin, Gina M. Ylitalo, Eric S. Zolman, and Teresa K. Rowles (2014) Health of Common Bottlenose Dolphins (Tursiops truncatus) in Barataria Bay, Louisiana, Following the Deepwater Horizon Oil Spill Environ. Sci. Technol., 2014, 48 (1), pp 93–103, DOI: 10.1021/es403610f

Schwacke, Lori H. , Cynthia R. Smith, Forrest I. Townsend, Randall S. Wells, Leslie B. Hart, Brian C. Balmer, Tracy K. Collier, Sylvain De Guise, Michael M. Fry, Louis J. Guillette ,Jr., Stephen V. Lamb, Suzanne M. Lane, Wayne E. McFee, Ned J. Place, Mandy C. Tumlin, Gina M. Ylitalo, Eric S. Zolman, and Teresa K. Rowles (2014) Response to Comment on Health of Common Bottlenose Dolphins (Tursiops truncatus) in Barataria Bay, Louisiana Following theDeepwater Horizon Oil Spill. Environ. Sci. Technol., 2014, 48 (7), pp 4209–4211 DOI: 10.1021/es5009278

Schwacke, Lori H. , Cynthia R. Smith, Forrest I. Townsend, Randall S. Wells, Leslie B. Hart, Brian C. Balmer, Tracy K. Collier, Sylvain De Guise, Michael M. Fry, Louis J. Guillette Jr., Stephen V. Lamb, Suzanne M. Lane, Wayne E. McFee, Ned J. Place, Mandy C. Tumlin, Gina M. Ylitalo, Eric S. Zolman, Teresa K. Rowles (2013) Supporting Information for Health of Common Bottlenose Dolphins (Tursiops truncatus) in Barataria Bay, Louisiana, Following the Deepwater Horizon Oil Spill. Environ. Sci. Technol., 2014, 48 (1), pp 93–103.

Scott NM, Hess M, Bouskill NJ, Mason OU, Jansson JK and Gilbert JA (2014) The microbial nitrogen cycling potential is impacted by polyaromatic hydrocarbon pollution of marine sediments. *Front. Microbiol.* 5:108. doi: 10.3389/fmicb.2014.00108

Seaman, C., D.V. Brower, H. Tang, S. Le. *Development of a Post-Installed Deepwater Monitoring System*. Offshore Technology Conference 2015. May 2015

Seung Jun Kim, Dusan Spernjak, Samuel Holmes, Vimal Vinayan, and Arun Antony, "Vortex-Induced Motion of Floating Structures: CFD Sensitivity Considerations of Turbulence Model and Mesh Refinement," OMAE2015-42221, Proceedings of the 34th International Conference on Ocean, Offshore and Arctic Engineering, OMAE15, 31 May - 5 Jun., 2015, St. John's, Newfoundland, Canada

Sexson, M. G., J. M. Pearce, and M. R. Petersen. 2014. Spatiotemporal distribution and migratory patterns of Spectacled Eiders. BOEM 2014-665. Bureau of Ocean Energy Management, Alaska Outer Continental Shelf Region, Anchorage, Alaska. September 2014

Sewall F, Heintz R, Vollenwider J. 2014. Seasonal Trends in Growth and Stored Energy for Juvenile Pacific Herring in Prince William Sound (Poster). Alaska Marine Science Symposium, Anchorage, AK, Jan 2014

Shaffer, F.; Savas, Ö.; de Vera, G.; Lee, K. Determining the discharge rate from a submerged oil leak jet using ROV video. Flow Measurement and Instrumentation 2015, 43, 34–46.

Sharma, Shikha, Michon L. Mulder, Andrea Sack, Karl Schroeder, and Richard Hammack, "Isotope Approach to Assess Hydrologic Connections During Marcellus Shale Drilling", Groundwater Vol. 52, No. 3,May-June 2014 (pages 424–433)

Sharma, Shikha; Lindsey Bowman, Karl Schroeder, Richard Hammack, "Assessing changes in gas migration pathways at a hydraulic fracturing site: Example from Greene County, Pennsylvania, USA", Applied Geochemistry. 2014.

Shen, J., J. M. Pappas, and W. Letton, "More Improvements to Deepwater Subsea Measurement," OTC 25395, 2014 Offshore Technology Conference, 5-8 May, 2014, Houston, TX

Shigenaka, Gary. 2015. *Physical and Chemical Characteristics of In-Situ Burn Residue and other Environmental Oil Samples Collected During the Deepwater Horizon Spill Response*. Interspill 2015 Conference Proceedings March 25, 2015

Shigenaka, G. 2014. Twenty-Five Years After the Exxon Valdez Oil Spill: NOAA's Scientific Support, Moni-toring, and Research. Seattle: NOAA Office of Response and Restoration. 78 pp. [March 2014]

Shupe, Danielle, Gary Ott, and Kristen Preble. 2014. Evaluating Place of Refuge Risk in the Chesapeake Bay. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 814-824.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.814

Silliman, Benjamin Douglas. 2014. Guidelines to Prepare for Oil Sands Product Spills in Varied Aquatic Environments. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 426-433.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.426

Silva, M., P.J. Etnoyer, and I.R. MacDonald. 2015. Coral injuries observed at mesophotic reefs after the Deepwater Horizon oil discharge. Deep Sea Research Part II: Topical Studies in Oceanography. doi:10.1016/j.dsr2.2015.05.013

Sim, L.; Graham, J.; Rose, K.; Duran, R.; Nelson, J.; Umhoefer, J.; Vielma, J. Developing a Comprehensive Deepwater Blowout and Spill Model. Submitted to Environmental Modelling & Software, in review.

S.L. Ross Environmental Research Ltd. 2015. Review of ASTM Standards for Oil Spill Response. Herndon, VA: Bureau of Safety and Environmental Enforcement

S.L. Ross Environmental Research Ltd. 2014. *Subsea Chemical Dispersant Research*. Herndon, VA: Bureau of Safety and Environmental Enforcement.

S.L. Ross Environmental Research Ltd. 2015. Research to Support the Prediction of Effectiveness of Dispersant Use in the U.S. Beaufort and Chukchi Seas. Herndon, VA: Bureau of Safety and Environmental Enforcement

Sligh, Kevin. 2014. Oil Spill Preparedness & Response Compliance with the Endangered Species Act (ESA) and Reducing Action Agency Exposure to Future Litigation. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 300264. **doi:** http://dx.doi.org/10.7901/2169-3358-2014-1-300264.1

Smith, CAPT Shep. 2015. *Future Navigation: Building upon Navigation's history*. The Coast Guard Journal of Safety & Security at Sea – Proceedings of the Marine Safety & Security Council. Summer 2015.

Smith, Donald P. 2014. Inspection Technologies and Crisis Management: Field Automation lessons from the field. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 300246.
doi: http://dx.doi.org/10.7901/2169-3358-2014-1-300246.1

Socolofsky, S. A.; Adams, E. E.; Boufadel, M. C.; Aman, Z. M.; Johansen, Ø.; Konkel, W. J.; Lindo, D.; Mads, M. N.; North, E. W.; Paris-Limouzy, C. B.; Rasmussen, D.; Reed, M.; Rønningen, P.; Sim, L. H.; Uhrenholdt, T.; Anderson, K. G.; Cooper, C.; Nedwed, T. J. Intercomparison of Oil Spill Prediction Models for Accidental Blowout Scenarios with and without Subsea Chemical Dispersant Injection. Marine Pollution Bulletin 2015, 96, 110–126.

Somasundaran, Ponisseril, Partha Patra, Raymond S. Farinato, and Kyriakos Papadopoulos. 2014. Oil Spill Remediation: Colloid Chemistry-Based Principles and Solutions. ISBN: 978-1-118-20670-6

Sreenivasan A. 2014. Estmation of the Relationship Between Growth and Consumption Rates of Juvenile Pacific Cod (Gadus macrocephalus). Alaska Marine Science Symposium, Anchorage, AK, Jan 2014

St. John, Mark, "Phase 1 Final Technical Report and Human Factors Literature Review, 111215101-01," Document No. 11121.5101.01.01, RPSEA, 30 Apr., 2015

Stacy N, Innis C, Hernandez J (2013) Conservation Physiology Development and evaluation of three mortality prediction indices for cold-stunned Kemp's ridley sea turtles (Lepidochelys kempii) 2013 vol: 1 (1) pp: cot003-cot003 DOI:10.1093/conphys/cot003

Stalford, Harold L., "Intelligent Casing-Intelligent Formation Telemetry (ICIFT) System, FINAL REPORT," Document Number: 10121.4504.01.final, Contract Number: 10121-4504-01, RPSEA, 28 Jan., 28, 2015

Stalford, Harold, "FINAL PRESENTATION: Intelligent Casing-Intelligent Formation Telemetry System," 4 Jun., 2014

Steffek, Timothy. 2015. *Comparative Testing of Corexit EC9500A, Finasol OSR52, Accell Clean DWD, and ZI 400 at Ohmsett in a Simulated Arctic Environment.* Interspill 2015 Conference Proceedings March 24, 2015.

Stone, CDR John M. 2015. *21st Century Waterway Design: Providing Safe, efficient, and resilient waterways*. The Coast Guard Journal of Safety & Security at Sea – Proceedings of the Marine Safety & Security Council. Summer 2015.

Stout, Jordan and LCDR Jeff Rubini. 2014. National Contingency Plan Phase II Activities: A Problem Analysis & Decision Framework for Understanding & Evaluating Oil Pollution Threats from Sunken Ships Off California. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 2134-2145.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.2134

Sundaravadivelu, D., M.T. Suidan, A.D. Venosa, P. Rosales (2014) Effect of salinity on the effectiveness of solidifiers for crude oil spill remediation. IOSC Proceedings, Savannah, GA, Vol. 2014, No. 1; 1457-1464.

Sundaravadivelu, D., M.T. Suidan, A.D. Venosa (2015) Parametric study to determine the effect of temperature on oil solidifier performance and the development of a new empirical correlation for predicting effectiveness. Mar. Pol. Bul., 95(1), 297-304.

Symons, Lisa, James Delgado, Deborah Marx, and Erika Martin Seibert. 2014. A Means to Streamline Historic and Cultural Resource Consultation and Compliance for Pollution Assessment and Recovery Activities on Shipwrecks. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 2024-2036.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.2024

Symons, Lisa, Jacqueline Michel, James Delgado, Danielle Reich, Debbie French McCay, Dagmar Schmidt Etkin, and Doug Helton. 2014. The Remediation of Underwater Legacy Environmental Threats (RULET) Risk Assessment for Potentially Polluting Shipwrecks in U.S. Waters. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 783-793.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.783

Talbot, LTJG Kasey and Jeff Dauzat. 2014. Hurricane Isaac Post-Storm Response. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 2253-2259.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.2253

Tarpley, John, LTJG Alice Drury, and Doug Helton. 2014. Implementing Lessons Learned for NOAA's Emergency Response Division. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1420-1430.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.1420

Tarpley, John, Jacqueline Michel, Scott Zengel, Nicolle Rutherford, Carl Childs, and Frank Csulak. 2014. Best Practices for Shoreline Cleanup and Assessment Technique (SCAT) from Recent Incidents. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1281-1297.
doi: http://dx.doi.org/10.7901/2169-3358-2014.1.1281

Teague, W.J., H. W. Wijesekera, and E. Jarosz. 2014. Current-topography interaction and its influence on water quality and contaminant transport over shelf-edge banks. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2014-771. 280 pp. July 2014

Technology Systems, Inc. 2014. *CORN (Coordinated Oil-spill Response Network) Final Technical Report.* Herndon, VA: Bureau of Safety and Environmental Enforcement

Thomas J, Wafula D, Chauhan A, Green S, Gragg R, Jagoe C. 2014. A survey of deepwater horizon (DWH) oil-degrading bacteria from the Eastern oyster biome and its surrounding environment. Frontiers in microbiology 2014 vol: 5 pp: 149 DOI:

Thuring, Allen R. 2014. Oil Spill Response Under the NCP and the NRF/Stafford Act - Incompatible Regimes?. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1050-1058. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.1050

Thuring, Allen R. 2014. The Oil Spill Response Fund – Four Decades of Success. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 2146-2158. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.2146

Tidwell L, Allan S, O'connell S, Hobbie K, Smith B, Anderson K Polycyclic Aromatic Hydrocarbon (PAH) and Oxygenated PAH (OPAH) Air–Water Exchange during the Deepwater Horizon Oil SpillEnviron. Sci. Technol., 2015, 49 (1), pp 141–149 DOI: 10.1021/es503827y (2015).

Trigatti, Larry, Ole-Kristian Bjerkemo, and Mark Everett. 2014. Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1485-1496. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.1485

Tucci, CAPT Andrew. 2015. *Dial "C" for Cyber Attack: How marine system vulnerabilities can increase cyber risk.* The Coast Guard Journal of Safety & Security at Sea – Proceedings of the Marine Safety & Security Council. Summer 2015.

Tuttle, S.G., Farley, J. P, and Fleming, J.W. 2014. *Efficient Atomization and Combustion of Emulsified Crude Oil.* Herndon, VA: Bureau of Safety and Environmental Enforcement

Tuttle, Steven G., John P. Farley, and James W. Fleming. 2014. A Novel Low-Pressure Atomization Method for Burning Emulsified Crude Oil. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1806-1820. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.1806

Ufford, A., McKeon, C., Owston, R., Plumlee, J., & Supak, K. 2014. *Dispersant Effectiveness Literature Synthesis*. Herndon, VA: Bureau of Safety and Environmental Enforcement

U.S. Arctic Research Commission (USARC). 2015. *Report on the Goals and Objectives for Arctic Research 2015-2016 for the US Arctic Research Program Plan.* May 2015.

U.S. Army Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory. 2014. Testing of Oil Skimmer Equipment Components for use in Arctic Environments. Herndon, VA: Bureau of Safety and Environmental Enforcement

U.S. Coast Guard Research and Development Center. 2014. Arctic Technology Evaluation 2014: August 8-30, 2014. Newsletter Updated July 23, 2014

U.S. Coast Guard Research and Development Center. 2014. Detection of Oil within the Water Column Final Report: Detection Prototype Tests. Herndon, VA: Bureau of Safety and Environmental Enforcement

U.S. Coast Guard Research and Development Center. 2014. Modernization of Special Monitoring of Applied Response Technologies (SMART) Technology and Methods. Herndon, VA: Bureau of Safety and Environmental Enforcement

U.S. Environmental Protection Agency (USEPA). 2014. Risk Assessment Forum White Paper: Probabilistic Risk Assessment Methods and Case Studies. EPA/100/R-09/001A. Washington, D.C.: Risk Assessment Forum, Office of the Science Advisor, USEPA.

ED_001324_00007486-00071

U.S. Fire Administration. 2014. Coffee Break Bulletin: Bakken Crude in Transportation. (No. HM-2014-1) June 23, 4014

U.S. Fire Administration. 2014. Coffee Break Bulletin: Petroleum Crude Oil Transportation and Response Considerations. (No. HM-2014-2) October 27, 2014

U.S. Fire Administration. 2014. Coffee Break Bulletin: Petroleum Crude Oil: Preincident Planning. (No. HM-2014-3) November 3, 2014

U.S. Fire Administration. 2014. Coffee Break Bulletin: Petroleum Crude Oil: Principles of Successful Incident Management. (No. HM-2014-4) November 10, 2014

U.S. Fire Administration. 2014. Coffee Break Bulletin: Petroleum Crude Oil: Railroad Safety Procedures. (No. HM-2014-5) November 17, 2014

U.S. Fire Administration. 2014. Coffee Break Bulletin: Petroleum Crude Oil: Hazard Assessment and Risk Evaluation. (No. HM-2014-6) November 24, 2014

U.S. Fire Administration. 2014. Coffee Break Bulletin: Petroleum Crude Oil: Implementing Response Objectives. (No. HM-2014-7) December 1, 2014

URS Group Inc. 2015. Geo-Referencing Identification (GRID) Tag Final Report. Herndon, VA: Bureau of Safety and Environmental Enforcement

Van Dolah, F.M., M.G. Neely, L.E. McGeorge, B.C. Balmer, G.M. Ylitalo, et al. 2015. Seasonal Variation in the Skin Transcriptome of Common Bottlenose Dolphins (Tursiops truncatus) from the Northern Gulf of Mexico. PLoS ONE, 10(6): e0130934. doi:10.1371/journal.pone.0130934. June 25.

Venn-Watson, S., K.M. Colegrove, J. Litz, M. Kinsel, K. Terio, J. Saliki, et al. 2015. Adrenal Gland and Lung Lesions in Gulf of Mexico Common Bottlenose Dolphins (Tursiops truncatus) Found Dead following the Deepwater Horizon Oil Spill.. PLoS ONE, 10(5): e0126538. doi:10.1371/journal.pone.0126538. May 20.

Venn-Watson, S, L. Garrison, J. Litz, E. Fougeres, B. Mase, et al. 2015. *Demographic Clusters Identified within the Northern Gulf of Mexico Common Bottlenose Dolphin (Tursiops truncates) Unusual Mortality Event: January 2010 - June 2013*. PLoS ONE 10(2): e0117248. doi: 10.1371/journal.pone.0117248

Venosa, Albert D., Paul T. Anastas, Mace G. Barron, Robyn N. Conmy, Marc S. Greenberg, and Gregory J. Wilson. 2014. Science-Based Decision Making on the Use of Dispersants in the Deepwater Horizon Oil Spill (In Oil Spill Remediation: Colloid Chemistry-Based Principles and Solutions. ISBN: 978-1-118-20670-6. Wiley Publishing. April 2014)

Vidic-Perunovic, Jelena, "Final Concept Selection Report, Low Cost Flexible Production System for Remote Ultra Deepwater Gulf of Mexico (GOM) Field Development: 10121-4404-03," Document No.: 10121-4404-03.Final, 12 Nov., 2014

Vidic-Perunovic, Jelena, Final Global Performance Assessment Report of the circular floater concept, Low Cost Flexible Production System for Remote Ultra Deepwater Gulf of Mexico (GOM) Field Development: 10121-4404-03," Document No.: 10121-4404-18.Final, 19 Aug., 2014

Viet, R.R, H.F. Goyert, T.P. White, M.-C. Martin, L.L. Manne, and A. Gilbert. 2015. Pelagic Seabirds off the East Coast of the United States 2008-2013. US Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study BOEM 2015-024. 186 pp.

Vinayan, Vimal, Arun Antony, John Halkyard, Seung-Jun Kim, Sam Holmes and Dusan Spernjak. 2015. Vortex-Induced Motion of Deep-Draft Semisubmersibles: A CFD-Based Parametric Study. Paper No. OMAE2015-42209, pp. V002T08A003; 11 pages doi:10.1115/OMAE2015-42209

Vipulanandan, C., and R. Krishnamoorti, "Report on Performance of New Slurries of Model-1 Wells - Smart Cementing Materials and Drilling Muds for Real Time Monitoring of Deepwater Wellbore Enhancement, RPSEA Ultra-Deepwater Program, Final Report – PHASE 2, Project No. 10121-4501-01," Dec., 2014

Vipulanandan, C., R. Krishnamoorti, A. Mohammed, V. Boncan, G. Narvaez, B. Head, and J. M. Pappas, "Iron Nanoparticle Modified Smart Cement for Real Time Monitoring of Ultra Deepwater Oil Well Cementing Applications," ROTC-25842-MS, Offshore Technology Conference, Houston, Texas, USA, 5–8 May, 2015

Vipulanandan, C. 2014."Development and Charcterization of Smart Cement for Real Time Monitoring in Deep Oil Well Applications," University of Minesota Warren Lecture Series, St. Paul, MN, 10 Oct., 2014

Vipulanandan, C. 2014."Smart Cement for Real Time Monitoring of Oil Well Cementing, " Ocean Energy Safety Institute R&D Roadmap Forum, College Station, TX, 7 Oct., 2014

Vlietstra, Lucy S., Karina L. Mrakovcich, Peter A. Tebeau, and Gregory J. Hall. 2014. Marine Oil Spill Simulation: A Scenario-Based Classroom Application of Meteorology and Oceanography to Environmental Protection. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 292696. **doi:** http://dx.doi.org/10.7901/2169-3358-2014-1-292696.1

Vocke, William T. 2014. *Using Exercises as a Source of Oil Pollution Research Ideas.* International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1400-1407.**doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.1400

Vocke, William T. 2014. *Building a Legacy of Research Coordination: A History of the ICCOPR from Exxon Valdez to Present Day.* International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 93-101. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.93

Volk, M. 2015. "Phase I Preliminary Design Report-FINAL: Riser Lifecycle Monitoring System for Integrity Management, Contract 11121-5402-01," 11121.5402.01, 18 Feb., 2015

Wall, Andrew J. ; Rosemary C. Capo, Brian W. Stewart, Thai T. Phan, Jinesh C. Jain, J. Alexandra Hakalaa and George D. Guthrie "High throughput method for Sr extraction from variable matrix waters and 87Sr/86Sr isotope analysis by MC-ICP-MS", J. Anal. At. Spectrom 2013.

Warren, Christopher J., Amy MacFadyen, and Charlie Henry Jr. 2014. Mapping Oil for the Destroyed Taylor Energy Site in the Gulf of Mexico. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 299931. **doi:** http://dx.doi.org/10.7901/2169-3358-2014-1-299931.1

Warzinski, R. P.; Lynn, R.; Haljasmaa, I.; Leifer, I.; Shaffer, F.; Anderson, B. J.; Levine, J. S. Dynamic morphology of gas hydrate on a methane bubble in water: Observations and implications for hydrate film models. Geophysical Research Letters 2014, 41, 6841–6847.

Watters, Jeff, "Analysis of Best Practices for Deepwater Cementing in Oil Based Mud (OBM) and Synthetic Based Mud(SBM), Phase 1 Report, RPSEA 12121-6503-01," 12121.6503.01.04, 10 Jun., 2015

Watters, Jeff, "Final Report to RPSEA, Deepwater Reverse-Circulation Primary Cementing, 10121-450201.FINAL," 21 Sep., 2014

Whelan, Ann, Josie Clark, Gary Andrew, Jacqueline Michel, and Bradford Benggio. 2014. Developing Cleanup Endpoints for Inland Oil Spills. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1267-1280. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.1267

Wilkin, Sarah. 2015. National Guidelines for Oiled Marine Mammal Response in the United States. Interspill 2015 Conference Proceedings March 26, 2015

Worcester Polytechnic Institute. 2014. *Burning Behavior of Oil in Ice Channels*. Herndon, VA: Bureau of Safety and Environmental Enforcement

Wreden, Crystal , Kyle Macfarlan, Richard Giroux, and Michael LoGiudice, "Reliability is key to developing deepwater RCPC," E&P Magazine, Mar., 2014.

Wreden, Crystal, "Analysis of Best Practices for Deepwater Cementing in Oil Based Mud (OBM) and Synthetic Based Mud (SBM), RPSEA 12121-6503-01," RPSEA Ultra-Deepwater Technology Conference, Norris City Center Conference Center, Houston, Texas, 3 Sep., 2014

Wreden, Crystal, "Analysis of Best Practices for Deepwater Cementing in Oil Based Mud (OBM) and Synthetic Based Mud (SBM), RPSEA 12121-6503-01," RPSEA Ultra-Deepwater Technology Conference, Norris City Center Conference Center, Houston, Texas, 3 Sep., 2014

Wreden, Crystal, "Deepwater Reverse-Circulation Primary Cementing, 10121-4502-01: Final Presentation," RPSEA UDW Technology Conference, , Norris Conference Center, Houston, TX, 3 Sep., 2014

Yan, C., "Solubility Study of Magnetite under Extreme High Pressure and High Temperature" OTC 25216, 2014 Offshore Technology Conference, 5-8 May, 2014, Houston, TX

Yan, C., et al., "Solubility Study of Magnetite under Extreme High Pressure and High Temperature" OTC 25216, 2014 Offshore Technology Conference, 5-8 May, 2014, Houston, TX

Yan, Chao, Jin Huang, Paula Guraieb, and Ross C. Tomson, "Evaluation of Ferrous Carbonate/Iron Oxides Scaling Risk under High Temperature in the Absence and Presence of Scale Inhibitors," SPE-173785, SPE International Symposium on Oilfield Chemistry, Marriott Waterway Conference Center, The Woodlands, TX, 13-15 Apr., 2015

Yan, Chao, Paula Guraieb, Jin Huang, and Ross C. Tomson, "Study of Siderite Solubility under Extreme High Temperature and Pressure at 1 M NaCl Solution," NACE-5623, NACE International Corrosion 2015 Conference & Expo, Kay Bailey Hutchison Convention Center, Dallas, TX, 15-19 Mar., 2015

Yemington, Charles R., "Final Summary Report – Year Two [Phase 2], Coiled Tubing Drilling and Intervention, System Using a Cost Effective Vessel," 10121-4505-01, Document Number: 10121.4505.02.02, 22 Dec., 2014

Young, Jaclyn. 2014. Assuring your agency's Area Contingency Plan is equipped with an effective Joint Information Center Model. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 2127-2133. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.2127

Yuan B, Warneke C, Shao M, de Gouw JA. 2014. Interpretation of volatile organic compound measurements by proton-transfer-reaction mass spectrometry over the deepwater horizon oil spill. International Journal of Mass Spectrometry 358:43-48.

Zaleski M, Heintz R, Garrison M. 2014. They Grow Up So Fast: Comparing Conditions of Young of the Year Gadids in Bering Sea and Gulf of Alaska (Poster). Alaska Marine Science Symposium, Anchorage, AK, Jan 2014

Zapp Sluis, M. and J.H. Cowan, Jr. 2013. *Platform recruited reef fish phase II: Do platforms provide habitat that increases the survival of reef fishes?* U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study. October 2013. BOEM 2013-0120 43 pp.

Zengel S, B.M. Bernik, N. Rutherford, Z. Nixon, and J. Michel. 2015. *Heavily Oiled Salt Marsh following the Deepwater Horizon Oil Spill, Ecological Comparisons of Shoreline Cleanup Treatments and Recovery*. PLoS ONE 10(7): e0132324. doi:10.1371/journal.pone.0132324

Zengel, Scott, Nicolle Rutherford, Brittany Bernik, Zachary Nixon, and Jacqueline Michel. 2014. Salt Marsh Remediation and the *Deepwater Horizon* Oil Spill, the Role of Planting in Vegetation and Macroinvertebrate Recovery. International Oil Spill Conference Proceedings: May 2014, Vol. 2014, No. 1, pp. 1985-1999. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.1985

Zhang, Jianfeng, "Subsea Produced Water Discharge Sensor Technical Requirements Final Report, 12121-6301-03," RPSEA 12121.6301.03.01, 19 Jun., 2015

Zhang, Jianfeng, "Technical Requirements and Gaps Analysis (Phase 1 Final) Presentation, Subsea Produced Water Sensor Development, 12121-6301-03," 10 Jun., 2015

Zhang, Liwei; Nicole Anderson, Robert Dilmore, Daniel J. Soeder, and Grant Bromhal,2014. "Leakage Detection of Marcellus Shale Natural Gas at an Upper Devonian Gas Monitoring Well: A 3□D Numerical Modeling Approach", Environ. Sci. Technol. 2014, 48, 10795−10803

Zhao, Hongying, "Technology Status Assessment: Heavy Viscous Oil PVT, 08121-2201-02," RPSEA, 20 Nov., 2014

Zhao, L.; Boufadel, M. C.; Socolofsky, S. A.; Adams, E.; King, T.; Lee, K. 2014. Evolution of droplets in subsea oil and gas blowouts: Development and validation of the numerical model VDROP-J. Marine Pollution Bulletin 2014, 83, 58–69.

Zhao, L.; Torlapati, J.; Boufadel, M. C.; King, T.; Robinson, B.; Lee, K. 2014. VDROP: A numerical model for the simulation of droplet formation from oils of various viscosities. Chem. Eng. J. 2014, 253, 93–106.

Zhao, L., B. Wang, P.M. Armenante, R.N. Conmy, M.C. Boufadel (2015) Evaluation of turbulence structures in laboratory baffled flasks under different mixing energy: Implications for dispersant effectiveness testing. J. Environmental Engineering.

Ziccardi, Michael, Sarah Wilkin, and Teresa Rowles. 2014. Modification of NOAA's National Guidelines for Oiled Marine Mammal Response as a Consequence of the Macondo/Deepwater Horizon Oil Spill. International Oil Spill Conference Proceedings:

May 2014, Vol. 2014, No. 1, pp. 986-997. **doi:** http://dx.doi.org/10.7901/2169-3358-2014.1.986

Ziomek-Moroz, M.; Hawk, J. A.; Collins, W. K.; Thodla, R.; Gui, F. The Consequence of Stress Intensity on Fatigue Crack Propagation in High-Strength Steels in Sour Environment. Electrochemical Society Transactions 2014, 61, 37–47.

Zuang, M. Abulikemu, P. Campo-Moreno, W.E. Platten, A.D. Venosa, R.N. Conmy (2015) A comparative study on the biodegradability of crude oil dispersed with JD-2000 at 5 and 25 °C. Chemosphere.

Independent Reports Sponsored by Interagency Committee Member Agencies:

Committee to Review the EDRC Project Final Report, Ocean Studies Board, National Research Council. 2013. A Review of Genwest's Final Report on Effective Daily Recovery Capacity (EDRC): A Letter Report (2013). The National Academies Press, Washington, DC. November 2013. 41 pages DOI: 10.17226/18579 DOI: 10.17226/18579Energy Information Administration. 2014. Annual Energy Outlook 2014 With Projections to 2040. DOE/EIA-0383(2014). April 2014

Energy Information Administration. 2015. Annual Energy Outlook 2015 With Projections to 2040. DOE/EIA-0383(2015). April 2015

National Academy of Sciences. 2014. Responding to Oil Spills in the Arctic Marine Environment. July 2014.

National Petroleum Council. 2015. Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources. July 2015.

Interagency Committee Publications not reported in the FY2012-2013 Biennial Report to Congress

The following are Interagency Committee member publications that were inadvertently left of the list of publications in the FY2012-2013 Biennial Report to Congress:

Bai, Z., Xiao, L., Kuo, Y., & Yang, L. 2013. Research on Vortex Induced Motion of a Deep Draft Semisubmersible With Four Rectangular Columns. International Society of Offshore and Polar Engineers. June 30, 2013

Chapman, Elizabeth C.; Capo, Rosemary C.; Stewart, Brian W.; Kirby, Carl S.; Hammack, Richard W.; Schroeder, Karl T.; and Edenborn, Harry M. 2012. "Geochemical and Strontium Isotope Characterization of Produced Waters from Marcellus Shale Natural Gas Extraction." Environmental Science & Technology 46, no. 6 (2012) : 3545-3553.

Chapman, Elizabeth C. , Rosemary C. Capo, Brian W. Stewart, Robert S. Hedin, Theodore J. Weaver, Harry M. Edenborn,. 2013. "Strontium isotope quantification of siderite, brine and acid mine drainage contributions to abandoned gas well discharges in the Appalachian Plateau", Applied Geochemistry 31 (2013) 109–118.

Clarke, J.T., C.L. Christman, A.A. Brower, and M.C. Ferguson. 2013. Distribution and Relative Abundance of Marine Mammals in the Northeastern Chukchi and Western Beaufort Seas, 2012. Annual Report, OCS Study BOEM 2013-00117. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Kaiser, M.J., B. Snyder, and A.G. Pulsipher. 2013. Offshore drilling industry and rig construction market in the Gulf of Mexico. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2013-0112. 375 p.

Konar, Brenda and Alexandra M. Ravelo. 2013. Epibenthic Community Variability on the Alaskan Beaufort Sea Continental Shelf Final Report. OCS Study BOEM 2013-01148. May 2013

Michel, J. (ed.). 2013. South Atlantic information resources: data search and literature synthesis. US Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2013-01157.

National Research Council of the National Academies. TRB Special Report 311: Effects of Diluted Bitumen on Crude Oil Transmission Pipelines. April 2013

Normandeau Associates, Inc. 2012. High-resolution Aerial Imaging Surveys of Marine Birds, Mammals, and Turtles on the US Atlantic Outer Continental Shelf—Utility Assessment, Methodology Recommendations, and Implementation Tools for the US Dept. of the Interior, Bureau of Ocean Energy Management. Contract # M10PC00099. 378 pp.

Quakenbush, L.T., R.J. Small, and J.J. Citta. 2013. Satellite tracking of bowhead whales: movements and analysis from 2006 to 2012. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Alaska Outer Continental Shelf Region, Anchorage, AK. OCS Study BOEM 2013-01110. August 2013. 60 pp + appendices.

Rouse, David R., Karen J. Nelson, and Jon C. Reiten. 2013. Montana - Impacts of Oil Exploration and Production to the Northeast Montana Wetland Management District. Montana Bureau of Mines and Geology Open-File Report 620. U.S. Fish & Wildlife Service, Region 6 Environmental Contaminants Program, Denver, CO. 264 pp.

S.L. Ross Environmental Research Limited and Mar Inc. 2013. Skimmer Tests in Drift Ice: Ice Month 2013 at Ohmsett. August 2013

Varmer, Ole. 2014. Underwater Cultural Heritage Law Study. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Herndon, VA. OCS Study BOEM 2014-005.

White, H.K., P.Y. Hsing, W. Cho, T.M. Shank, E.E. Cordes, A.M. Quattrini, R.K. Nelson, R. Camilli, A. Demopoulos, C.R. German, J.M. Brooks, H.H. Roberts, W. Shedd, C.M. Reddy, and C.R. Fisher. 2012. Impact of the Deepwater Horizon oil spill on a deep-water coral community in the Gulf of Mexico. Proceedings of the National Academy of Science. March 27.

White, H.K., P.Y. Hsing, W. Cho, T.M. Shank, E.E. Cordes, A.M. Quattrini, R.K. Nelson, R. Camilli, A. Demopoulos, C.R. German, J.M. Brooks, H.H. Roberts, W. Shedd, C.M. Reddy, and C.R. Fisher. 2012. Reply to Boehm and Carragher: Multiple lines of evidence link deep-water coral damage to Deepwater Horizon oil spill. Proceedings of the National Academy of Science, 190(40). October 2.

Zapp Sluis, M. and J.H. Cowan, Jr. 2013. Platform recruited reef fish phase II: Do platforms provide habitat that increases the survival of reef fishes? U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2013-0120 43 pp.

Zhang, X., J. Zhang, J. Krieger, M. Shulski, F. Liu, S. Stegall, W.Tao, J. You, W. Baule, and B. Potter. 2013. Beaufort and Chukchi Seas Mesoscale Meteorology Modeling Study, Final Report. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Alaska OCS Region, Anchorage, AL. OCS Study BOEM 2013-0119. 204 pp.

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FY2014-2017 Interagency Committee Member Projects[5]

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[5] The Interagency Committee monitors a variety of oil pollution research projects conducted by other non-Committee entities and, for purposes of brevity, only those research projects funded and managed by Interagency Committee members (includes those principally having access to the Oil Spill Liability Trust Fund) are listed in the appendices. The research projects are presented using the Interagency Committee's new Oil Pollution Research Categorization Framework. Projects are listed within their relevant Classes and SRAs.

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PREVENTION

Human Error Factors

Trident: A Human Factors Decision Aid Integrating Deepwater Drilling Tasks, Incidents, and Literature Review (11121-5101-01)
Contracting Agency: DOE
Estimated Completion: September 2016
The objective of this project is to design and develop Trident, a Human Factors database and decision aid to help industry practitioners understand and mitigate those aspects of deepwater drilling in which human and organizational performance limitations can result in the failure to meet safety, environmental, productivity, and other system goals. This is an industry accepted and participatory study to provide understanding of those aspects of deepwater drilling systems in which human error can lead to failure to meet system goals, which can guide operators, designers, vendors, service providers, and others in developing system improvements. The study includes the development and field testing of appropriate software to address the issue of predicting human error.

Human Centric Approach to Improve Pipeline Non-Destructive Evaluation (NDE) Performance and Reliability
Contracting Agency: PHMSA, Battelle Memorial Institute, Corporate Operations
Estimated Completion: 2018
The project will first identify major human factors impacting NDE measurements and then solve those high-impact gaps with human and technology interventions. Human factors will be identified using well-established Saba™ Peak Performance System (PPS) and its accompanying Human Performance Technology (HPT) Front-end Analysis (FEA). The project will then develop and validate intervention solutions that target those top human factors identified previously identified. Project reporting is publicly available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=644

PHMSA Transportation Rail Incident Preparedness and Response (TRIPR) Tools
Contracting Agency: PHMSA
Estimated Completion: on-going
The Transportation Rail Incident Preparedness and Response, Flammable Liquid Unit Trains resource materials were developed to provide critical information on best practices related to rail incidents involving hazard class 3 flammable liquids, such as crude oil and ethanol. A key component of this initiative is to learn from past experiences and to leverage the expertise of public safety agencies, rail carriers, and industry subject matter experts in order to prepare first responders to safely manage incidents involving flammable liquid unit trains. These training resources offer a flexible approach to training the first responders and emergency services personnel in pre-incident planning and response. Each module contains a PowerPoint presentation, Student Workbook, and Instructor Lesson Plan. Development and the tools is a collaboration between PHMSA, industry, and Interagency Committee members USCG, EPA, and FEMA/USFA.

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Offshore Facilities and Systems

Effect of H_2S and CO_2 in HP/HT Wells on Tubulars and Cement
Contracting Agency: BSEE
Completed: 2015
This project aimed to improve our understating of the impacts of H_2S and/or CO_2 environment on oil and gas tubulars and cement. Specifically, the goals were to establish how commonly used tubulars and cement are affected by exposure to H_2S and/or CO_2 in HPHT wells, determine the capability of these materials to function properly in harsh downhole environments, and develop and evaluate new cement and specialty steel formulations which are suitable for HPHT sour gas environment to ensure long term integrity of the well.

Ice Scour and Gouging Effects with Respect to Pipeline and Wellhead Placement and Design
Contracting Agency: BSEE
Completed: 2015
The objective of this project was to identify the knowledge gaps in ice scour and gouging effects with respect to pipeline and wellhead placement and design in the Beaufort Sea. The review included, but was not be limited to collected field data, physical testing data and programs conducted to date, and numerical modeling techniques developed.

Physical Oceanographic and Meteorological Data for Beaufort and Chukchi Seas to Support Reliability-Based Design Criteria for Arctic Offshore Oil and Gas Structures
Contracting Agency: BSEE
Completed: 2015
The objective of this project was to produce information that facilitated strict implementation of the ISO J 9906 Standard: Petroleum and Natural Gas Industries - Arctic Offshore Structures. The information gathered under this contract consisted of meteorological and oceanographic information, for US waters in both the Chukchi and Beaufort seas, in a format consistent with the philosophy of the Normative.

High Resolution 3D Laser Imaging for Inspection, Maintenance, Repair, and Operations (09121-3300-06)
Contracting Agency: DOE.
Completed: December 2014
The primary objective of this project was to improve the accuracy and efficiency of the inspection, maintenance, and repair of ultra deepwater assets. 3D at Depth has successfully developed a subsea LiDAR system with performance comparable to its terrestrial counterpart. Through this RPSEA funded project, the team extended the technologies beyond the lab environment, developed a working prototype and now have two commercially available systems called the SL1 and SL2. The project has led to the development of a new industry segment called subsea LiDAR, which has redefined many subsea measurement processes and is rapidly being adopted.

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Ultra-Reliable Deepwater Electrical Power Distribution System and Power Components (08121-2901)
Contracting Agency: DOE
Estimated Completion: 2014
The project goal is to design an electrical power transmission and distribution (T&D) system that will enable subsea oil and gas production for a deepwater field development scenario; it includes designing, building, and qualifying critical components in a system demonstration to advance their Technology Readiness Levels (TRLs). In Phase I, the Modular Stacked Direct Current (MSDC) system will be assessed against existing subsea T&D solutions, and critical building block components to enable the technology will be identified. In Phase II, four components will be designed, developed, and qualification tested using a demonstration system.

Hydrate Modeling & Flow Loop Experiments for Water Continuous and Dispersed Systems (10121-4202-01)
Contracting Agency: DOE
Estimated Completion: October 2015
The project objectives are to: (1) modify the current pressure drop modeling approach to account for a free water phase, (2) perform flow loop experiments to identify and quantify the key parameters affecting pressure drop, (3) incorporate the pressure drop model with the growth rate model in CSMHyK-fw, (4) validate the improved CSMHyK-fw model by predicting flow loop experiments, (5) model development for water+gas and water+gas+oil (continuous and partially dispersed) systems.

Autonomous Underwater Inspection Using a 3D Laser (10121-4903-02)
Contracting Agency: DOE
Completed: November 2014
This project integrated the capabilities of two prior projects to evaluate and characterize the viability of high resolution underwater 3D laser inspection from an autonomous underwater vehicle (AUV) in a local offshore trial. Current ultra-deepwater laser products are not operable from a moving platform and are very short range. This project successfully completed an open water field trial of the prototype.

Corrosion and Scale at Extreme Temperature and Pressure (10121-4204-01)
Contracting Agency: DOE
Estimated Completion: August 2015
A lack of data and models for corrosion, scale, and stress cracking at the extreme temperatures and pressures encountered in ultra-deepwater reservoirs increases the economic and safety risks of offshore production. The objective of this project is to develop the necessary data, models, and experimental tools to assess corrosion, stress cracking, and scale formation at extremes of temperature and pressure encountered in deepwater development. The key overall deliverable will be a detailed technical manual of recommended decision support guidelines based upon extended SAFT/Pitzer models to predict scale and corrosion formation potential in ultra-deep high-pressure -high -temperature wells.

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More Improvements to Deepwater Subsea Measurement (10121-4304-01)
Contracting Agency: DOE
Estimated Completion: December 2015
The objective of the project is to reliably and economically identify and assess flow and well production or well control events and conditions for the purpose of preparing the appropriate response actions. The project puts emphasis on the development of techniques and methods that reduce the risk of uncontrolled fluid emissions from subsea equipment, such as blowout preventers, wellheads and Christmas trees, and risers and flowlines.

All Electric Subsea Autonomous High Integrity Pressure Protection System (HIPPS) Architecture (10121-4306-01)
Contracting Agency: DOE
Estimated Completion: May 2016
The project team will develop an all-electric high-integrity pressure protection system (HIPPS) to enable extraction from high-pressure fields and enable expansion of existing low-pressure subsea networks. Phase I of the development effort will research the state of the industry for HIPPS architecture, component technology, and functional requirements. Phase II will select the key component technology options and mature the system to TRL 2 using proof-of-concept hardware tests. Control hardware and power delivery and storage hardware may achieve technology readiness beyond level 2 with the use of full-scale prototypes in test.

Construction and Testing of Deepwater Permanent Subsea Pressure Compensated Chemical Reservoir (11121-5302-01)
Contracting Agency: DOE
Estimated Completion: September 2016
The project's objective is to develop a functional and qualified subsea chemical storage and injection system design with an effective 3,000+ barrel chemical storage volume. The size of the chemical storage dominates the operational constraints for this system. There are several viable approaches to replenishing the chemistry and installation of the facility. Proven technology with economic factors is expected to dominate the selection of these installation and maintenance approaches as the technology for this objective is matured.

Qualification of Flexible Fiber-Reinforced Pipe for 10,000-foot Water Depths (10121-4402-01)
Contracting Agency: DOE
Estimated Completion: December 2015
The objective of this work is to develop a novel hybrid flexible riser technology by a combination of design, analysis of performance, material and subcomponent testing, and prototype testing. The goal of this project is to develop a novel 7-inch ID hybrid (composite/metal) flexible deep-water pipe technology which meets the following oil and gas industry requirements; 10,000 foot (3,000m) water depth; 12,000 psi capability; 120°C fluid temperature capability; 25 year field life; and sour gas capability.

Vortex Induced Motion Study for Deep Draft Column Stabilized Floaters (11121-5404-03)
Contracting Agency: DOE
Estimated Completion: December 2015
The objective of the study is to improve the overall mooring system safety and riser system integrity by testing design parameters for deep draft column stabilized floaters (DDCSFs) to determine which have the most impact on vortex induced motion (VIM), and which VIM mitigation strategies are preferred for DDCSFs. DDCSFs have excellent applicability to development of challenging reservoirs in deepwater and ultra-deepwater in the Gulf of Mexico. However, increased payload requirements and a general desire to reduce platform motions have resulted in larger platforms with deeper drafts, making them susceptible to VIM. Improved VIM performance has the potential to increase hydrocarbon reserves by making reservoirs more accessible to safe, reliable development.

Low Cost Flexible Production System for Remote Ultra-Deepwater Gulf of Mexico Field Development: Flexible Production Systems for UDW GOM: Concept Development and Comparison of Three Different Solutions (10121-4404-03)
Contracting Agency: DOE
Estimated Completion: January 2016
The objective of this project is to study the feasibility of a circular shaped floating platform unit as compared to two current floating production unit concepts, semi-sub and spars. The floater host will be located in 2,000-3,000 meters of water depth. Production will be gathered via four production risers from two separate drill centers. It is planned that gas will be exported with a gas riser/pipeline. The drill centers will sustain a total of 10 wells. Each well will be connected to wet trees controlled via umbilicals and power cables. Artificial lift supplied by either subsea pumps or downhole electric submersible pumps, is required. Processed oil will be directly offloaded from a single offloading station. It is anticipated that capacity for three additional risers for future improved oil recovery via water injection and/or future tie-ins will be required.

Integrity Management of Risers to Support Deepwater Drilling and Production Operations (11121-5402-01)
Contracting Agency: DOE
Estimated Completion: March 2016
The overall objective of this work is to develop a reliable, cost-effective real-time, riser integrity management system by closing technology gaps that include: availability of historical riser data for assessment of long-term integrity management of deepwater riser systems; on-board subsea equipment controls to detect anomalous behavioral modes and implement mitigation strategies; essential safety management system/software for riser system integrity data storage, riser

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performance and user interface for on-ship and on-shore; and integrated deepwater drilling and production riser integrity management solutions encompassing hardware, software, processes, and people.

Methodology and Algorithm Development for the Evaluation of Ultra-deepwater or Arctic Floating Platform Performance under Hazardous Sea Conditions (12121-6402-01)
Contracting Agency: DOE
Estimated Completion: July 2016
The objective of the project is to improve the overall safety of ultra-deepwater or arctic floating platforms by implementing nonlinear effects in a state of the art software code that could be used by the industry. Better understanding of the effects of nonlinearity on floating platforms through research and development would inherently decrease the risks associated with implementing ultra-deepwater or arctic design projects. The objective will be met through the development of a methodology and associated algorithms for the evaluation of ultra-deepwater floating platform performance under hazardous sea conditions. Numerical tools will be developed and implemented for the computation of ultra-deepwater floating platform performance and safety for the extreme ocean conditions.

Hi-Res Environmental Data for Enhanced UDW Operations Safety (11121-5801-01)
Contracting Agency: DOE
Estimated Completion: September 2016
Ocean currents can pose significant challenges to safe oil and gas operations in the Gulf of Mexico (GoM). One primary objective of this research program is to better understand the physical mechanisms that cause periods of elevated current velocities. Specifically, the passage of Tropical Revolving Storms (TRS) over areas of relatively higher sea surface temperature (e.g., loop current (LC) or associated eddy (LCE)) may cause elevated currents in the boundary layers of the water column. Two in situ current measurement programs will focus on near bottom and near surface boundary layers and compare them to expert 3-D numerical models. The second primary objective of this program is to develop a technique to survey surface currents in real-time over a large horizontal range of at least 300 km per day.

Development of Advanced CFD Tools for the Enhanced Prediction of Explosion Pressure Development and Deflagration Risk on Drilling and Production Facilities (12121-6403-01)
Contracting Agency: DOE
Estimated Completion: September 2016
The objective of the project is to provide oil and gas companies operating in the GOM with the tools necessary to design "inherently safer" offshore facilities that can survive gas explosion incidents and prevent escalation. This project will enhance and validate the capabilities of the industry-standard explosion modeling CFD software, FLACS, to aid in reducing the HS&E-related incidents in the GOM. The project will improve and adapt the capabilities of FLACS to predict MCE early in the design phase of GOM UDW drilling and production facilities and provide the information necessary to design facilities to minimize the consequences of explosion incidents.

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Subsea Produced Water Sensor Development (12121-6301-03)
Contracting Agency: DOE
Estimated Completion: September 2016
The overall objective of this work is to develop and design subsea water quality monitoring sensors to measure the quality of produced water separated at the Sea-floor. The sensors will also offer an improved failsafe system as well as for controls of Subsea production equipment. These sensors will be capable of determining if the level of contamination is below, at, or above the permitted level, and then be able to give signals to shut down operations or to divert all of the production fluids to a topside facility. The project intends to develop Subsea produced water (PW) sensors to Technology Readiness Level (TRL) 3.

Subsea DC Connectors for Environmentally Safe and Reliable Powering of UDW Subsea Processing (12121-6302-01)
Contracting Agency: DOE
Estimated Completion: September 2016
The objective of this project is to assess the risks and close the technology gaps of subsea DC connectors, a critical component to ensure the safe and reliable operation of subsea high voltage direct current (HVDC) transmission and distribution (T&D) systems, which is the emerging technology for environmentally safe and reliable powering of long step-out, ultra-deepwater (UDW) subsea oil and gas processing. The program will demonstrate the HVDC electrical functionality of the connector, and together with the field-proven mechanical design this will retire the key technical risks in order to reach Technology Readiness Level (TRL) 3.

Effects of Fiber Rope-Seabed Contact on Subsequent Rope Integrity (10121-4406-01)
Contracting Agency: DOE
Completed: October 2014
Objectives of this program included (1) developing a fundamental technical understanding of the effects of fiber-rope/seabed contact, whether accidental or planned, to ensure safe production when seabed contact occurs, (2) understanding the primary cyclic-wear process that reduces the strength of fiber ropes so that risks and unsafe conditions can be identified and avoided, and (3) assembling a testing plan and reach agreement between project industry participants and the US regulatory agencies for qualifying polyester mooring ropes for incidental seabed contact and seabed pre-installation. All testing conducted during this program has demonstrated that rope designs with multiple layers of filtering material (as well as one alternative filtering system evaluated) can completely protect mooring ropes from soil ingression. Based on these results, it is concluded that these types of ropes can be dropped to the seafloor without damage.

Ultra-deepwater Dry Tree System for Drilling and Production in the Gulf of Mexico, Phase 2 (10121-4405-02)
Contracting Agency: DOE
Completed: December 2014
The primary objective of this project was to mature two concepts of very large floating systems that are suitable for drilling and production in up to 10,000-foot GOM Ultra-Deepwater using conventional dry trees. This work performed validation and maturation of all safety/environmental critical aspects of the concepts so that each concept is 'project-ready.'

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Development of Carbon Nanotube Composite Cables for Ultra Deepwater Oil and Gas Fields (09121-3300-10)
Contracting Agency: DOE
Completed: May 2014
The purpose of this project was to develop a new technology for electrical power cables, using a composite of carbon nanotubes (CNT) and copper. The primary goal was to build a CNT-copper composite cable with twice the conductivity of an equivalent size pure copper cable. This composite cable should also be lighter and stronger than a comparable copper cable. Experimentally, the project developed an efficient method for dispersing the CNTs in solutions suitable for dip-coating. The solution-coating and wire drawing steps have been shown to produce highly-aligned, dense CNT coatings. The composite wires have resistivities that are close to Cu. The resistivities of the CNT coatings themselves are among the lowest reported to date by any research group world-wide.

Ultra-High Conductivity Umbilicals: Polymer Nanotube Umbilicals (PNUs) (10121-4302-01)
Contracting Agency: DOE
Estimated Completion: 2015
Estimated Completion: November 2015
The next step in this continuation project is to achieve a conductivity capability for subsea umbilicals (10-6 O•cm in a Polymer Nanotube Umbilical (PNU)) that is at least comparable to that of copper, but at a much lower weight. A polymer nanotube-based high conductivity wire for umbilicals, the cables that provide power to satellite wells, will increase the distance that satellite wells can be located away from surface facilities, leading to a reduction in energy requirements and a smaller operations carbon footprint. Ultimately, the reduced size and weight of the umbilicals will result in easier and potentially safer handling of cable during installation. It will also decrease the need to build and use hubs and platforms, since more efficient power transmission will allow for a subsea option as opposed to a platform option in some cases. The successful application of this technology should be able to be extended onshore, resulting in added efficiency and less stress on onshore power grids.

Ultra-Deepwater Riser Concepts for High Motion Vessels (10121-4401-02)
Contracting Agency: DOE.
Estimated Completion: December 2015
Research Objectives: (1) Develop a fundamental technical understanding of the differences between existing riser concepts to the response of high motion vessels, such as semi-submersibles and ship shape floating, production, storage and offloading (FPSO) units. Dynamic analysis will be used to capture riser response to both high and low frequency motions in extreme and fatigue seastates. (2) Develop a better understanding of the limitations of each riser concept and their causes. A risk assessment covering all phases of the riser's life will be key to obtaining this knowledge. (3) Assemble a meaningful testing plan, as agreed to between project industry participants and the U.S. regulatory agencies and carry out the testing within the agreed project schedule.

Gulf 3-D Operational Current Model Pilot Project – Phase I (08121-2801-02)
Contracting Agency: DOE
Completed: June 2014
The objective was to demonstrate a well-validated operational 3D modeling system that produces timely, accurate forecasts, nowcasts, and hindcasts of currents. Two major loop events in the past 1.5

years have been successfully predicted two months in advance. The Model has been running in real-time with minimal interruption since January 2013, producing 60- day forecasts once per week. Standard products (animations/plots) and value added products (RACs, trajectories) are processed and posted to the web automatically.

Effect of Climate Variability and Change in Hurricane Activity in the North Atlantic (10121-4802-01)

Contracting Agency: DOE

Estimated Completion: September 2015

The overall objective of this work is to help provide better planning guidelines to enable improved design of structures and operating procedures that will provide more efficient future oil and gas production and aid in the minimization of environmental and safety risks. The immediate goal of this project is to provide industry with credible projections of future hurricane activity in the Gulf of Mexico together with an assessment of direct impacts on safety, environmental risk and production.

Synthetic Hurricane Risk Model for Gulf of Mexico (10121-4801-01)

Contracting Agency: DOE

Estimated Completion: December 2015

The objective of this project is to develop of a synthetic track model and hurricane track database (both synthetic 100,000 years, and historical ~110 years). The research efforts from this project will produce a state of the art synthetic Gulf of Mexico hurricane model to evaluate hurricane risk to offshore and coastal locations for current and future climate scenarios. Improving the ability to accurately model and understand the hurricane hazards resulting from high wind and wave conditions will in turn result in safer designs for offshore structures, minimizing the risk of infrastructure and personnel loss.

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Waterways Management

Project Title: Automatic Identification System (AIS) Transmit Capability
Contracting Agency: USCG/RDC/USACE
Estimated Completion/Completed: June 2015
This project explored the transmit capability of the AIS system to determine requirements and potential types of information that could be sent for both government and commercial users. Messages include specific warnings about hazards or other safety issues, such as weather. A test bed in Louisville evaluated process and procedures.
Another related project focused on the requirements specifically for the USACE for use in lock operations. The results of these efforts are being used by the Western Rivers project described below.

Project Title: Western Rivers e-AtoN Technology Demonstration
Contracting Agency: USCG/RDC/USACE
Estimated Completion/Completed: May 2017
This project is designed to demonstrate benefits and demands posed by e-Navigation (e-NAV) technology to inform maritime security, safety, and mobility requirements in the Western Rivers. It will inform USCG requirements to successfully operate an e-NAV system that includes the distribution of navigation, safety, and environmental information to users via the AIS. The test bed (both shoreside and potential users) has been expanded to address the employment of electronic Aids to Navigation (e-AtoN), use of electronic Maritime Safety Information (e-MSI) to distribute critical marine information, and the implementation of e-Navigation Management.

Project Title: Next Generation Arctic Navigational Safety Information System
Contracting Agency: USCG/RDC
Estimated Completion/Completed: January 2018
Reliable navigation information is not easily found in the Arctic. In addition, conditions can change quickly putting vessels and personnel into peril. This project is partnering with the Marine Exchange Alaska (MXAK) that already has a string of AIS systems along the coast. The objective of this project is to develop the Arctic Navigation Safety Information System (ANSIS) that builds on the messaging system identified in the previous projects to demonstrate expanded use of AIS transmit capability in Alaska. Basic messages were transmitted line-of-sight starting in 2015 with methods for longer distances being investigated.

Vessel Design

SSC SR-1461: Strength and Fatigue Testing of Composite Patches for Ship Plating Fracture Repair
Contracting Agency: USCG/Ship Structure Committee
Estimated Completion: 2014
This project will explore and experimentally validate the use of composite patches for preventing crack growth and extending the lifetime of aluminum and steel ship structures.

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SSC SR-1469: Improving Decisions About Ship Structural Fatigue Performance and Construction Quality
Contracting Agency: USCG/Ship Structure Committee
Estimated Completion: 2015
Provide easy-to-use guidance, tools and training for use by ship surveyors, owners and government officials to make better, more-informed decisions about ship structural workmanship requirements, structural fatigue design performance and vessel service life.

SSC SR-1473: Survivability of Hull Girder in a Damaged Condition
Contracting Agency: MARAD/Ship Structure Committee
Completion: 2015
The objective of this project is to systematically study the effect of various types of structural damage on the hull girder ultimate strength using state of the art nonlinear finite element analysis techniques as well as to identify the most suitable modeling techniques. The results of this study will aid in rapid hull girder residual strength evaluations following an accident, and for improving the criteria for ship residual strength requirements.

Ultimate Strength of Ice Class Ship Structures in Intact and Damaged Conditions
Contracting Agency: USCG/Ship Structure Committee
Estimated Completion: 2015
The objective of this research project is to improve the ability to estimate the residual strength of ship structures operating in low temperatures and in ice-covered waters that have sustained damage. Damage sustained by ships in these conditions will necessarily impair to some degree the ultimate strength of the ship structure. The purpose of this study is to quantify, to the degree possible, the loss of strength of the structures as a result of in-service damages (e.g., local denting) and accidental damages (e.g., resulting from collision or grounding), taking into account the effect of low temperatures. The study includes a literature review on structural failures for ships operating in the Arctic Ocean and the effects of cold temperatures on ship materials and structures. A hypothetical ice-class tanker will be used as the basis for structural material modeling, ultimate panel strength analysis, and ultimate strength panel model tests.

Drilling

Effects of H_2S and CO_2 in High Pressure High Temperature (HPHT) Wells on Tubulars and Cement
Contracting Agency: BSEE
Estimated Completion: 2014
This project is aimed at improving our understating of the impacts of H_2S and CO_2 on oil and gas tubulars, cement, and commonly used materials in HPHT wells. It will determine the capability of these materials to function properly in harsh downhole environments while attempting to develop new cement formulations which are suitable for a HPHT sour gas environment and provide recommendations and guidelines to ensure long term integrity of the well.

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Low Temperature Effects on Drilling Equipment
Contracting Agency: BSEE
Completed: 2015
The selection and effective qualification of new and existing materials, fluids and drilling methodologies commonly used in the Gulf of Mexico and the North Sea was reevaluated to take into consideration the 'cycles' in the temperature and extreme conditions in the arctic.

Evaluation of Automated Well Safety
Contracting Agency: BSEE
Estimated Completion: 2015
This study is to identify automated well safety technologies with the potential to increase safety during Outer Continental Shelf (OCS) drilling, well completion, well work over and production operations, as well as to assess early well kick detection approaches, equipment, techniques, and systems associated with drilling operations in the OCS.

Well Stimulation Effects on Annular Seal
Contracting Agency: BSEE
Estimated Completion: 2015
This proposed research will address the issue of OCS stimulation operations and cement/casing integrity. The proposed work fully covers the issue from fundamental research, to engineering, to field application. Strong emphasis is placed on regulation and control of well construction and stimulation processes as well as the impact of new or additional regulation on safety and environmental protection. Operational difficulties of new regulation will be identified along with methods to mitigate operational or enforcement concerns. In addition to current stimulation techniques and regulations, future industry trends and technology in these areas along with their corresponding effect on safety and regulation also will be considered. The objective of this proposal is to evaluate technological and safety aspects of well stimulation techniques in the OCS.

Real Time Data Monitoring
Contracting Agency: BSEE
Completed: February 2014
An independent assessment of the various types of real-time data monitoring systems available for offshore oil and gas operations was conducted. The assessment focused on drilling and production technologies and included a cost benefit analysis that would detail potential costs to industry, potential increases in safety performance, government resources needed for implementation, and necessary training for all parties involved. The assessment identified what automation systems are available or being developed, the potential they have to increase offshore drilling safety, and any negative impacts they have on operations.

Assessment of Blowout Preventer (BOP) Stack Sequencing, Monitoring and Kick Detection Technologies
Contracting Agency: BSEE
Completed: January 23, 2014
The key objectives of the project were to assess the potential for a new design of blind shear rams and BOP stack configurations to enable the reduction of the potential for unsupported pipe in the BOP bore and increase the possibility that pipe shear will be successful. Also, it evaluated new design methods for detecting failure and monitoring of BOP components and control

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systems using the latest technology in order to prevent failure, explore the reliability of an independent complete acoustic package for functioning a short BOP deployed in deep water, and identify and assess equipment and technologies capable of and/or design to detect kicks.

Reliability of Annular Pressure Buildup (APB) Mitigation Technologies (12121-6502-01)
Contracting Agency: DOE
Estimated Completion: December 2015
This project will analyze APB mitigation technologies. Moreover, it will provide industry with a stochastic tool for analysis, comparison, and choice of possible APB mitigation techniques applicable to an operator's well and field situation. APB occurs in all wells with high bottom-hole temperature, multiple casing strings and annuli that cannot be vented --- which includes most deepwater Gulf of Mexico wells. APB can result in casing string and premature well failure, unless a well is properly designed, APB risks are fully assessed for all load cases, and any necessary APB mitigation methods are evaluated, fully analyzed for effectiveness, and properly implemented.

Intelligent BOP RAM Actuation Sensor System (11121-5503-01)
Contracting Agency: DOE
Estimated Completion: July 2016
The objective of this work is to design and develop an instrumented BOP ram prototype and laboratory testing. The technology development will be conducted in five stage gates within two phases. A system feasibility determination, gaps analysis, and a risk assessment will be conducted, followed by technology selection (TRL0).Instrumentation will be conceptualized and reviewed (TRL1), designed (TRL2), a prototype will be constructed and bench scale tested (TRL3-4), followed by review with BSEE and API, and development of a commercialization plan.

A 1,000 level Drill Pipe Deployed Fiber Optic 3C Receiver Array for Deep Boreholes (09121-3700-02)
Contracting Agency: DOE
Completed: February 2014
The objectives of this project were to design a drill pipe deployed 3C borehole seismic array that is capable of deploying 1,000 3C sensors, i.e., 3,000 channels, using novel broad band fiber optic geophones that can be deployed to at least 200ºC (392ºF) and 30,000 psig to a drilled depth of 30,000 feet. The deployment system based on small diameter drill pipe was designed and the prototypes were manufactured and tested for load bearing capabilities. This project demonstrated reception of useable signals up to 1500 Hz using next generation fiber optic sensors as compared to less than 100 Hz for conventional state-of-art receivers. In the sediments tested, this represents a resolution improvement from 100 feet vertical resolution to less than 2 feet. The project confirmed that the drill pipe based deployment system can be built to support a 30,000 foot long borehole seismic system.

Ultra Deepwater Resources to Reserves Development and Acceleration through Appraisal (08121-2701-03)
Contracting Agency: DOE
Completed: May 31, 2014

The objective of the project was to develop techniques to assess the connectivity characteristics of deepwater sediments based on analysis of reservoir analogs, reservoir databases, and a reservoir model for a mature reservoir. This project developed a new geological modeling framework based on multiple-point geostatistics and formulated a novel multiple point proxy function that represents the well test response in terms of the flow connectivity. The methods and techniques developed in this research were applied on the data for the Ewing block of the Lobster field. The addition of higher order terms to the proxy expression for a well test allows us to detect important permeability features such as transition between rock types by analyzing the well test profile.

Pressure Prediction and Hazard Avoidance through Improve Seismic Imaging (12121-6002-02)
Contracting Agency: DOE
Estimated Completion: September 2016
The primary objectives of the defined research are (1) to deliver a benchmark simulated seismic dataset that will be used by industry and academic research institutes to investigate improved approaches for prediction of deep over-pressured reservoirs, and (2) to reduce drilling risk – both safety and environmental – through improved pre-drill pressure prediction methodologies that are derived from iterative interpretations of the simulated dataset. The benchmark simulated seismic dataset will be acquired over a model that is representative of the challenges facing those who do pore pressure prediction using seismic data collected in the U.S. Gulf of Mexico. The model will be constructed to contain physically realistic pore pressure scenarios and in a manner that allows acquisition of realistic seismic data using numerical wave-field simulation over the model.

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Intelligent Casing - Intelligent Formation Telemetry (ICIFT) System (10121-4504-01)
Contracting Agency: DOE
Completed: December 2014
The Intelligent Casing-Intelligent Formation Telemetry (ICIFT) system was developed in this project to enhance well control capabilities during cementing and completions operations by providing measurements from the external part of the production casing. The ICIFT system effectively places and isolates the casing without damaging the instrumentation. Efforts in this project included an extensive literature survey and background studies, review and evaluation of borehole telemetry systems, and design, development, and testing of the telemetry system's component prototypes.

Deepwater Reverse-Circulation Primary Cementing (10121-4502-01)
Contracting Agency: DOE
Completed: June 2014
The primary objective of this project was to assess the applicability of Reverse-Circulation Primary Cementing (RCPC) techniques to deepwater wells. With conventional primary cementing fluids are pumped down the casing and then up into the annulus; while with RCPC, the fluids are pumped down through the annulus and up into the casing shoe. Using RCPC greatly reduces the bottom-hole circulating pressure of the fluids compared to conventional cementing. One major challenge in deepwater cementing is the narrow formation fracture gradient, so the application of RCPC has clear beneficial potential. The scope of work included analysis of the RCPC cementing method, preparation of a development path for technology required to apply RCPC to deepwater wells, and creation of preliminary operational procedures with associated contingency plans. The project resulted in development of a finite-element software package which was used to develop a robust model capable of handling deepwater RCPC. The project also conducted laboratory intermixing studies to determine that rheology is a key parameter in fluid design and placement. Finally, key mechanical components required for deepwater RCPC were analyzed to determine state-of-the-art and future performance requirements.

Coil Tubing Drilling and Intervention System Using Cost Effective Vessel (10121-4505-01)
Contracting Agency: DOE
Completed: August 2014
The primary objective of this project was to advance the work previously done with industry funding by performing an offshore demonstration of a cost-effective Coil Tubing (CT) system for down-hole work in deepwater Gulf of Mexico satellite wells, without the need for a Mobile Offshore Drilling Unit (MODU). This project developed a design for a SSR and supporting equipment suitable for a cost effective vessel to do coiled tubing intervention in ultra-deepwater. The riser enables a full performance envelope of coiled tubing abilities. A successful field test on a deepwater satellite well will prove that a small vessel can operate coiled tubing through an SSR in deepwater, demonstrate improved safety and environmental protection, and incur a cost less than half that of a MODU.

Smart Cementing Materials and Drilling Muds for Real Time Monitoring of Deepwater Wellbore Enhancement (10121-4501-01)
Contracting Agency: DOE
Estimated Completion: August 2016

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The objective in this project is to enhance the sensing properties of the drilling mud and cementing slurry, so that it can be used for real time monitoring during installation and the entire service life of the deepwater well by incorporating new technologies in the areas of materials and monitoring. Incorporation of new additives to the cementing slurry will make it piezoresistive (change in electrical resistivity with stress, strain, temperature and chemical reactions) from the time of mixing the drilling mud and cement slurry through the entire service life of the hardened cementing material. Advances in materials and grouting technologies will be combined with advancement in surfactant technology to produce drilling mud and cementing materials with enhanced sensing capabilities. With the sensing capabilities installed in the drilling mud and cementing slurry, it will also be possible to monitor the advancement of the drilling mud and cementing slurry front around the casing during the construction phase.

Development of Best Practices and Risk Mitigation Measures for Deepwater Cementing in Oil Based Mud (OBM) and Synthetic Based Mud (SBM) (12121-6503-01)
Contracting Agency: DOE
Estimated Completion: September 2016
The objectives of this project are to develop fundamental knowledge of mud-cement compatibility issues related specifically to deepwater cementing, to quantify risks associated with cementing in OBM/SBM and to develop best practices and derive recommendations in order to reduce the recognized risks. This study will analyze the relationship between temperature, pressure, cement bond, degree of mud removal and its effect on zonal isolation in complex well architecture. Fluids under laboratory investigation will include typical commercially available designs of cement slurries, SBM, OBM, and spacers with a focus on micro-particulate fluids and other new technologies. Environmental benefits of a successful project include a decrease in contamination, the formation of channels, and improved bonding of cement. Long-term wellbore integrity will be improved and environmental and safety issues such as leaks from the formation

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and Sustained Casing Pressure (SCP) will be mitigated. The enhanced integrity of the cement will not only save operators from costly remedial work and additional rig time, but also increase productivity as well as reduce environmental and safety risks.

Onshore Drilling:

Coupled Flow- Geomechanical- Geophysical –Geochemical Analysis of Tight Gas Production (08122-45)
Lead Performer: DOE
Completed: March 2014
This study's objective was to provide new knowledge for application by the oil and gas industry, including how to design optimized production systems, the underlying relationship between changes in the pressure regime and the geomechanical status of a tight gas system, the long-term behavior of the induced and natural fracture systems and the effect on production, and the possible geophysical markers that can track the evolution of the flow properties and fracture characteristics of the reservoir. The key deliverable was monitoring during production, well stimulation designs, and improved pressure/production curves.

Improved Drilling and Fracturing Fluids for Shale Gas Reservoirs (09122-41)
Lead Performer: DOE
Completed: June 2014
The primary objective of the defined research was a reduction in the cost and environmental footprint of drilling and fracturing that will lead to a significant expansion of shale gas development. This project aims at developing materials and methods for substantially reducing drilling and completion costs and maximizing gas well productivities in shale gas reservoirs. The key deliverables were novel drilling and fracturing fluids for water-sensitive shales, fluorocarbon additives, and data.

Simulation of Shale Gas Reservoirs Incorporating Appropriate Pore Geometry, Capillarity, and Fluid Transport (09122-11)
Lead Performer: DOE
Completed: August 2014
The objective was to develop the algorithms necessary to implement the correct physical principles and pore geometries in a shale gas simulator by modifying current commercial simulators by substitution of new modules containing more appropriate approximations of pore geometries. The key deliverables were algorithms for commercial exploration and production simulators.

Field Demonstration of Eco-Friendly Creation of Propped Hydraulic Fractures (11123-23)
Lead Performer: DOE
Completed: October 2014
The overall objective of this research was to develop and demonstrate a biodegradable polymer for delivering proppant during hydraulic fracturing. The key deliverables were development of a hydraulic fracturing treatment method that employs a biodegradable polymer for transporting proppant, requires less horsepower, is simpler to execute, has a smaller footprint, and requires less water.

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Zonal Isolation Improvements for Horizontal Wells Drilled in the Marcellus and Haynesville Shales (10122-19)
Lead Performer: DOE
Completed: October 2014
The objective of this project was to undertake a comprehensive study of the cementing process applied to horizontal wells drilled in the Marcellus Shale play along with the effects of zonal isolation problems on safety and environmental issues. Currently, a major challenge in the Marcellus Shale is maintaining proper zonal isolation from the time cement is placed, through completions. This study will focus on using zonal isolation improvements to lower the cost of drilling, improve operational safety, and reduce overall environmental impact.

Gas Well Pressure Drop Prediction under Foam Flow Conditions (09122-01)
Lead Performer: DOE
Completed: December 2014
This research addresses the issue of foam application for gas wells. The goal of this research was to develop better correlations for calculating pressure drop under foam flow conditions, in addition to developing recommendations for using foam and its operational constraints. The key deliverable was correlations to calculate the pressure drop in vertical gas wells.

Annular Isolation in Shale Gas Wells: Prevention and Remediation of Sustained Casing Pressure and other Isolation Breaches (11122-42)
Lead Performer: DOE
Estimated Completion: May 2015
The objectives of this project are to develop techniques to mitigate risk to groundwater resources associated with shale gas development, to remediate failed annular seal to stop communication in an existing well, to improve techniques that enhance lifelong wellbore annular isolation during the wellbore construction process, and to prevent potential annular seal failure which can cause sustained casing pressure (SCP) later in the well life. The application of this project will illustrate positive value and acceptable risk of the gas shut-off and prevention concepts. The success of the field trials will drive the technology transfer of this developed concept to shale gas driller cross the U. S. as well as other unconventional plays employing factory drilling methods for wells with high potential of SCP. In general, the issue of sustained SCP as it relates to horizontal shale wells will be researched.

Well integrity monitoring using Nanite™ (FE00014144)
Lead Performer: DOE
Estimated Completion: September 2016
The project goal is to demonstrate how real-time sensing of Nanite™ can improve long-term wellbore integrity and zonal isolation in shale gas and applicable oil and gas operations. Nanite is a cementitious material that contains a proprietary formulation of functionalized nanomaterial additive to transform conventional cement into a smart material responsive to pressure (or stress), temperature, and any intrinsic changes in composition. Nanite's electrical, radiometric, and acoustic properties; improved chemical and physical properties; and durability have the potential to ensure long-term wellbore integrity and zonal isolation.

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nXis tool for interrogating well integrity in zones with multiple strings of casing (FE0024293)
Lead Performer: DOE
Estimated Completion: September 2017
The goal of this project is to develop a novel well-integrity inspection system capable of providing enhanced information about the flaw structure and topology of conventional and unconventional gas-filled wells. This will be achieved by developing a novel combined X-ray/neutron backscatter imaging device, suitably sized for operation in well bores.

Well integrity via MICP (FE0024296)
Lead Performer: DOE
Estimated Completion: September 2017
This project is aimed at develop improved methods at improving and testing the viability of Microbial-Induced Calcite Precipitation (MICP) process for sealing compromised wellbore cement in leaking natural gas and oil wells, thereby reducing the risk of unwanted upward gas migration. Integrated laboratory testing, simulation modeling, and field testing will be conducted to achieve this goal.

Utica Shale Energy and Environmental Laboratory
Lead Performer: DOE
Estimated Completion Date: September 2018
The goal of this project is to develop and maintain a field research facility in the heart of the Utica Shale play that will provide a platform for environmental and geotechnical studies before, during, and after unconventional oil and gas (UOG) development. The Ohio State University-led Team will: (1) identify and implement best practices that enhance long-term borehole integrity and assure the isolation of production zones from overlying sources of drinking water; (2) characterize the petrophysical, geological, geochemical, and microbiological conditions of reservoir rock and seals before, during, and after reservoir stimulation; (3) provide a site that will accommodate other projects and programs for improved characterization of reservoir conditions, fracture development and propagation, fluid emplacement, reservoir response, and stimulate rock volume; (4) conduct baseline and real-time monitoring of the environmental impact on land, air, water, and communities as well as demonstrating mitigation technologies; and (5) demonstrate as feasible the effectiveness of emerging environmental impact-mitigation technologies that have been developed with DOE support.

Subsurface Gas and Fluid Migration Assessment
Lead Performer: DOE
Estimated Completion: Ongoing
This project is aimed at improving understanding of the density and distribution of legacy wells located within the Appalachian Basin that could serve as conduits for gas or fluid migration into shallow systems. The outcome is expected to be an identification of an appropriate seal leakage model that represents potential gas or fluid leakage from shale gas reservoirs into shallow systems.

Effects of Well Activities on Shallow Gas Migration
Lead Performer: DOE
Estimated Completion: Ongoing
This project involves a field study to investigate the potential for gas well drilling in the Marcellus Shale to mobilize groundwater and stray methane gas in nearby water wells as the borehole penetrates shallow groundwater aquifers. This should produce data from baseline

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groundwater analysis, water levels in observation wells, and hydraulic head monitoring at gas wells will be used to evaluate the potential for methane migration in shallow groundwater.

Effects of Gas Flow on Well Cementing (EPAct Complementary Program)

Lead Performer: DOE
Estimated Completion: Ongoing
The project goal is to evaluate potential for regional gas flow from shallow gas formations into the wellbore environment during drilling and/or completion, and the effects of shallow gas on hydration of wellbore cements (focus on Appalachian Basin). The key outcome will be data sets that quantify how the presence of shallow gas affects the integrity of wellbore cement during *in situ* hydration.

Pipeline Systems

Slug Loading and Response in Pipeline (SLARP) JIP
Contracting Agency: BSEE
Completed: 2014
This research was to investigate and conclude current state of industry practice and technology gaps with respect to evaluating slugging effects on pipeline, spools and riser, to investigate alternative methodologies analysis methods for defining slug and turbulence loading and assessing structural response in pipeline and spool and riser, to develop best practices guideline for modeling and analysis of slug and turbulence loading and response of pipeline, spool and risers.

SAFEBUCK Phase III & SAFEBUCK GEO Joint Industry Project (JIP)
Contracting Agency: BSEE
Estimated Completion: December 2014
This project sets out to increase knowledge, and thereby reduce conservatisms, associated with the design process and related limit states of deepwater pipeline design. Key areas of work include undertaking structural reliability analysis to confirm that the SAFEBUCK Design Guideline methodology ensures that the pipeline failure probabilities are consistent with industry targets; the collection of data on operating pipelines to generate lessons for future design by sharing the combined knowledge of lessons learned from recent projects; and the development of a new 'force-resultant plasticity model' to run inside standard software packages, capturing experience from modeling and testing lateral pipe-soil interaction.

Slug Loading & Response in Pipelines, Risers and Jumpers (SLARP) Joint Industry Project (JIP)
Contracting Agency: BSEE
Completed: December 2013
The goal of this JIP was to investigate and conclude the current state of industry practice and technology gaps with respect to evaluating slugging effects on pipeline, spools and riser; to investigate alternative methodologies analysis methods for defining slug and turbulence loading and assessing structural response in pipeline, spool, and riser; and to develop a best practices guideline for modeling and analysis of slug and turbulence loading and response of pipeline, spool, and risers.

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Comprehensive Study to Understand Longitudinal Electrical resistance Weld (ERW) Seam Failures
Contracting Agency: PHMSA, Battelle Memorial Institute
Estimated Completion: 2015
The objective of the proposed project is to assist PHMSA in favorably closing NTSB Recommendation P-09-1 arising from the Carmichael Mississippi pipeline rupture involving an ERW seam, which directed that PHMSA conduct a comprehensive study of ERW pipe properties and the means to assure that they do not fail in service. The proposed work is anticipated to validate that periodic use of the current ERW seam integrity assessment methods (hydrostatic testing and in-line inspection using a crack-detection tool) are the best means to prevent ERW seam ruptures.

The work will address the characteristics of ERW seams that make them susceptible to failure, and it will identify the factors the pipeline operators must consider in order to assure that their ERW pipelines are safe. The scope was expanded in FY12 and FY13 to address broader seam weld challenges beyond just low frequency EWR pipelines and to address a review of the effectiveness of technology used to detect defects in seams. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=390.

Meandering Winding Magnetometer (MWM)-Array Characterization of Mechanical Damage and Corrosion
Contracting Agency: PHMSA, JENTEK Sensors Inc.
Completed: 2014
This project will advance the JENTEK MWM-Array technology to provide quantitative characterization of corrosion and mechanical damage. This includes characterization through coatings/insulation; followed by higher resolution imaging with coatings/insulation removed. For mechanical damage, quantitative characterization includes geometric variations and multidirectional residual stresses (near the surface and deeper within the pipeline).
This project will develop capability to detect cracks at damage sites. For corrosion, enhanced high resolution imaging of both external and internal corrosion will be developed for specific applications to support life management decisions. This team will build on demonstrated MWM-Array (and MR-MWM-Array) detection capabilities to deliver substantially enhanced characterization of damage and practical means for implementation. Project reporting is publicly available at:http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=354.

Fuelfinder: Remote Leak Detector for Liquid Hydrocarbons
Contracting Agency: PHMSA, Physical Sciences Inc.
Completed: December 31, 2013
The project goal was to develop a commercially successful Remote Methane Leak Detector platform to a general purpose hydrocarbon leak detector – Fuelfinder™. Fuelfinder will adopt recent advances in room-temperature diode laser technology operating near 3 microns to enable remote sensing of gasoline, petrochemicals, biodiesel, and ethanol leaks from pipelines with man-portable, mobile, and airborne platforms in a low-cost, commercially-viable product offering. Project reporting is publicly available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=362.

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Advanced Learning Algorithms for the Proactive Infrasonic Gas Pipeline Evaluation Network (PIGPEN) Pipeline Encroachment Warning System
Contracting Agency: PHMSA, Physical Sciences Inc.
Completed: June 30, 2014
Physical Sciences Inc., with American Innovations Ltd. and NYSEARCH, are addressing the technology gap of Early Warning Damage Prevention Monitoring Systems, specifically Advanced Development of Algorithms for Detecting Digging Threats and Avoiding Alarms. This research will implement and evaluate self-training algorithms in the Proactive Infrasonic Gas Pipeline Evaluation Network (PIGPEN) autonomous distributed seismic sensor system.

PIGPEN provides real-time warning of unauthorized right-of-way encroachment and excavation activity near a pipeline. Early warning enables a response to the potential intrusion in time to prevent pipeline damage, and thus preclude the additional cost and risk of repairs. The ideal PIGPEN alarm system would activate an intruder notification with 100% reliability and no alarms. The project will enhance reliability by enabling PIGPEN to learn the characteristics of its local environment and optimize its intruder detection algorithms based on learned experience. Field tests are expected to demonstrate better than 97% alarm reliability with few alarms. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=366.

A Quantitative Non-destructive Residual Stress Assessment Tool for Pipelines
Contracting Agency: PHMSA, Generation 2 Materials Technology LLC
Completed: 2014
Mechanical damage, including dents, bends, wrinkles, and other forms, is one of the leading causes of pipeline failures. Mechanically damaged regions act as fatigue crack initiation sites under cyclic loading (present for in-service pipelines). Crack initiation is the first stage of the appearance of fatigue cracking, which becomes much easier to initiate in the presence of damage because of the locally enhanced strain/stress field around the flaw. The damage and residual stresses lower the overall fatigue strength of the steel and its weldments. The size and shape of the flaw actually determines the level of stress necessary for crack initiation and propagation. This research will develop technology for detecting the limits of critical damage severity is essential to mitigating crack initiation and, therefore, mitigating fast crack propagation before failure. Project reporting is publicly available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=441.

Consolidated Project Full Scale Testing of Interactive Features for Improved Models
Contracting Agency: PHMSA, Electricore, Inc.
Estimated Completion: 2017
This project, which began in FY 2014, is addressing pipeline crack growth as influenced by complex operational circumstances. Full scale testing, is gathering data on mechanical damage interacting with secondary features – gouges (with cracks and micro-cracks), corrosion, and welds. The primary objectives of the project are to strengthen industry consensus standards and to generate data which will promote new knowledge. Project reporting is publicly available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=555

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Improving Models to Consider Complex Loadings, Operational Considerations, and Interactive Threats
Contracting Agency: PHMSA, Kiefner Applus RTD
Estimated Completion: 2017
This project will be guidance in the form of decision processes and data needs for identifying and evaluating complex and/or interactive situations. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=557

Threat/Anomaly Mitigation Decision-Making Process
Contracting Agency: PHMSA, Kiefner Applus RTD
Estimated Completion: 2015
The objective of the project is to strengthen related pipeline industry consensus standards by providing enhanced guidance for conducting the technical aspects of a pipeline integrity management program. The work builds on the existing technology for defect assessment. Project reporting is publicly available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=558

Repair/Replacement Considerations for Pre-Regulation Pipe
Contracting Agency: PHMSA, Kiefner Applus RTD
Estimated Completion: Completed - 2015
This project created guidelines for implementing and executing a pre-regulation pipeline repair/replace program. The guidelines are tailored not only to natural gas transmission pipelines but to the special concerns associated with natural gas distribution pipelines and hazardous liquid pipelines as well. Project reporting is publicly available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=559

Definition of Geotechnical and Operational Load Effects on Pipeline Anomalies
Contracting Agency: PHMSA, BMT Fleet Technology Limited
Estimated Completion: 2016
The objective of this project is to use the previously validated pipe soil interaction model to develop an engineering tool to define the effects of operational and geotechnical loads on liquid and gas pipeline systems to support decision making regarding threat severity or repair scheduling. This tool would be incorporated in strain based design and assessment to facilitate the consideration of complex loading scenarios inducing significant flexural loads, including pipeline subsidence or lowering, and ground movements inducing lateral pipeline movements. Project reporting is publicly available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=561

Pipeline Damage Prevention Radar
Contracting Agency: PHMSA, Ball Aerospace & Technologies Corp.
Estimated Completion: 2016
This project will conduct a proof of concept demonstration of airborne Synthetic Aperture Radar (SAR) is proposed to reliably detect excavation damage threats in areas where the pipeline routes may be obscured by dense brush, forest canopy, low cloud cover, smoke, fog, haze, precipitation or low light conditions. SAR is widely used by the DoD for threat detection. Pipeline damage prevention offers a new application where SAR reduces false positives, lessens repeat flight passes and reduces weather related aircraft downtime resulting in operations cost savings. Project reporting is publicly available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=652

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Combined Vibration, Ground Movement, and Pipe Current Detector
Contracting Agency: PHMSA, Operations Technology Development NFP
Estimated Completion: 2018
This project will use a suite of sensors to monitor pipelines and determine if there is unauthorized activity within the right of way. The sensors are discrete point types that can be installed in a small excavation. A vibration sensor and a current sense wire are attached directly to the pipe; a motion sensor is placed in the soil close by. The coincidence of events seen by these devices will help discriminate false positives. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=655

Framework for Verifying and Validating the Performance and Viability of Leak Detection Systems for Liquid and Natural Gas Pipelines
Contracting Agency: PHMSA, C-FER Technologies
Estimated Completion: 2017
This project will develop a Leak Detection Evaluation Framework for verifying and validating leak detection technologies. The framework will include standardized methods to assess the performance of technologies intended to detect small release events (i.e. leaks) and quantitative criteria to rank the performance of these systems over a range of release scenarios. The intent is to identify technologies that would be appropriate for field pilots but will not cover the processes required for the field pilot or operational implementation as these processes are well established in each operating company. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=657

Development of Comprehensive Pressure Test Design Guidelines
Contracting Agency: PHMSA, Kiefner Applus RTD
Estimated Completion: 2017
The project will develop comprehensive guidelines for the design of pressure tests that could be incorporated into industry standards or regulations. The proposed work will draw heavily on industry experience and scientific knowledge from prior research. The guidelines will assure as much as possible that pressure testing is carried out safely and effectively, that testing is performed to a consistent standard of quality, and that all stakeholders can have confidence in the safety of the tested pipeline. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=645

Use of Electromagnetic Sensors to Quantify Strength and Toughness in Steel Pipelines In and Out Of Service
Contracting Agency: PHMSA, Generation 2 Materials Technology LLC.
Estimated Completion: 2017
The project will produce a new nondestructive electromagnetic sensor for assessment of bulk strength and toughness of new and vintage steel pipelines operating in any environment. The strength and toughness of the steel pipelines determined from the electromagnetic system will be linked with other inspection and materials characterization testing to provide improved Integrity Management. At the end of the two-year program, the electromagnetic system will be appropriately commercialized and ready for inspectors to begin offering services to the industry. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=649

Approaches for Preventing Catastrophic Events
Contracting Agency: PHMSA, Gas Technology Institute
Estimated Completion: 2016
The project will present a thorough and critical review of approaches for preventing catastrophic events, both within and outside the natural gas industry, in order to be able to select the most appropriate approach(es) and model(s), develop them further, and ultimately issue guidelines for effective implementation in risk models and integrity management programs. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=638

Paper Study on Risk Tolerance
Contracting Agency: PHMSA, Kiefner Applus RTD
Estimated Completion: 2016
The project will conduct an initial literature search to understand what other regulatory bodies and industries have done to define risk criteria. This information will be supplemented with data gathered from a survey of pipeline industry members about their risk management decision-making process. Together, these activities will identify methods for defining risk criteria and highlighting best practices across the pipeline industry. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=639

Critical Review of Candidate Pipeline Risk Models
Contracting Agency: PHMSA, C-FER Technologies
Estimated Completion: 2016
The project will produce guidelines for developing the next generation of pipeline risk models based on the probabilistic quantitative risk analysis approach. The model development framework will be based on the following:
- A critical review of existing quantitative risk models both in the pipeline and other industries.
- An assessment of the desirable model attributes related to accuracy, verifiability, transparency, practicality and fit within the decision making processes used by both operators and regulators.

Project reporting is publicly available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=656

Patch and Full-Encirclement Repairs for Through-Wall Defects
Contracting Agency: PHMSA, University of Tulsa
Estimated Completion: 2016
CAAP Project: This project will investigate the effectiveness of patch-style bonded composite repairs of through-wall corrosion defects. Composite repairs of pipeline and pressure equipment are a growing segment of the corrosion mitigation industry and have seen large expansions since the introduction of the technique in the early 1990's. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=564

Wall Break-Through in Composite Repaired Defects
Contracting Agency: PHMSA, University of Tulsa
Estimated Completion: 2016
CAAP Project: This project will study the performance of composite repairs applied over realistic defects. Unique facilities for the investigation of erosion/corrosion at The University of Tulsa will be used to generate internal defects on pipe elbows. These defects will be repaired and then hydrostatically tested to determine failure pressure. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=565

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Improved Coatings for Pipelines
Contracting Agency: PHMSA, Texas A&M University
Estimated Completion: 2015
CAAP Project: The research program focuses on using a novel epoxy nanocomposites spray coating technology to prevent corrosion of steel pipelines. A battery of tests will be conducted through collaboration with our industrial partners on test panels: adhesion, water permeability, electrical impedance, scratch resistance, ductility, and accelerated corrosion tests. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=568

Robust Anomaly Matching for ICIPs: Reducing Pipeline Assessment Uncertainty Through 4-Dimension Anomaly Detection and Characterization
Contracting Agency: PHMSA, Colorado School of Mines
Estimated Completion: 2016
CAAP Project: This work will focus on supporting the unique anomaly matching requirements of Integrated Internal Inspection and Cleaning Pigs (ICIPs). The goal is to develop a novel technique for automatic anomaly matching to optimize the accuracy and data processing capabilities of a developed algorithm. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=569

Laser Peening for Preventing Pipe Corrosion and Failure
Contracting Agency: PHMSA, Board of Regents of the University of Nebraska for the University of Nebraska-Lincoln
Estimated Completion: 2016
CAAP Project: The main objective of this project is to develop laser peening of steels used for pipelines to improve corrosion resistance. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=570

Corrosion Under Insulation: Innovative Solutions to Cold Climate Corrosion Challenges
Contracting Agency: PHMSA, University of Alaska Anchorage
Estimated Completion: 2017
CAAP Project: The project will investigate the corrosion properties of carbon manganese steel in bentonite clays and explore opportunities for mitigating Corrosion Under Insulation (CUI) using injectable bentonite inhibitors. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=637

Understanding and Mitigating the Threat of AC Induced Corrosion on Buried Pipelines
Contracting Agency: PHMSA, The University of Akron
Estimated Completion: 2018
CAAP Project: This project will explore new methods for assessing the threat of AC corrosion on buried pipelines. The results from this project will improve indirect inspection methods for assessing the impact of induced AC currents on pipeline corrosion rates and could be used for national and international standards. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=636

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Bayesian Network Inference and Information Fusion for Accurate Pipe Strength and Toughness Estimation
Contracting Agency: PHMSA, Arizona State University
Estimated Completion: 2018
CAAP Project: This project will focus specifically on Development of Inspection Tools to Quantify Pipe Strength and Toughness. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=627

An Inorganic Composite Coating for Pipeline Rehabilitation and Corrosion Protection
Contracting Agency: PHMSA, Rutgers, The State University
Estimated Completion: 2017
CAAP Project: This project will address the need for an inorganic coating composite for corrosion protection and rehabilitation of pipeline in aggressive environments. We propose to use nano-modification and fiber reinforcement to improve the performance of coating composite as corrosion barrier and strengthening system for pipeline. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=635

Mitigating Pipeline Corrosion Using A Smart Thermal Spraying Coating System
Contracting Agency: PHMSA, North Dakota State University
Estimated Completion: 2018
CAAP Project: This project will achieve an ultimate and affordable corrosion mitigation solution for onshore pipelines through the advances of smart thermally sprayed coatings. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=634

Chemically Bonded Porcelain Enamel Coated Pipe for Corrosion Protection and Flow Efficiency
Contracting Agency: PHMSA, University of Missouri (The Curators - Rolla)
Estimated Completion: 2018
CAAP Project: This project will explore, develop, and demonstrate electrostatically-applied, chemically-bonded, dense and consistent enamel powder coating for improved corrosion resistance and durability, reduced surface roughness and pressure loss, and increased bond strength of underground steel pipes under combined external pressure, thermal effect, and internal pressure. Project reporting is publicly available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=631

PREPAREDNESS

Pre-Spill Baseline Studies

Atlantic Marine Assessment Program for Protected Species (AMAPPS)
Contracting Agency: BOEM, NOAA/NMFS, USFWS, USGS, DoD
Estimated Completion: 2014
BOEM is actively collecting new information about whales, turtles and birds through the on-going AMAPPS to fill data gaps in the distribution, abundance, migration, and habitat of endangered and non-endangered marine species. This multi-agency effort involving BOEM, NOAA, U.S. Geologic Service (USGS), USFWS, and the DoD expands upon previous studies under BOEM's Cetacean and Turtle Assessment Program (CETAP), which helped define critical habitat for protected species in the North Atlantic between North Carolina and Nova Scotia.

The AMAPPS effort includes seasonal vessel and aerial surveys to quantify abundance and distribution of protected species and to produce spatially explicit density distribution maps. The results will support environmental assessments and programs that monitor risk of extinction and recovery of the species detected during the surveys. The results will also provide important input to oil and gas leasing decisions as well as NRDA efforts in the event of an oil spill.

The AMAPPS spatial modeling efforts will be integrated into online or distributed products. In addition, the collected data will be incorporated into modeling efforts in an interactive manner to allow users to develop customized models for times and areas of interest. This effort will build off the Strategic Decision Support System developed jointly by NOAA and Duke University and funded by the USN's Strategic Environmental Research and Development Program (SERDP). Paper products expected to be produced by the project include at a minimum: annual updates to the Atlantic Oce*an and Gulf of Mexico Marine Mammal Stock Assessment Report,* annual reports of survey results, and a peer reviewed journal manuscript describing the model development and results.

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Hanna Shoal Ecosystem Study
Contracting Agency: BOEM
Estimated Completion: 2016
This study constitutes a key component of Chukchi Sea environmental studies pertinent to Chukchi Sea oil and gas activity. The highest oil industry interest is in the area just to the south of Hanna Shoal. The BOEM analysts and decision makers will use the information in NEPA analysis and documentation for Lease Sales, EPs and DPPs decision-making in the Chukchi Sea.

Mackenzie River Delta Marine Arctic Ecosystem Study (MARES)
Contracting Agency: BOEM, USARC, USCG, USGS, NOAA, Office of Naval Research, et.al.
Estimated Completion: 2019
The BOEM and National Oceanographic Partnership Program (NOPP) partners awarded a contract for a broad Arctic study that will investigate the interrelationship among the physical, biological, chemical and social science components of the Beaufort Sea ecosystem from Barrow, Alaska, to the Mackenzie River delta in Canadian waters. The overarching goals of the study are to better understand the interrelationship of the physical, biological, chemical, and human systems, including traditional knowledge, of the Beaufort Sea and to advance scientific prediction capabilities for linkages between marine life, human uses, sea ice, atmospheric and oceanic processes and river discharge.

Technological Assessment of Alaskan Arctic Oil Spill Response Temporary Oil Storage Options (Project 1019)
Contracting Agency: BSEE/PCCI
Completed: November 30, 2014
This project conducted an assessment of Alaskan arctic oil spill response temporary storage options for available offshore vessels, onshore storage devices and pumping and transfer systems. This information was compiled into a user friendly Worst Case Discharge (WCD) Scenario tool. This tool was then used to evaluate temporary recovered oil storage capabilities for two Worst Case Discharge (WCD) scenarios. Given user inputs, the tool presented:

- volume of oil spilled by day
- running cumulative volume of spilled oil
- volume of oil removed by weathering
- volume of water uptake into an emulsion
- additional volume of free water collected by skimming
- percentage of free water removed by decanting
- percentage of total volume recovered mechanically, which was then used to determine adequacy of available temporary oil storage capacity.

Inventory of Gulf of Mexico ecosystem indicators using an ecological resilience framework
Contracting Agency: NOAA RESTORE Act Science Program, NatureServe
Estimated Completion: 2017
This research will evaluate ecosystem indicators collected by existing monitoring programs, assess their strengths and weaknesses, and make recommendations for a set of scientifically rigorous, practical, and cost-effective indicators for five key habitats (salt marsh, mangrove, seagrass, oyster beds/reefs, and coral reefs) across the Gulf of Mexico. This contract was awarded in August, 2015.

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Ecosystem modeling efforts in the Gulf of Mexico: current status and future needs to address management and restoration activities
Contracting Agency: NOAA RESTORE Act Science Program, Texas A&M University Corpus Christi
Estimated Completion: 2017
The research team will work with resource managers and other researchers to test and align ecosystem models with management needs and restoration activities in the Gulf of Mexico. This contract was awarded in August, 2015.

Defining abnormal events of oceanographic, biological, and physical properties in the Gulf of Mexico to identify data gaps
Contracting Agency: NOAA RESTORE Act Science Program, The University of Southern Mississippi
Estimated Completion: 2017
This research will use archived satellite ocean observations, ocean circulation models, and existing fish and nekton sampling datasets to identify ecological active regions in the Gulf of Mexico and gaps in current oceanographic data collection. This contract was awarded in August, 2015.

Cooperative monitoring program for spawning aggregations in the Gulf of Mexico: an assessment of existing information, data gaps and research priorities
Contracting Agency: NOAA RESTORE Act Science Program, The University of Texas at Austin
Estimated Completion: 2017
The research team will work with a diverse group of experts from academia, federal and state government, and nongovernmental organizations to compile and evaluate existing information of fish spawning aggregations in the Gulf of Mexico to inform the conservation and management of the region's fisheries. This contract was awarded in August, 2015.

The central role of the Mississippi River and its delta in the oceanography and ecology of the Gulf of Mexico large marine ecosystem
Contracting Agency: NOAA RESTORE Act Science Program, Louisiana Universities Marine Consortium
Estimated Completion: 2017
This research will investigate the influence of the Mississippi River and its delta on the oceanography, ecology, and economy of the Gulf of Mexico and identify the additional data collection and modeling necessary for managers to better monitor and manage the Gulf's natural resources. This contract was awarded in August, 2015.

Improving Arctic baseline information
Contracting Agency: NOAA/ORR/ERD
Estimated Completion: On-going
Develop and implement plan for collaborative Arctic baseline studies and food security risk assessments, including determination of background PAH levels in the environment, marine mammal tissue archiving and analysis, and establishment of food consumption risk framework. This on-going effort will use opportunities to collaborate with Industry, the National Centers for Coastal Ocean Science, and the National Marine Fisheries Service for sampling and outreach.

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Coastal Land Ocean Interactions in the Arctic (Arctic – COLORS)
Contracting Agency: NASA
Completed: September 2015
Arctic-COLORS is a Field Campaign Scoping Study funded by NASA's Ocean Biology and Biogeochemistry Program. The study's overarching objective is to better understand the impact of climate change on land-ocean processes in the Arctic Ocean and its effect on coastal ocean biology, biogeochemistry, and biodiversity. The study scoped a possible field campaign to establish baselines to assess the impacts of future changes on coastal ecosystems and biogeochemistry.

Response Management Systems

Special Monitoring of Applied Response Technologies (SMART) Protocol Enhancement (Project 1020)
Contracting Agency: BSEE/USCG RDC
Completed: October 27, 2014
The purpose of this project was to validate recent recommendations intended to improve the SMART Protocol's effectiveness, and recommend and pursue improvements to the SMART Protocol. The SMART program objectives and how the program has been used in recent spill response events were reviewed. This data was used to assess areas where the Protocol meets the program's goals, and identify areas where improvements could be made. This information was summarized in "Modernization of Special Monitoring of Applied Response Technologies (SMART) Technology and Methods - 2014" which documents the SMART program goals in spill response, discusses where the current SMART Protocol succeeds in meeting program goals, and where improvements can be made, and provides a review and assessment of potential value of new technologies that could be used to improve the SMART Protocol.

Software Development in Support of Preparedness Activities Regulated by BSEE (Project 1062)
Contracting Agency: BSEE with NOAA/NOS/ORR/ERD
Estimated Completion: February 12, 2017
This Intra-Agency Agreement establishes an agreement between the DOI BSEE, and the DOC, NOAA, Office of Response and Restoration, Emergency Response Division. (NOAA/NOS/ORR/ERD) through which NOAA will conduct software development activities to support preparedness activities regulated by BSEE. The goal of this interagency agreement is to support two activities:
1. Develop and implement a methodology for capturing existing Geographic Response Plan (GRP) and/or Area Contingency Plan resource protection data into a format that can be ingested into GIS systems, such as the Environmental Response Management Application (ERMA), and
2. Transition existing Response Operations Calculator into an open source web tool that can be more readily accessed by potential users and linked into potential future systems.

Effective Recovery System Potential (ERSP) Calculator Refinements
Contracting Agency: BSEE/Genwest Systems, Inc.
Estimated Completion: On-going
The ERSP Calculator was developed with the intent of reinforcing incentives for creating and acquiring more effective oil recovery systems. This project is an on-going effort to refine the current ERSP calculator for evaluating the potential of an advancing oil spill skimming systems to meet various regulatory planning requirements. The calculator is a tool that enables users to

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explore how to configure a skimming system to best encounter, recover, store, and offload oil more efficiently. The project also is evaluating the possibility of expanding the calculator to evaluate in situ burning and dispersant systems.

Emergency Response Exercise Best Practices (Project 1055)
Contracting Agency: BSEE/PCCI
Completed: May 2015
PCCI, Inc. identified best practices, innovative approaches, and new concepts for designing, conducting, and evaluating oil spill exercises. All categories of exercises included in the Draft Updated January 2014 NPREP Guidelines were included in this study, with particular emphasis on notification exercises, announced and un-announced exercises, and equipment deployment exercises.
Task 1. Conduct literature searches and solicit input from oil spill professionals
PCCI reviewed published literature and reports on oil spill exercises, including NPREP exercises, to identify best practices as well as opportunities for improvements in exercise, design, execution, and evaluation.
Task 2. Identify and assess well-organized emergency response exercise programs
PCCI reviewed select government, industry emergency exercise programs to identify best practices with application to the design, conduct, and evaluation of NPREP exercises.
Task 3. Identify Innovative Exercise Design Features and Approaches
PCCI took a creative, new look at how exercises are designed.
Task 4. Identify innovative ways to conduct exercises
PCCI reviewed and identified innovative methods for conducting exercises that could more closely simulate the organizational, operational and technical problems, conflicts, social media, and other challenges that typically occur in large or complex oil spill events.
Task 5. Opportunities for improvement in Exercise Evaluation
PCCI explored ways to provide valuable training to the exercise players during the evaluation process.

Review of ASTM Standards for Oil Spill Response Equipment (Project 1024)
Contracting Agency: BSEE/SL Ross
Completed: February 16, 2015
This project reviewed currently existing applicable ASTM F20 "Committee on Hazardous Substances and Oil Spill Response standards" to determine those that may be applicable to assist in BSEE's regulatory mandate. Suggestions were made to the ASTM committee to modify standards where appropriate. In addition, new standards were initiated and spearheaded though the ASTM committee workgroups. These new standards will continue to move through the ASTM approval process.

Tagging of Oil Under Ice for Future Recovery (Project 1051)
Contracting Agency: BSEE/URS Group, Inc
Estimated Completion: September 2015
The goal of this project is to develop innovative, cost effective, and robust tagging devices and an automatic tracking system for use in tracking spilled oil under, or encapsulated within ice. This will be accomplished via the following key novel developments:

1. Implementing an innovative, multi-faceted pinging lamb wave communication system to use in an underwater acoustic identification (UWID) tag.

2. Develop a commercial off-the-shelf (COTS)-based GPS/satellite transponder with a lamb wave detector tag that is ruggedized for the Arctic environment and for a variety of deployment options including air drops.
3. Adaptive power management algorithms in conjunction with interfaced sensors to automatically stay dormant, when needed, to conserve power.
4. Employ an adaptive system level approach, along with an innovative packaging, material and coating design that will mitigate the adverse effects of snow buildup and ice formation on the wireless links.

Geo-Referencing Identification (GRID) Tag (Project 1050)
Contracting Agency: BSEE/URS Group, Inc
Estimated Completion: September 2015
The goal of this project is to develop a small, cost-effective and robust Geo-Referencing Identification (GRID) technology package to tag and automatically track equipment and assets in real time. This will be accomplished via the following key development issues:

1. Develop the device architecture for deployment such that low cost mesh radio-frequency identification (RFID) tags communicate in groups with just a few satellite/GPS modules;
2. Modify existing lower-cost commercial off-the-shelf active RFID tags to survive harsher conditions with the goal of subzero temperatures, seawater and prolonged deployment to provide more effective global tracking tags;
3. Adapt power management firmware and integrate additional sensors combined with intelligent algorithms with the goal to extend battery life by 25% compared to existing tags for all devices in the system;
4. Employ an adaptive system level approach, along with a novel GRID packaging design, to mitigate the adverse effects of snow buildup and ice formation on the wireless links; and
5. Integrate and confirm software to allow the system to stay dormant and conserve power; this could be accomplished via either user requests or automatically.

4203 Robot Capability Requirements and Alternatives for National Strike Force Response Support
Contracting Agency: RDC
Estimated Completion: 2017
The objectives/ scope of this project have evolved over the course of the project, which began in January of 2015. The National Strike Force (NSF) requested assistance in finding or developing a robot with a particular set of response capabilities. The current objective is to conduct market research to seek / test Commercial Off-the-Shelf technology and evaluate whether the needs articulated by the NSF can be met by existing technology. If no such technology exists, there is discussion about seeking alternative opportunities to develop capabilities. The project is expected to run through FY17.

2016-23 Shale Oil & Gas Preparedness and Response
Contracting Agency: RDC
Estimated Completion: 2017
The objective of this project is to develop an assessment characterizing the behavior of shale oil and the chemical composition of Shale Gas Extraction Wastewater (SGEWW), which could then serve as guidance to shape response policy and FOSC actions. The project is new as of FY16 and has been allocated funding through a partnership with the EPA's Great Lakes Restoration Initiative (GLRI).

Developing a Capabilities-Based Framework for Designing and Evaluating Oil Spill Response Exercises (Project 1048)
Contracting Agency: BSEE/George Washington University
Estimated Completion: March 2016
The objective of this project is to develop a framework that identifies capabilities critical to marine oil spill response readiness, and maps them to the design concepts and evaluation techniques for each capability within an exercise. GWU will research existing literature and couple that with their experience in other industries to develop a set of capabilities, exercise design concepts and evaluation techniques. GWU will observe four oil spill response exercises to collect data for analysis using Atlas.ti software. This information will be used to identify measureable elements within an exercise that demonstrates a capability. The final report will provide guidelines for using the framework to design and evaluate oil spill response exercises to ensure that each exercise is effective in testing and improving oil spill response readiness.

Leveraging Offshore Hydrocarbon Risk Assessment Models and Datasets to Support the Evaluation and Ranking of Worst Case Discharge Scenarios (Project 1046)
Contracting Agency: BSEE/National Energy Technology Laboratory (NETL)
Estimated Completion: September 2016
The objective of this effort is to develop a set of methodologies and algorithms, and a computer model for the comparison and ranking of different spill scenarios to determine which one has the greater potential for damage to the environment or result in other significant impacts, and should be classified as the worst case discharge scenario.
The model enhancement and testing for simulating various oil discharge scenarios are complete. The project team has completed all Gulf of Mexico simulations on the various NETL, Pacific Northwest National Laboratories (PNNL), and NOAA models to verify functionality. Simulations for Gulf of Alaska, Puget Sound, and Southern California are on-going. Efforts continue to apply additional datasets and user inputs to transition the software from a blowout model to a response planning tool.

Regulatory Application of Real-Time Monitoring
Contracting Agency: BSEE
Estimated Completion: 2016
This study is to explore how real-time monitoring technology can improve offshore drilling, workover, completion and production safety operations; and the implication that technology has BSEE's regulatory and oversight roles.

Responding to Oil Spills in Arctic Marine Environments
Contracting Agency: USARC, NOAA, USCG, BOEM, and BSEE
Completed: March 2014
The National Research Council Ocean Studies Board was tasked by five Interagency Committee agencies and three other organizations to assess the current state of science and engineering regarding oil spill response and environmental assessment in the Arctic region (with a specific focus on the Bering Strait and north), with emphasis on potential impacts in U.S. waters. As part of its report, the NRC-appointed committee assessed existing decision tools and approaches that utilize a variety of spill response technologies under the types of conditions and spill scenarios encountered at high latitudes. The report reviewed new and on-going research activities (in both the public and private sectors), identify opportunities and constraints for advancing oil spill research, describe promising new concepts and technologies for improving the response, including containment (surface and subsurface) approaches to reduce spill volume and/or spatial

extent, and recommend strategies to advance research and address information gaps. The committee also assessed the types of baselines needed in the near-term for monitoring the impacts of an oil spill and for developing plans for recovery and restoration following an oil spill in U.S. or international waters where a spill could potentially impact U.S. natural resources. http://dels.nas.edu/Study-In-Progress/Responding-Spills-Arctic/DELS-OSB-09-02

Advanced Oil Spill Response in Ice Training Course
Contracting Agency: CRREL/Alaska Clean Seas
Completed: January 2015
The advanced oil spill response in ice training course was held at the Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, NH. The course included both classroom and hands-on instruction to provide students with the opportunity to practice tactics for use in oil spill detection, containment, and recovery to include in situ burning with and without herders.

OCIO-managed DWH Institutional Repository
Contracting Agency: NOAA CIO
Estimated Completion: On-going
NOAA's Office of Chief Information Officer (OCIO) partnered with the National Technical Information Service (NTIS) to develop the Deepwater Horizon Institutional Repository (DWH-IR), which serves as a searchable, online index of thousands of publicly cleared DWH files located across NOAA data centers, Line Offices, libraries and websites. The DWH-IR is the result of NOAA's need to ensure the agency's DWH data and information is preserved, available and easily accessible through a single site; http://noaa.ntis.gov. The Institutional Repository Technology provides several benefits:

- Offers a cloud-based solution to host and disseminate data and information
- Promotes shared services across agencies and the federal landscape
- Reduces cost and effort associated with: hosting and maintaining multiple, redundant web sites, managing NOAA records, publishing Freedom of Information Act (FOIA) records, responding to eDiscovery requests
- Serves as a data and information management model for real-time use during future response and restoration efforts

Mobile Asset Tracking and Reporting during Incident if National Significance (IONS)
Contracting Agency: USCG/RDC
Estimated Completion: January, 2017
The objective of this project is to develop a flexible ad hoc interoperable communication/information system to enhance the USCG's ability to respond to Incidents of National Significance (IONS). Specifically, this effort will prototype a flexible interoperable communication/information system, processes, and procedures to enhance the USCG's ability to transfer information that will assist personnel responding to an IONS (e.g., oil spill). The system, processes, and procedures should make use of the equipment the responders are expected to bring to the incident such as smart phones, tablet computers, and laptops

At this time, mobile asset tracking systems have been developed for multiple mobile platforms. Called the Portable Handheld Next-Generation Incident Command System (PHINICS) it can be used on digital telephones, laptops, and tablets including Apple iOS devices. It will also be integrated with the Incident Action Plan (IAP) software recently procured by the USCG.

RESPONSE

Structural Damage Assessment and Salvage

Remediation of Underwater Legacy Environmental Threats (RULET)
Contracting Agency: NOAA/ORR/Emergency Response Division (ERD), NOAA Office of National Marine Sanctuaries
Estimated Completion: Publications are completed, support is on-going
During the reporting period, two wreck reports were updated, and four more are pending update based on changes in their status or survey information. Per a 2010 congressional appropriation, NOAA performed an assessment of the most significant potentially polluting wrecks in U.S. waters and provided a national report and 87 individual wreck risk assessments to the USCG. The report details the risk assessment process NOAA used to review the 20,000 wrecks in U.S. waters and provide a multidisciplinary assessment of the physical integrity, pollution potential for impacts to socio-economic and ecological resources. NOAA recommended in May 2013, that USCG consider in-water assessments and potential pollution recovery on 17 vessels. Currently, NOAA will continue to provide support to USCG districts and sectors incorporating this information into area contingency plans, as well as provide or facilitate surveys of opportunity where possible. As USCG units move forward with assessment and recovery activities, NOAA engagement continues with typical scientific support as well as support regarding the reevaluation of information in the individual RULET wreck risk assessments as surveys of opportunity occurs, new technical or historical information comes to light.

At Source Control and Containment

Capping Stack Technology Requirements
Contracting Agency: BSEE
Estimated Completion: 2015
This study aims to determine the state-of-the-art of Capping Stack technologies with the potential to increase safety during Outer Continental shelf drilling, well completion, well workover and production operations. The assessment will determine the differences between capping stacks currently in use by industry in the Gulf of Mexico, Alaska and overseas. This study will also conduct an assessment of the current capping stack standards, compile a list of usable Potential Incidents of Non Compliance (PINC) and provide criteria and guidelines for design, manufacture, maintenance, and inspection of Capping Stacks.

Oil Boom Biofouling Control by Mechanical Intervention and Material Technologies
Contracting Agency: USN's Environmental Sustainability Development to Integration (0817 NESDI) /NSWC Carderock
Estimated Completion: 2016
This project explores the use of a novel integrated coating to enhance boom performance with regard to the ease of cleaning beyond the rate fouling. The flexible, silicone-based coating (ClearSignal™) has been optimized for the long-term deployment of oceanographic instrument platforms such as offshore buoys and autonomous glider-like vessels used to collect data. The energy and effort to clean ClearSignal has been shown to be 1/10 or less of that needed to clean an untreated substrate, with the cleaned flexible material returning to its unfolded pristine condition.

Prototype sections of ClearSignal-coated boom will be fabricated and deployed with baseline boom material at three locations. These planned test sites are Port Canaveral Florida as managed by Florida Institute of Technology (FIT); Port Hueneme, California; and Indian Island, Washington. In some cases, booms will be subjected to cleaning as part of a test and evaluation protocol developed by Naval Surface Warfare Center Carderock (NSWCCD) and Severn Marine Technologies. In-water cleaning will be accomplished with powered tools such as rotary brushes and/or medium-high pressure water-jets. The rate of biofouling accumulation and time to clean will be compared to uncoated booms.

Concurrent with the in-water testing, refinements will be implemented as needed into the coating process and cleaning tools for the full commercial development of ClearSignal coated booms. Port Hueneme and Indian Island are active USN port facilities and FIT/Port Canaveral is a USN recognized corrosion and biofouling test-site. All combined, these sites should provide a good balance of practical field experience and research test rigor. It is anticipated that use of coated oil containments boom will result in a savings of 25 percent in material costs and a 70 percent reduction in maintenance costs.

Chemical and Physical Behavior Modeling

Development of Crude Oil Simulants to Mimic the Behavior of Oil Droplets in Seawater
Contracting Agency: BSEE/EPA
Estimated Completion: November 2017
The objective of this project is to develop a Crude Oil Simulant (COS) that advances the spill response and scientific community's understanding of the behavior and transport of oil plumes and floating slicks in aquatic environments. Materials currently used to simulate crude oil behavior in water are actually surrogates for slick, and not plume behavior (e.g., coffee beans, dog food, peat moss, oranges). This work represents a fundamental paradigm shift where the developed COS mimic's oil behavior within a plume, even at dilute concentrations. Phase One of this project demonstrated that (1) a COS can be fabricated using non-reactive fluorescent dye encapsulated within quasi-transparent core shells at the nanometer size range using synthesis techniques that are readily scalable from bench to industrial production, (2) the optically-active COS particles can be detected at dilute concentrations in artificial seawater due to their high fluorescent signature using commercial off-the-shelf (COTS) spill response fluorometers and (3) "Tuning" of the COS using innovative synthesis techniques allows flexibility in creating behaviors ranging from floating to sinking in the water column; The EPA is pursuing a patent for this technological approach and the period of performance has been extended to develop larger particles (micron-scale) in monodispersed and polydispersed batches to further the development and the Technology Readiness Level (TRL) of the oil simulant.

The goal is to do that without the risk of harming the environment and associated ecosystems. In order to do that, a means to conduct experiments with oil simulants that mimic the behavior of dispersed oil in the natural environment is needed. Experiments using materials that behave like oil but are environmentally benign would enable field testing without requiring rigorous permitting. This project will address these issues by: (1) Fabricating environmentally benign, optically active particles that simulate oil droplets in the water column using synthesis techniques that are readily scalable from bench to industrial production; (2) "Tuning" the oil simulant using innovative synthesis technique to allow flexibility in creating behaviors ranging from floating to sinking in the water column; (3) Detecting the oil simulant under dilute

concentrations due to the high fluorescent signature of the oil simulant; and (4) Verifying the oil simulant behavior using commercial off-the-shelf (COTS) response tools, such as fluorometers and particle size analyzers. The EPA is pursuing a patent for this technological approach and the period of performance has been extended to develop larger particles to further the development and the Technology Readiness Level (TRL) of the oil simulant.

Diluted bitumen oil biodegradation and toxicity
Contracting Agency: EPA ORD NRMRL
Estimated Completion: 2016
The production and shipping of emerging crude oils has increased substantially in the past 5 years. In turn this causes increased risk to ecosystems and communities for potential spills. One type of emerging crude, bitumen, poses unique problems for spill response and remediation options. This is due to its high viscosity, which requires dilution prior to transport. Dilution with condensate, diluent or synthetic oil produces 'diluted' and 'synthetic' bitumen (dilbit and synbit, respectively). Hence the chemical nature of the bitumen various widely, thus evaluating degradation rates, fate and transport models and toxicity is challenging. This project aimed at providing biodegradation rates for 2 types of diluted bitumen (Cold Lake and Western Access Blends) for freshwater microbial cultures collected from the Kalamazoo River and Gulf of Mexico seawater cultures at two temperatures. Metagenomic sequencing of the contrasting cultures will provide for information on the key oil degraders present in these waters.

Toxicity and oil concentrations were also evaluated. Both fresh and salt water species (fish and invertebrates) were used in the toxicity studies, with two types of bitumen oil. The toxicity tests used the standard effluent slow stir WAF (Water Accommodating Fraction) for fresh and salt water, with range finder tests conducted to bracket concentration ranges. Chemical analyses (TPH – total petroleum Hydrocarbons) for each test were evaluated. Acute toxicity for lethality and chronic toxicity for sublethal effects were evaluated. Results will inform transport modeling efforts by NRMRL in Ada, Oklahoma for the 2010 bitumen spill in the Kalamazoo River.

GNOME2/ADIOS 3
Contracting Agency: NOAA/ORR/ERD
Estimated Completion: 2016
The General NOAA Operational Model (GNOME) has been rewritten to account for new 3D functionality, ensuring better support of chemical spills and subsurface oil releases, and better interaction with external data sources and GIS systems. The new model will include oil property data and integrate weathering algorithms from the Automated Data Inquiry for Oil Spills (ADIOS3) model. Subsea release and oil-in-ice elements are in development for the final GNOME 2 release. The new model will primarily be available as a web application, but also able to run off-line in a scripting mode, or as a platform independent stand-alone application. New visualization capabilities will result in improved trajectory products for planning and the Unified Command.

GNOME2 is being designed as a piece within a larger risk assessment framework for future tool development in order to ensure cohesive development of future risk assessment tools. Following recommendations of the Ocean.us Data Management and Access Committee (DMAC), the GNOME2 can fully access datasets available via OPeNDAP. The code is being developed as a fully open-source application to allow review and contributions from others.

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GNOME Online Oceanographic Data Server (GOODS)
Contracting Agency: NOAA/ORR/ERD
Estimated Completion: On-Going
Over the last few years, ERD has been developing an online tool to allow users of the transport model GNOME to easily utilize model output or observational data from external sources. The GNOME Online Oceanographic Data Server or "GOODS" website provides access to base maps, ocean currents, and winds from various models and data sources. GOODS allows users to select model data in their specific region of interest and download it in a format that can be read directly into GNOME. After being used successfully in-house for several years, in early 2012, GOODS was made publicly available at http://gnome.orr.noaa.gov/goods. Since then, ERD has received positive feedback from a diverse group of international GNOME users from within NOAA and other government agencies, the academic community and industry, with applications ranging from research to planning and emergency response.

ADIOS3
Contracting Agency: NOAA/ORR/ERD
Estimated Completion: On-going
ADIOS is an oil weathering response tool for emergency spill responders and contingency planners. The program integrates a library of oil properties with a short-term oil fate and cleanup model to estimate the amount of time that spilled oil will remain in the marine environment, and to develop cleanup strategies. ADIOS provides weathering information to NOAA's oil spill trajectory program, GNOME2. ADIOS3 builds on previous versions of ADIOS and includes new algorithms for biodegradation and sedimentation as well as technology upgrades to include a web interface.

Arctic Trajectory Analysis Planner (Arctic TAP)
Contracting Agency: NOAA/ORR/ERD supported by NFWF
Estimated Completion: October 2016
The Trajectory Analysis Planner (TAP) is superior to traditional oil spill trajectory models when the user doesn't know when or where a spill could occur and for providing extended response outlook beyond the certainty of weather forecasts in a specific incident. NOAA has developed the Trajectory Analysis Planner (TAP) incorporates historic weather and currents for developed TAP areas to explore a wide range of possibilities. Using funding from the National Fish and Wildlife Federation, NOAA ORR/ERD is developing a TAP geographic instance for the Alaskan Arctic. When complete, it will allow the user to set numerous options such as the location, amount, and type of oil that might be spilled and a level of concern. The user can then view maps that show probabilities of where oil could go, maps of how quickly oil can impact sensitive receptor sites, and maps of where oil could come from to impact a site.

The Roles of Gas Hydrates During the Release and Transport of Well Fluids into Deep Ocean
Contracting Agency: BSEE
Estimated Completion: 2014
The objective of this project is to use existing, novel equipment for obtaining fundamental, crosscutting chemical, physical, and hydrodynamic information on fluids that could be released and transported from deep, subsea hydrocarbon reservoirs and inadvertently released into a deepwater environment. Specifically, the research will use the resulting fundamental information in numerical, thermodynamic, and plume models to comprehensively describe potential roles and impacts of gas hydrates in such a scenario. The goal is to have a comprehensive understanding of the formation and stability of simple and complex hydrates

under deepwater conditions; the stability of hydrates and their interaction with hydrocarbon fluids at or near the point of release into deep water and at longer times as they are transported away from the point of release into the seawater column; and the impact of dispersants and anti-agglomerates on the fate and interaction of hydrates near the point of release and during transport in the seawater column.

Heavy Viscous Oil PVT (08121-2201-01)
Contracting Agency: DOE, Schlumberger
Completed: November 2014
The objectives of this work were to evaluate current practices in viscosity measurements, correlations, and models of heavy, viscous oil, to include experimental validation of the models; develop best practices of sample handing and laboratory measurement methods; study the impact of solvent and commingling of different fluids on viscosity change and asphaltenes instability, including examination of the existing models and mixing rules in handling the property change; and report on conditions in which multiple phases exist.

Oil Spill Detection and Surveillance

Detection of Oil within the Water Column
Contracting Agency: USCG RDC
Completed: July 30, 2014
The current spill technology is limited in its ability to accurately detect and mitigate subsurface oil within the water column down to 10,000 feet. The first objective of this project was to develop a technology that was capable of detecting and tracking oil along a water column down to a depth of 200 feet. The minimum requirements for the proposed technology were to operate in all environmental conditions and to locate and mark subsurface oil; this will aid decision-makers in formulating the most feasible approach to mitigate or remove the oil. In addition, the final product should have sufficient resolution for detecting small droplets of oil. The proposed technology should also have the ability to be efficiently used near shore and in rivers.

A Broad Agency Announcement (BAA) was issued in 2011 and three contracts were awarded in 2012 to perform analysis and designs for systems to detect oil. Two follow-on contracts for a sonar system and a system that uses a compact multi-angle scattering instrument were funded to develop prototypes. The prototypes were tested at Ohmsett in December 2013 with useful results. There were numerous lessons learned and Ohmsett was able to develop a novel oil release mechanism to create subsurface oil plumes that can be used for future projects.

Assessment of USCG Aviation Force's Capability for Airborne Oil Spill Remote Sensing and Reporting (Project 1060)
Contracting Agency: BSEE /USCG RDC (project 7609)
Estimated Completion: July 1, 2016
The objective of this project is to provide data that documents the capabilities of organic USCG airborne sensors to detect, map, and report oil spills. Specifically, this effort will:

- Conduct a comprehensive review of current USCG airborne sensor oil spill detecting, mapping, and reporting abilities.
- Review USCG aviation efforts involved with Deepwater Horizon Response spill surveillance.

- Evaluate current state of USCG airborne sensor data dissemination and near-term improvements, including the Minotaur Mission System and shift from INMARSAT voice to INMARSAT data.
- Perform in-flight evaluations on current USCG airborne sensor systems.
- Provide recommendations for future sensor requirements.
- Provide comprehensive data on available USCG capabilities and recommended use including assessment of oil thickness mapping.

During the week of May 18-24, 2015 the test team completed a soft test of all data acquisition equipment onboard the HC130J and executed the Field Test in Santa Barbara, CA. Approximately 210 GB of image, video, geolocation, environmental, and other data were collected from the primary data sources during the course of the exercise along with physical samples of the imaged oil.

CORN (Coordinated Oil-spill Response Network)
Contracting Agency: BSEE
Completed: December 5, 2013
The objective of this project was to develop a Coordinated Oil-spill Response Network (CORN) that will benefit response command centers by enabling them to provide clear mission profiles to vessels, share up-to-date oil spill/response information, collect field data for input into models used to reflect and predict conditions, and maintain and distribute a Common Operational Picture across all participants. It will provide real-time views of operational areas, and be electronically overlaid with routes, contamination/hazard areas, navigational aids, and other responders and vessels locations. Additionally, it will provide vessel operators with a computer-enhanced navigational system, Augmented Reality (AR). Augmented Reality enables vessel responders to see where transit routes, skim zones, other vessels, and other relevant objects are regardless of visibility.

Evaluation of Oil Fluorescence Characteristics to Improve Forensic Response Tools
Contracting Agency: BSEE & EPA
Estimated Completion: 2015
The objective of this project is to translate oil fluorescence Research & Development into operational tools for spill response, which will be highlighted by three specific goals. The first is to generate a comprehensive Excitation Emission Matrix Spectroscopy (EEMS) database, building upon existing data to provide fluorescence peak information as a function of oil type, weathering state, concentration and Dispersant-to-Oil Ratios (DORs). The second is to examine the database using advanced statistical methods and models to identify wavelengths best suited for oil monitoring during dispersant application and degradation. The third is to conduct wave tank experiments to determine submersible sensors capable of providing data comparable to scanning and/or fixed wavelength laboratory fluorometers for rapid deployment during response efforts.

Enhanced Oil Spill Detection Sensors in Low-light Environments (Project 1013)
Contracting Agency: BSEE & U.S. Army
Estimated Completion: **June** 2016
The goal of this collaborative effort is to enhance the methods currently in place to detect oil in a marine environment. The methods currently in place are not conducive to oil spill recovery operations during periods of low light and rely heavily on time-delayed aerial remote sensing technologies or visual observation. This project will leverage the knowledge and expertise of the

Army's Research, Development, and Engineering Command's Night Vision and Electronic Sensors Directorate (NVESD) personnel to assist BSEE in the identification and documentation of existing capability gaps; identification and assessment of technology gaps; test and evaluate potential new or alternative hardware; and, if necessary, support the design, development and demonstration of new technologies to meet identified needs.
Army NVESD will also perform preliminary design of aerial vehicle options (manned vs unmanned) for the demonstration in May 2017 International Oil Spill Conference (IOSC) with suitable sensors and data handling options for both. Sensor and data transmission capabilities tradeoffs will be based upon aircraft flight requirements and payloads. The task culminates with a preliminary design report and decision brief in March 2016 with decision to pursue potential follow on effort.

Oil Leak Detections with a Combined Fluorescence Polarization Instrument and a Wide Band MultiBeam Sonar (Project 1039)
Contracting Agency: BSEE / EIC Laboratories, Inc. and Norbit US, Ltd.
Estimated Completion: December 2015
This project will develop and test a prototype sensor that integrates two partial solutions (fluorescence and sonar) with a goal of operating at a suitable standoff distance and interrogating a wide area, while providing real-time data feed from the subsea environment. The project will be conducted in two phases.

Phase 1 objectives:

1. Enhance the long range detection capability of the fluorescence polarization sensor
2. Develop a mounting scheme for the two sensors so that the field of view of the sensors overlap
3. Develop a firmware/software that will integrate the data from the two sensors with accurate time tagging.

Phase 2 objectives:

1. Evaluate the performance of the combined sensors in open-water using oil simulants

Distributed Chemical Sensing for Sub-surface Oil Spill Sensing (Project 1040)
Contracting Agency: BSEE / University of Houston
Estimated Completion: December 2016
The objective of this project is to develop distributed chemical sensing by integrating plasmonic nanostructures, multi-modal spectroscopic sensing, and optical fiber technology, with the ultimate goal toward real-time leak quantification appropriate for subsea pipeline monitoring. This project will develop a small-scale mock-up instrument that will be tested in the laboratory and at Ohmsett.

Two important design parameters for nano porous gold disks (NPGD) were investigated: underlying gold layer thickness and etch depth into the NPG film. A systematic study of the influence of these parameters on Surface-enhanced Raman spectroscopy (SERS) activity of NPGDs has been conducted. The results have shown that the existence of a continuous gold under-layer significantly increases the performance of NPGDs.

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HC-Sentinel: An AUV Glider for High Endurance Subsea Hydrocarbon Detection (Project 1041)
Contracting Agency: BSEE / Woods Hole Oceanographic Institution
Estimated Completion: September 2016
The objective of this project is to develop and test a next generation in-situ mass spectrometer payload that operates on an autonomous underwater vehicle (AUV) glider for real-time subsea hydrocarbon detection and classification. The system will be designed to operate for long-term subsea inspection, monitoring, and incident response. The project will be comprised of six main elements:

1. Construction of the HC-Sentinel hydrocarbon mass spectrometer.
2. Modification of a Slocum glider payload bay to accommodate the HC-Sentinel.
3. Calibration of the payload instrument system.
4. Development of goal-directed mission executive and rules-based expert system to adaptively survey areas of interest.
5. Sea trials in Buzzards Bay, Massachusetts.
6. Demonstration operations at a naturally occurring seafloor petroleum seep site.

Development of acoustic methods to measure oil droplet size and slick thickness on ROV and AUV platforms (Project 1065)
Contracting Agency: BSEE / Applied Research Associates (ARA), Inc.
Estimated Completion: September 2016
The objective of this project is to develop and test acoustic techniques and sensors mounted in free-swimming platforms [Remotely Operated Vehicles (ROVs) and/or Autonomous Underwater Vehicles (AUVs)] for field applications to measure: (a) slick thickness on the surface of the water, and/or (b) oil droplet size distribution at the well head for subsurface releases of crude oil and dispersants in the presence of natural gas.

Oil Spill Detection and Mapping under Arctic Sea Ice using Autonomous Underwater Vehicles (AUV)(Project 1000)
Contracting Agency: BSEE/Woods Hole Oceanographic Institution
Completed: **August 30,** 2014
The goal of this project was to evaluate and develop an AUV-based system for detection and mapping of oil in ice-infested waters from below the water and/or ice. Extensive laboratory ice-tank tests were be conducted to evaluate each candidate sensor package to develop a sensor suite capable of detecting and quantifying the thickness of oil, and suitable for deployment via an AUV. An AUV mission strategy to efficiently map the distribution of oil under complex sea ice terrain, and in the variety of ice conditions found in U.S. Arctic coastal waters, was also developed. The mapping capability of the system was tested at Lake Michigan and off the USCGC HEALEY in Alaska. Sensor package capabilities including communication of large volumes of data were tested off the Alaska North Slope.

Geo-Referencing Identification (GRID) Tag (Project 1050)
Contracting Agency: BSEE/AECOM, Inc (formerly URS)
Completed: September 24, 2015
The goal of this project is to develop a small, cost-effective and robust Geo-Referencing Identification (GRID) technology package to tag and automatically track equipment and assets in real time. This will be accomplished via the following key development issues:

1. Develop the device architecture for deployment such that low cost mesh radio-frequency identification (RFID) tags communicate in groups with just a few satellite/GPS modules;
2. Modify existing lower-cost commercial off-the-shelf active RFID tags to survive harsher conditions with the goal of subzero temperatures, seawater and prolonged deployment to provide more effective global tracking tags;
3. Adapt power management firmware and integrate additional sensors combined with intelligent algorithms with the goal to extend battery life by 25% compared to existing tags for all devices in the system;
4. Employ an adaptive system level approach, along with a novel GRID packaging design, to mitigate the adverse effects of snow buildup and ice formation on the wireless links; and
5. Integrate and confirm software to allow the system to stay dormant and conserve power; this could be accomplished via either user requests or automatically.

Tagging of Oil Under Ice for Future Recovery (Project 1051)
Contracting Agency: BSEE/AECOM, Inc (formerly URS)
Estimated Completion: December 31, 2016
The goal of this project is to develop innovative, cost effective, and robust tagging devices and an automatic tracking system for use in tracking spilled oil under, or encapsulated within ice. This will be accomplished via the following key novel developments:

i. Implementing an innovative, multi-faceted pinging lamb wave communication system to use in an underwater acoustic identification (UWID) tag.
ii. Develop a commercial off-the-shelf (COTS)-based GPS/satellite transponder with a lamb wave detector tag that is ruggedized for the Arctic environment and for a variety of deployment options including air drops.
iii. Adaptive power management algorithms in conjunction with interfaced sensors to automatically stay dormant, when needed, to conserve power.
iv. Employ an adaptive system level approach, along with an innovative packaging, material and coating design that will mitigate the adverse effects of snow buildup and ice formation on the wireless links.

Validation of Surface and Subsea Oil Detection Capabilities Using Remote Sensing Technologies in a Controlled Laboratory Setting
Contracting Agency: CRREL/International Association of Oil and Gas Producers (OGP) Joint Industry Programme (JIP)
Completed: July 2014
In support of a larger effort titled Oil Spill Detection and Mapping in Low Visibility and Ice, efforts undertaken at CRREL focused on implementing an OGP-JIP test program that was developed to identify and qualify sensors platforms capable of determining the presence of oil on, in, and under ice and capable of mapping the extent of the oil slick at each horizon. The test program performed at CRREL was the first time that an array of above surface and subsea sensors were deployed under controlled conditions. Simultaneous, multi-sensor data was collected from the point of initial sea ice growth through to complete melt.

Optical and Microstructure of Oil in Ice
Contracting Agency: CRREL/Prince William Sound Science Center
Completed: June 2015
In support of the larger effort titled Oil Spill Detection and Mapping in Low Visibility and Ice, efforts undertaken at CRREL focused on measuring the spectral albedo and transmittance of ice cover at distinct test sites during the validation of above surface and subsea oil detection capabilities in a controlled laboratory environment.

In- and On-Water Containment and Recovery

Detection of Oil in the Water Column
Contracting Agency: USCG RDC (4702)/BSEE (project 1021)
Estimated Completion: 2017
The current spill technology is limited in its ability to accurately detect and mitigate subsurface oil within the water column down to 10,000 feet. The first objective of this project is to develop a technology that is capable of detecting and tracking oil along a water column down to a depth of 200 feet. The minimum requirements for the proposed technology are to operate in all environmental conditions; and locate and mark subsurface oil to allow the decision-makers to formulate the most feasible approach to mitigate or remove the oil. In addition, the final product should have sufficient resolution for detecting small droplets of oil. The proposed technology should also have the ability to be efficiently used near shore and in rivers.

A Broad Agency Announcement (BAA) was issued in 2011 and three contracts were awarded in 2012 to perform analysis and designs for systems to detect oil. Two follow-on contracts for a sonar system and a system that uses a compact multi-angle scattering instrument were funded to develop prototypes. Testing is scheduled for December 2013.

Mitigation of Oil within the Water Column
Contracting Agency: USCG RDC/BSEE (Project 1033)
Estimated Completion: 2017
The Mitigation of Oil within the Water Column project builds on the efforts and lessons learned during RDC's work in the detection phase as well as those learned during the USCG's Deepwater Response. Once submerged oil in the near-shore or river environment has been encountered, the next step is to make the decision of whether an active approach is necessary to remove the oil or mitigate the subsurface plume's impacts on the environment, water intakes, and commercial facilities. Currently, there is no well-established technology, technique, or strategy to prevent the detected submerged oil from having further adverse impacts on the environment or manmade structures.

A Broad Agency Announcement (BAA) was issued in 2015 and two contracts were awarded in the same year to perform concept developments of the proposed systems to mitigate the impacts of oil. One system is based on reusable, environmentally benign absorbent foam and the other is based on microbubble flotation. Follow-on contracts to develop prototypes for the two systems are Government Options that may be exercised; they are dependent on the outcomes of the concept development phase. Should the Government Options be exercised, testing of the prototypes is anticipated for November 2016.

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Arctic Technology Demonstrations
Contracting Agency: USCG RDC
Estimated Completion: On-going
The USCG RDC's continuing involvement with the USCG's Arctic Shield exercise, and now separately through specific demonstrations, has included testing of spill response equipment and operations. Efforts to date incorporated testing of five key process activities in Arctic oil spill response: searching above and below an ice flow, detecting spilled oil, producing data to be used to plot the safest course to the spilled oil, deploying response equipment to recover the spilled oil, and monitoring the recovery operation (above and below the ice) to ensure complete recovery. As part of the exercises, the RDC also evaluated five specific technologies and components: small unmanned aircraft system (sUAS), autonomous underwater vehicle (AUV), oil recovery skimmers, remotely operated vehicle (ROV), and communications support. The RDC released a video to document the 2012 and in 2013 Arctic Shield spill response logistics and operations. The focus of the 2016 demonstration is oil spill response off the North Slope of Alaska. The following Interagency Committee agencies have participated in one or more of the Arctic Shield exercises: NOAA, BSEE, and USN.

4701 Response to Oil in Ice
Contracting Agency: RDC/EPA
Estimated Completion: 2017
The USCG RDC is conducting an on-going series of demonstrations to develop and validate equipment and techniques for detecting, tracking, and recovering oil in ice-filled waters under all conditions. To date, the USCG has conducted three Oil-in-Ice Demonstrations in the Great Lakes in April 2011, January 2012, and February 2013. The Great Lakes demonstrations involved deploying autonomous underwater vehicles (AUVs), a remotely operated vehicle, tethered observation balloons, ice radar systems, and different skimmer systems. During the latest demonstration, USCG and BSEE collaborated to test BSEE's AUV equipment. The demonstrations also included testing of the incident command structure as well as collaboration with Canadian government and industry response groups. The project also provided a knowledge base and lessons learned that informed USCG operators as well as Arctic exercises during the summer of 2012 and 2013. The RDC is planning another Great Lakes demonstration for February 2016.

Oil Sands Products Spill Response
Contracting Agency: RDC (Project 4705)
Estimated Completion: 2017
The objective of this project is to identify best practices to assist the FOSC in responding to spills involving Oil Sands products. The RDC recently completed the first phase of this project, which included researching the existing literature on this topic to hone in on the particular research areas that the RDC could address. This also included background information on the ways that oil sands products are transported and refined. The RDC awarded a task order for analysis of a sediment sampling approach in FY15. Research on potential mitigation techniques should start in 2016. The project is scheduled out through FY17.

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Development of Surrogate Ice Modules for Simulated Arctic Environment Testing at Ohmsett (Project 1023)
Contracting Agency: BSEE/PCCI
Completed: May 29, 2015
The purpose of this project was to explore the feasibility of using surrogate ice modules at the National Oil Spill Response Research & Renewable Energy Test Facility (Ohmsett) to test oil spill response equipment in various, repeatable, simulated arctic conditions. This project was initiated in order to devise a lower cost alternative to purchase of salt ice for this seasonal testing. The contracted portion of this project is complete. Internal work is ongoing to further develop the surrogate ice modules.

Testing of Skimmer Hoses and Hose Couplings Under Simulated Arctic Conditions (Project 1026)
Contracting Agency: BSEE/Cold Regions Research and Engineering Laboratory (CRREL)
Completed: October 31, 2014
This project's objective was to assess performance of standard skimmer hoses and hose couplings used during oil recovery operations when subjected to low temperatures found in the Arctic. Several separate, complimentary studies were conducted within this project. Pumping of oil/water/ice product at various concentrations at low temperatures was tested to highlight situations where the product flow through a hose might become an issue. Data on force required to couple/uncouple standard hose connections at varying temperatures with various gaskets was collected to provide guidance on gasket selection for use in low temperature conditions. Life cycle testing on gaskets and hose/hose couplings was also studied.

Mitigation of Oil in the Water Column (Project 1033)
Contracting Agency: BSEE/USCG RDC
Estimated Completion: April 4, 2016
The objective of this project is to develop techniques to mitigate oil in the water column. These techniques will be capable of being outfitted to any vessels of opportunity, operate in water depths of up to 200 feet, and be employable in a variety of conditions including offshore, near shore, and river environments. To date two alternative technologies have been selected for development. Design and laboratory testing is ongoing. This design phase may be followed by a prototype development phase for promising technologies.

Development of an Autonomous Oil Skimmer (Project 1037)
Contracting Agency: BSEE/Alion Science and Technology Corporation
Estimated Completion: April, 2016
The goal of this project is to develop a strap-on navigation, sensor, and computer control system that could be used to direct a variety of commercial off the shelf (COTS) skimmers and vessels to autonomously maneuver and skim the oil from a given area with automatic tracking and reporting of progress and performance. This autonomous oil skimmer (AOS) system consists of a commercial of the shelf (COTS) skimmer and vessel, a COTS autopilot system, a high precision navigation package, oil thickness sensors and a custom computer algorithm. This system will monitor the thickness of the oil being skimmed in real time and track oil thickness versus position as it is skimming. Based on the oil thickness gradients, the tracking algorithm will direct the vessel/skimmer to head in the direction of thickest oil concentration. As oil is recovered, statistics on oil thickness and oil recovery rate as a function of position will be tabulated for real time performance monitoring. During this effort Alion will develop a proof of concept prototype that will be field tested at the Ohmsett in 2016.

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Development of a Universal Submersible Skimmer Delivery System (Project 1053)
Contracting Agency: BSEE/Alion Science and Technology Corporation
Estimated Completion: May, 2016
Alion will investigate a new approach to how oil skimmer technologies are deployed in ice-infested waters. They will leverage their experience with submersible ROV technology to develop a system to deploy and maneuver a skimmer underwater to the location of the oil, enhancing the ability to remove oil from otherwise inaccessible locations. During this effort they will develop a proof of concept prototype that will be field tested at the Ohmsett facility in 2016.

Development of DoubleHelix Oil/Water Separation Skimming Technology (Project 1054)
Contracting Agency: BSEE/Clean Ocean Technology Systems LLC (COTS)
Estimated Completion: March, 2016
COTS will investigate a new approach for addressing the recovery of oil in ice. They will develop and test a new skimming method that lifts and separates water and oil mixtures while minimizing the collection system's overall surface area. This system will be designed to respond to an assortment of oil/ice conditions, oil types and temperatures. The prototype system will be tested at the Ohmsett facility in 2016.

ASTM F2709-08 Testing of Skimmer Systems (Project 1064)
Contracting Agency: BSEE/MAR
Completed: June 30, 2015
BSEE recently conducted independent performance testing of various skimming systems owned by BSEE and the USCG with the goal of better understanding the relationship between manufactures' published nameplate recovery rates and rates obtained through testing with a prescribed standard. Skimmers were tested at the Ohmsett Facility to ASTM F2709-08 "Standard Test Method for Determining Nameplate Recovery Rate of Stationary Oil Skimmer Systems". Most skimmers were tested in Type I and Type II test oils as defined by ASTM F631 standard. Skimmers were tested in a boomed area within the Ohmsett tank in calm conditions with an initial slick thickness of 3 inches. Data collected included Oil Recovery Rate (ORR) and Oil Recovery Efficiency (ORE) for each skimming system as defined in ASTM F2709-08.

On Board Flotation System for the Removal of Surface Oil under Arctic Conditions (Project 1069)
Contracting Agency: BSEE/National Energy Technology Laboratory (NETL)
Estimated Completion: September, 2016
This project will focus on separation of water from emulsified oily water solution in simulated arctic conditions using flotation technology. Experiments will focus on efficiency of oil separation using different surfactants, temperatures, and ice conditions and will evaluate both batch and continuous operations. This technology has been previously developed for oil water separation at ambient temperature. This project seeks to verify the viability of this technology at environmental conditions that might be experienced in recovering oil in an arctic environment.

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Literature Synthesis of Oil Properties and their Impact on Spill Response Options
Contracting Agency: BSEE
Completed: 2014
The range of oil products transported through, explored for, and produced in U.S. waters has increased dramatically over the last two decades. With these increases, the potential for spills of new materials, in new locations, or in severe climates brings into question the efficacy of traditional cleanup and spill response options. To support BSEE's mission towards promoting safety and protecting the marine environment, this project will synthesize the current state of knowledge on the relationship between the range of oil properties and spill response options to establish a baseline and aid in developing a roadmap for future research and technical development. The findings concerning the state of knowledge and key knowledge gaps will be summarized in a report and a searchable database of articles and/or abstracts and links will be provided.

Rapidly Deployable Thermal Hydrate Preventer for Subsea Oil Spill Mitigation
Contracting Agency: BSEE
Completed: October 31, 2013
The objective of the research was to assess the feasibility of a Thermal Hydrate Preventer (THP) system that will provide spill response teams with a tool that can be used to quickly mitigate subsea oil spills while preventing the formation of hydrates that can cause buoyancy problems and clog flow lines. The project established a set of deep sea conditions and requirements that can be used as a basis from which an analytical and chemical feasibility study can be conducted to assess the feasibility of a THP system with regard to conditions that will likely exist at the damaged well head; consider the hydrodynamics, thermodynamics, and chemistry of hydrates as they relate to the THP system to prevent formation of hydrates during the process of interfacing and initially capturing oil flowing from a damaged well on the sea floor and maintain a hydrate-free environment once the THP is successfully engaged with the damaged well; developed a set of scaling rules that can be used to scope and size the THP system; developed a preliminary THP system design; designed a THP demonstration test plan that can be performed immediately following the completion of this project; and established a commercial implementation plan, which defined pathways and possible commercialization partners, as well as potential funding opportunities to support the commercialization and implementation of the THP tools outside of the funding provided under this project.

Dispersants

Validation of the Two Models Developed to Predict the Window of Opportunity for Dispersant Use in the Gulf of Mexico
Contracting Agency: BSEE
Completed: 2014
In a previous BSEE-funded research project entitled "Identification of Window of Opportunity for Chemical Dispersants on Gulf of Mexico Crude Oils," two correlation models were developed to predict the window of opportunity (or time-window) for successful chemical dispersant use in the Gulf of Mexico (GOM). The models consist of correlation relationships established using best-fit correlation between readily available fresh oil properties and the window of opportunity for successful chemical dispersant use estimated using data from GOM

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crude oils and spill volumes of 1,000 and 10,000 barrels. The study demonstrated that combination of Sulfur, Saturate, and Wax contents of the fresh oils correlated best with the time-window for dispersant use.

This project aims to validate and improve the two correlation models using a well known oil spill model OILMAP by adding crude oils from outside the GOM for which physical and chemical properties are available, introducing 10 new crude oils from the GOM for which physical and chemical properties will be measured in this study, considering existing data from large tank tests and field trials/spills, and using data from new small tank tests. The project also aims to evaluate the sensitivity of the models to water temperature, wind speed, and the oil viscosity with the aim to include effects of these parameters into the models.

Operational Chemical Dispersant Research at Ohmsett
Contracting Agency: BSEE
Completed: April 2014
The overall objective of the proposed research was to advance the state of the art and knowledge in chemical dispersant use in marine spill applications. Three separate projects were conducted primarily at the Ohmsett test facility in Leonardo, New Jersey. Project (1): Validation of Time Window for Dispersant Use Model. A two-week testing program was conducted at Ohmsett to validate the models that have been developed for predicting the time window for successful use of dispersants. Project (2): Comparison of Small Scale Dispersant Testing Methods to Ohmsett Results: The Effects of Dispersant Type and Oil Properties. A one-week dispersant effectiveness testing program at Ohmsett and a series of laboratory-scale dispersant effectiveness tests in Ottawa, ON, Canada were conducted to compare results of the two methods using different oil types and dispersants. Project (3): Effectiveness of Typical Aircraft Spray Dosages on Outer Continental Shelf Crude Oils. A one-week testing program at Ohmsett was conducted to study the effectiveness of dispersant applied at typical aircraft application dosages (5 gallon/acre) on light to medium Outer Continental Shelf oils including the MS 252 crude oil spilled during the BP Horizon incident under near-at sea conditions.

Subsea Chemical Dispersant Research
Contracting Agency: BSEE
Completed: 2014
The objective of the proposed research is to advance the state of the art and knowledge in chemical dispersant use when injected into an uncontrolled subsea oil release. The research will be conducted in the laboratory and at Ohmsett. The initial testing program in the laboratory and a small wave tank will investigate the role of natural gas in the gas-dispersant-oil system and evaluate measurement methods to quantify the oil drop and gas bubble plumes resulting from a treated or untreated subsea release. This testing will determine if it is feasible to use air in subsequent under water injection tests without biasing test results. The tests will also investigate dispersant effectiveness (DE) as a function of basic parameters such as oil type, dispersant to oil ratio, and dispersant injection location.

Acoustic Assessment of Subsea Chemical Dispersant Efficacy
Contracting Agency: BSEE
Completed: September 30, 2014
The goal of this project is to develop acoustic techniques to measure the droplet size distribution for subsea release of crude oil and dispersants in the presence of natural gas. It will build off of the results of BSEE's previous proof-of-concept study for using ultrasound to assess dispersant

efficacy by measuring oil droplet sizes. This project will add the variable of natural gas to advance the measurement technology to separate the responses from oil droplets and natural gas bubbles in a subsea plume.

The project includes laboratory measurements of dispersed oil and gas to measure the acoustic resonance and scattering response from gas bubbles released from the bottom of a tank of water. Using a non-flammable gas with similar acoustic resonance properties as natural gas, various sized oil drops ranging from below 100 microns to several millimeters in diameter will be measured. The oil will also be mixed with COREXIT 9500 to determine if the dispersant alters the bubble size. Droplet sizing algorithms will be developed to best determine the oil droplet size in the presence of gas and dispersants using acoustic scattering and resonance measurements. To optimize the methods for real world conditions, tests will be conducted in the Ohmsett wave tank and the SINTEF tower tank on both surface and subsurface applications of dispersants to further develop measurement methods and algorithms.

Dispersant Effectiveness, In-Situ Droplet Size Distribution, and Numerical Modeling to Assess Subsurface Dispersant Injection as a Deepwater Blowout Oil Spill Response Option
Contracting Agency: BSEE & EPA
Completed: 2015
The project will address three issues. The first is to evaluate the performance of dispersants for subsurface injection into sub-sea blowouts. The second is to track, model, and predict the movement and spread of the deepwater plume and oil surfacing from deepwater blowouts. The third is to evaluate the influence of dispersant applications in reducing the concentration of volatile organic compounds emanating from the water surface on one specific crude oil. This will be accomplished by a number of tasks; refine existing technologies, and methodologies for the assessment and monitoring of subsurface dispersant application by measuring dispersed oil concentration, fluorescence, and in-situ oil droplet size distribution; evaluate dispersion effectiveness (DE) as a function of oil type, oil release flow rate, and dispersant-to-oil ratio (DOR) for deepwater blowout spill response; model the particle size distribution of dispersed oil under high flow velocities in deepwater blowouts; integrate the new formulation on droplet size distribution with deepwater blowout models to study the effects of the new formulation on oil fate/transport models; study the effects of dispersant on the droplet size distribution; develop a formula to predict droplet size distribution and integrate it with a transport/behavior model component for oil released from deepwater blowouts.

Dispersant Effectiveness Literature Synthesis
Contracting Agency: BSEE
Completed: 2014
To address the need for a comprehensive review and record of completed and on-going research in dispersant effectiveness, this project will review, summarize, and report on the literature available regarding dispersant effectiveness. This effort will develop reference documents and a searchable database of historical research on dispersant effectiveness. Also, the project will analyze the gaps in the existing knowledge bank and suggest possible future topics for dispersant effectiveness research studies.

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Response Risk Communication Tools for Dispersants and Oil Spills
Contracting Agency: NOAA/CRRC, SEA Consulting Group
Completed: February 2014
This project developed preparedness recommendations and response tools to address public and stakeholder information needs and risk perceptions about dispersants and oil spills. The approach is original and integrative: building on the mental models approach for risk communications, this project conducts original survey research, analyzes social media data, leverages other current survey research and decision analysis, and integrates relevant social and natural science research findings to design effective and useful communications strategies for dispersant use at oil spills for use in future preparedness and response planning. The SEA/University of Washington team consisted of investigators with extensive public, private, and academic research experience with oil spills and risk communication. Qualitative research engages community participants from recent workshops and incorporates Twitter data collected during *Deepwater Horizon* by the investigators to inform the design of the national survey. The survey research and social media analyses exploited new technology and analytical capabilities in both domains, and built on data from prior oil spill workshops as well as *Deepwater Horizon*. Quality was assured through a workshop structured to produce peer-reviewed assessments of and guidance from the project's research results, put into the context of other relevant recent research. Products from this project can be applied immediately by NOAA, other federal, state and local, as well as industry, end users to promote effective response communications about dispersants and oil spills. Project deliverables are expected to provide direct input to a strategic risk communications plan for oil spills and response options, including dispersants, that to mitigate the consequences of spills which threaten coastal communities.

DTox: a Worldwide Quantitative Database of the Toxicological Effects of Dispersants and Chemically Dispersed Oil and CAFÉ incorporation
Contracting Agency: NOAA/CRRC/Research Planning Institute
Completed: April 2014/July 2015
The ability to rapidly assess the toxicity of chemically dispersed oils is a goal shared by government, industry, consultants, and academic groups involved in oil spill response. One common need of the oil spill community is the unrestricted and rapid access to available toxicity data on dispersants and chemically dispersed oils. However, there are no centralized data repositories gathering decades of existing toxicity data. The end-result of the proposed project, the Dispersant and Chemically Dispersed Oil Toxicity Database (DTox), addresses that shared need of the oil spill community, and will contribute to a better understanding of the biological effects of dispersants and dispersed oil, a major goal of the CRRC. This database also addresses one of the three main R&D needs on the biological effects of dispersants highlighted in a recent dispersant initiative workshop. The main objectives of this project were to identify, evaluate, compile, and integrate all available toxicity data on dispersants and chemically dispersed oil, and to generate an interactive tool that can assist the oil spill response community in their management decisions regarding the use of dispersants. The ultimate goal of this effort was the synthesis of information in a meaningful way to improve scientific decision-making as well as to provide rapid access to centralized toxicity data.

Data compilation efforts built upon on-going or existing efforts, such as using the information already available in various reference databases that have already identified research on the effects of dispersants and dispersed oil. Data consider for inclusion in DTox underwent a rigorous evaluation following a strict set of rules aimed at selecting the best available and suitable data for inclusion. Data entered into the database went through QA/QC procedures

including periodic reviews of the database to ensure accurate data entry. A stand-alone executable file of DTox contains interactive features including standard navigation buttons, a navigation page including search attributes (e.g., oil type) with single or multi-factorial keyword search capabilities (e.g., Arctic, Corexit, fish), and search results displayed in various table, graphic, or report formats. Critical steps in assessing the effectiveness and usefulness of the proposed database deals with its transferability to drills, workshops, or real oil spill situations, as well as its ability to provide information that can help inform tradeoff decisions based on the current state of knowledge. In order to address this particular concern, end-users worked closely with the PI and co-PI, and were given the opportunity to review the database and provide suggestions for improvement prior to its public release. Furthermore, as part of the objectives of this project, two small areas of current oil exploration interest and with very different characteristics were used as pilot sites to assess the usefulness of the database. These tests also helped identify data gaps and sources of uncertainty, and will provide information on specific research needs. The practical application of DTox is the organization of copious amounts of toxicity data into a practical, versatile, and logical system that is easy to use by oil spill practitioners, that can be used as a scientific support tool, and that can facilitate communication of risks with the public and the scientific community concerned about the use of dispersants. The continued strength and growth of this proposed database will ultimately depend upon the active support and involvement of the oil spill community who stand to derive greatest benefit from this shared effort.

The DTox database was incorporated as one of three primary toxicity data sources in NOAA's Chemical Aquatic Fate and Effects (CAFÉ) tool released in July of 2015, along with EPA's ECOTOX and the European Centre for Ecotoxicology and Toxicology of Chemicals datasets. See http://response.restoration.noaa.gov/CAFE

Understanding chronic impacts of chemical dispersant and chemically-dispersed oil on behavior, molting success, and hormone status and of blue crab larvae: inputs for recruitment and population models.

Contracting Agency: NOAA/CRRC, University of Maryland Center for Environmental Science (UMCES)

Estimated Completion: 2014

The use of chemical dispersants as a response option following an oil spill has always been controversial, and numerous reports and reviews have highlighted the many data gaps and uncertainties regarding their use (e.g. NRC, 2005). Their goal is to reduce the impacts of oil and provide a net environmental benefit. However, the unprecedented spatial and temporal extent of their use during the BP *Deepwater Horizon* (DWH) incident led to intense media and public outcry, particularly regarding their novel subsurface use directly at the wellhead. A meeting organized by the CRRC in May 2010 concluded that their use was indeed beneficial overall, but it also highlighted data gaps and uncertainties especially regarding the length of time of their use and the need for continued re-evaluations. There are still many unknowns regarding the environmental fate and effects of dispersant and chemically dispersed oil, particularly to nonstandard laboratory species and at chronic and sub-lethal levels. The blue crab, a keystone species of the Gulf of Mexico and Atlantic coast, is crucial to both the ecology and economy of both regions. Very little is known regarding the impacts of oil, dispersant and chemically dispersed oil on any stage of the blue crab life cycle. The timing of the DWH incident coincided with crab spawning, whereby pelagic crab early life stages were exposed to oil and/or chemically-dispersed oil offshore in the photic zone surface waters. Blue crab recruitment, and thence fishery abundance, depends upon larval survival in the coastal zone, which in turn hinges

on larval perception, feeding, molting, and swimming abilities. Even at sub-lethal levels (as determined by LC50 methods), oil, dispersant or chemically-dispersed oil may impair these behaviors, resulting in larvae that do not survive until the megalopa/crab transition. These behavioral effects would be therefore functionally lethal, because of the ensuing growth, feeding, recruitment, and ultimate population level consequences.

The proposal described herein seeks to understand the impacts of dispersant, oil and dispersed oil on blue crab larvae at various stages of development. Although we will carry out some preliminary experiments to define acute (for comparison to other species in the literature) and sublethal doses our goal is to focus on the sub-lethal effects that will ultimately result in recruitment failures. These include novel approaches to ascertain physiological (molting success and endocrine disruption) and behavioral perturbations. UMCES has a unique collection of crab hatchery technology and scientific expertise to address the question of how oil, dispersant and dispersed oil affects blue crab larvae using a multiple toolbox of molecular, biochemical, physiological and behavioral endpoints. Findings and methodology of the study proposed by UMCES investigators will have value as tools to assist managers and scientists in rapid risk assessment/decision making for dispersant use during spills. The project will also develop methods adaptable for simple *in situ* and laboratory assessments of the effects of oil, dispersant and dispersed oil on blue crab larval behavior. Interactions with end users at all phases of the project will ensure that protocols and metrics are adapted to be useful in modeling or forecasting the chronic effects of "subacute" levels of chemical dispersant use on larval crab behavior and crab recruitment.

Experimental Wave Tank Studies of Oil Spill Response Using Dispersants
Contracting Agency: EPA/NRMRL
Estimated Completion: 2015
This project, which is being conducted with the Department of Fisheries and Oceans Canada (DFO), addresses the performance evaluation of dispersants applied to oil spills on the water surface and subsurface injection in subsea blowouts during oil spill response. Dispersant effectiveness (DE) will be evaluated by conducting experimental studies using a modified flow-through wave tank that is capable of generating advective current flow. The EPA/DFO wave tank will be modified to incorporate a pressurized underwater oil and gas release system. DE will be evaluated by measuring dispersed oil concentrations, ultraviolet fluorescence, and droplet-size distributions. Analysis of dispersed oil droplet size distributions will be performed using submersible Laser In-Situ Scattering and Transmissometry (LISST-100X) instruments and a digital holographic imagery camera (DHIC) particle counter. Wave tank studies will be conducted to evaluate DE as a function of oil type, dispersant type, dispersant-to-oil ratio (DOR), and oil and gas flow rates. The influences of other operational conditions, such as high oil temperature, the presence of suspended particulate materials on oil dispersion efficiency will also be tested. The experimental results, particularly those obtained for in-situ droplet size distribution data, will have significant application in the oil spill trajectory and ocean circulation models required by responders to predict the fate and transport of subsurface plume and surface oil slicks.

A second aspect of this project is development of numerical models of dispersant use. One of the most important parameters required for oil spill models to provide better prediction of oil transport is oil droplet size distribution. Literature reviews indicate that this is still poorly understood, particularly for the case of a deep water blowout where dispersants are applied. This project addresses this issue by conducting research to: (1) model the particle size distribution of

physically dispersed oil in deep water blowouts; (2) study the effects of dispersants on droplet size distribution; (3) evaluate effects of high oil temperature, low water temperature, and the co-presence of natural gas on dispersed droplet size distribution; (4) determine the minimum droplet size needed for re-coalescence of oil droplets; and (5) develop a new numerical formula for droplet size distribution and integrate it into a deep water blowout model.

Biodegradability of Dispersants and Dispersed Oil at Two Temperatures
Contracting Agency: EPA/NRMRL
Estimated Completion: 2015
The BP *Deepwater Horizon* blowout raised questions not only about the biodegradability of oil in deep waters and surface waters of the Gulf of Mexico but also raised concerns about the rate of biodegradation of the dispersants per se and the dispersed oil. The objective of this study is to determine the rate of biodegradation of several crude and refined oils, beginning with S. Louisiana crude oil (SLC) spilled in the Gulf of Mexico (GOM) in the BP *Deepwater Horizon* blowout with and without the presence of two dispersants currently on the National Contingency Plan Product Schedule (NCPPS). Since the temperatures of the GOM at depth and at the surface are substantially different, a further objective was to determine biodegradation rates at 5 °C, corresponding to average temperature at depths > 1000 m, and at 25 °C, corresponding to average temperature in the top 5 m. The experiment with Corexit 9500 on SLC has been completed and published. Experiments with two other oils were also completed, and experiments with JD2000 on the three oils were also completed in 2013. Two manuscripts comparing results from the 2 dispersants and 3 oils at the 2 temperatures will be prepared during FY2014. Additional experiments on Corexit 9500 on SLC were also conducted with substantially lower concentrations of crude oil. A manuscript by Zhuang et al describing results from this project was available in 2015.

Mesocosm testing of dispersants, shoreline cleaning agents, and bioremediation agents
Contracting Agency: NOAA/NCCOS and NOAA/ORR
Estimated Completion: March 2016 (dispersant), 2016 (shoreline cleaners), and TBD (bioremediation)
This series of studies to take place at the NOAA National Centers for Coastal Ocean Science will look at chemical oil treatment options and interaction with estuarine mesocosms, including dispersants, shoreline cleaners, and tentatively bioremediation agents. The dispersant study will determine oil and dispersant exposure thresholds for survival and sublethal responses in seven key estuarine species, representing different habitats (water column and benthos), feeding types, and trophic levels. The proposed test species include: sheepshead minnow, grass shrimp, mysids (small, shrimp-like crustaceans), an amphipod (a small, shrimp-like crustacean without a carapace), a snail, the hard shell clam, and a polychaete worm. NCCOS will also examine the influence of oil and dispersants on the growth of clinical and environmental strains of the pathogenic bacteria, *Vibrio vulnificus*. Additionally, we will assess the impacts these chemicals have on salt marsh vegetation (e.g., growth and survival) and benthic sediment communities, and compare these data with field data from the Deepwater Horizon oil spill to better define recovery horizons for benthic communities.

Developing an Innovative Dispersant Spray Drift Model (Project 1070)
Contracting Agency: BSEE/AMOG Consulting, Inc.
Estimated Completion: September 30, 2016
The objective of this project is to develop a Computational Fluid Dynamics (CFD) model of the forces acting on dispersant as it is sprayed from four commonly used aircraft models. The CFD

model results will feed into a software tool that will identify operability windows and establish exclusion zoned based on the maximum extent of dispersant spray. Specifically this effort will:

(1) Develop a thorough operational understanding of aerial dispersant spraying campaigns and develop operability limits criteria.
(2) Develop and validate CFD numerical models on a set of 4 aircraft representing a cross section of platforms used for spraying dispersants.
(3) Evaluate the CFD models and integrate into existing dispersion modeling tools as applicable.
(4) Integrate the results of Tasks 1-3 to produce a software tool to support aerial dispersant spraying operations using meteorological conditions to identify operability windows and exclusion zones.

Comparative Testing of Corexit EC9500A, Finasol OSR 52, Accell Clean DWD, and ZI 400 at Ohmsett in a Simulated Arctic Environment
Contracting Agency: BSEE
Completed: 2015
The BSEE recently conducted independent dispersant effectiveness testing. Four dispersants were selected from the EPA's National Contingency Plan (NCP) Product Schedule and were tested on an Alaskan crude oil under simulated arctic conditions at Ohmsett. They include Corexit® EC9500A, Finasol® OSR 52, Accell® Clean DWD, and ZI 400. To capture operational effectiveness issues, the dispersants were applied to a surface slick using Ohmsett's spray bar, which simulated a system similar to a boat spraying system. Data collected included dispersant effectiveness (DE) based on the volume of the surface slick which remained after the test as compared to the volume dispersed into the water column and droplet size distribution. In addition to providing performance data of the products in pseudo-field conditions, operational performance was captured as a general discussion about the ease of use, limitations, and concerns about the products in the arctic environment.

Research to Support the Prediction of Effectiveness of Dispersant Use in the U.S. Beaufort and Chukchi Seas
Contracting Agency: BSEE
Completed: 2015
The objective of the study has been to provide information to support dispersant use decision-making with respect to oil spill chemical dispersant effectiveness under the environmental conditions likely to be encountered in the U.S. Beaufort and Chukchi Seas. The goals of the research were to identify the prevailing environmental conditions in the U.S. Beaufort and Chukchi Seas that would affect dispersant performance; identify existing dispersant effectiveness tests that have been completed on Alaskan oils under conditions similar to those that exist in these two regions and identify gaps in the knowledge of dispersant effectiveness; and conduct dispersant effectiveness tests at medium scale to address the knowledge gaps.

Biodegradation Following Dispersant Usage in a Cold, Stratified, Deep Sea Setting
Contracting Agency: BSEE/Pacific Northwest National Laboratory
Estimated Completion: August 31, 2016
This project will include a series of controlled laboratory experiments simulating environments of the US Outer Continental Shelf characterized by high pressure, low temperature, and low mixing to first characterize the performance of dispersants and second, to characterize subsequent biodegradation. The experiments will characterize the physical state of the oil after

treatment with a dispersant, the influence of droplet size on biodegradation, novel noninvasive approaches to characterizing emulsions and oil degradation in pressure chambers, and the combined effects of low temperature, high pressure, and low mixing on oil biodegradation

Effectiveness of Dispersants in Frazil or Slush Ice
Contracting Agency: BSEE
Estimated Completion: March 31, 2016
The objectives of this study will be to advance the understanding of the effectiveness of chemical dispersants when applied to oil in ice-infested waters, specifically in slush or frazil ice conditions. This study will conduct weathering studies and dispersant effectiveness tests at meso-scale to establish the rate of change of oil properties when spilled in frazil ice and determine the potential for the use of chemical dispersants in this scenario.

In situ Burning

Effort: In Situ Oil Burner Tests
Contracting Agency: CRREL/SL Ross Environmental Research Ltd.
Completed: February 2015
In support of a larger effort titled In Situ Burning of Oil in Ice – Herders Fate and Effects Window-of-Opportunity, research undertaken at the Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, NH focused on determining environmental windows-of-opportunity for two commercially available herders. The goal of this effort was to define the duration of time required for the herders to effectively herd slicks of different oils and emulsions, with different degrees of evaporation, to an ignitable thickness.
http://www.arcticresponsetechnology.org/research-projects/chemical-herders-fate-effects-and-window-of-opportunity

Development of a Low-Emission Spray Combustor for Emulsified Crude Oil (Project 1061)
Contracting Agency: BSEE/Naval Research Laboratory
Estimated Completion: October 31, 2016
The objective of this project is to transition the Technology Readiness Level (TRL) of a low-emission, low pressure atomization and combustion process for emulsified crude oil from TRL 3 to TRL 5 by developing and refining the performance of a quarter and half-scale flow blurring atomizer spray burner. This project builds off of the proof-of-concept project complete as OSRR #1012.
Traditional offshore *in situ* burning of crude oil is performed by gathering the surface oil into large pools where they are ignited to form large fires. This process generally produces large plumes of soot and leaves a slick of residual hydrocarbons remaining on the ocean surface. This project will develop an operable, low-pressure oil flare system that can be incorporated into an effective oil spill remediation strategy. The system will incorporate a flow-blurring atomizer (FBA) and associated flow system capable of burning at a minimum liquid flow rate of 225 barrels per day, a combustor shroud, and a plasma torch. Design of the full-scale system is expected to commence in November 2015.

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Efficient Atomization and Combustion of Emulsified Crude Oil
Contracting Agency: BSEE
Estimated Completion: July 2014
The objective of this project was to assess the potential effectiveness of low pressure atomizing burners as a means to augment in situ burning of emulsified crude oil while minimizing pump infrastructure requirements. During this project the droplet formation and combustion behavior of flow-blurring atomizers (FBA) and effervescent atomizers (EA) were evaluated to assess their suitability and determine infrastructure requirements for disposing of emulsified oil resulting from oil spills. Atomizers with flexible geometries were designed and constructed so that the geometry may be varied to minimize atomizing air flow rate and pressure while minimizing the atomized droplet diameter, as measured by phase Doppler interferometry (PDI). The combustion behavior of the atomized oil in both straight and swirled jets was examined, again measuring the droplet diameters at different locations within the jet to determine the rate of droplet evaporation and combustion, as well as determining the operational limits including turn down, ignition, and lean blow out. The same behaviors was measured with emulsions of crude oil and sea water to determine how the atomization and combustion behavior changed with increasing fractions of sea water and determined the practical combustion limits of emulsified oil. This project was successfully completed and the lessons learned were incorporated into a new project *Development of a Low-Emission Spray Combustor for Emulsified Crude Oil* to advance the Technology Readiness Level (TRL) from a 3 to a 5 by developing and refining a quarter- and half-scale flow blurring atomizer spray burner.

Development of a Planning Standard for In-Situ Burning Operations (Project 1057)
Contracting Agency: BSEE/ SL Ross Environmental Research Ltd.
Estimated Completion: November 30, 2015
The objective of this project is to develop a planning standard for in-situ burning of crude oil on the surface of the water. This standard will encompass all factors involved in offshore burns including operating conditions, mobilization and transit times, variations in the condition of the surface slick, burn rates, and the feasible boom swath widths and tow rates. A second component of this project will be the development of a computer-based planning tool for calculating burn potential for an in-situ burning system.

A Novel Experimental Approach to Enhance Burning of Oil-Water Emulsions by Immersed Objects (Project 1049)
Contracting Agency: BSEE/Worcester Polytechnic Institute
Estimated Completion: November 30, 2015
The objective of this study is to develop a technology to use conductive metal rods to enhance the burning rate of a liquid pool of emulsified oil. Worcester Polytechnic Institute (WPI) will develop experiments in order to evaluate and optimize various parameters of importance in developing this technology, including the length, diameter, and spacing of the rods. A simplified computational fluid dynamics (CFD) analysis will be performed in parallel with the experiments to help guide the experiments and to develop an understanding of how simplifications may be successful in developing empirical relationships that will ultimately be used for designing burners deployed in the field. This study has three phases:

Phase I (small scale tests) - An experimental setup will be developed with optimum size, number and placements of rods immersed in a 10 cm pool of oil-water emulsions of octane, octane/xylene, and Alaska North Slope (ANS) crude oil at various water content. A burn consumption rate of greater than 20 mm/min will be targeted. A CFD analysis will be conducted

in parallel to explore controlling parameters. The results will be used to develop an empirical model to predict the burning rate and efficiency for given immersed object geometry and fuel parameters.

Phase II (intermediate scale tests) - In this phase the configuration developed in Phase I will be analyzed to determine if it can deliver comparable burning rates and efficiencies in a 50 cm pool of water-oil emulsions. Adjustments will be applied to the experimental configuration based on the test results. Additional parameters associated with scaling radiative and convective heat fluxes, because of increase in size, will be incorporated in the empirical model developed during Phase 1.

Phase III (large scale tests) - A prototype burner design for field deployment will be implemented during Phase III. Four large scale tests will be performed using ANS crude oil. Three sets of tests will be performed with water content at 25%, 40%, and 60%. The outcome of these large scale tests could inform the design of a simple, efficient prototype burner design that could be implemented in the field.

Burning Behavior of Oil in Ice Channels (Project 1007)
Contracting Agency: BSEE/Worcester Polytechnic Institute
Completed: December 31, 2013
The objective of this project was to assess in-situ burn efficiency of oil spills in icy conditions and set new experimental and modeling framework to explore oil spill burning on ice. This allowed quantification of combustion efficiency as well as point of extinction for liquid fuel spills in icy conditions. The objectives were accomplished in two phases. Phase one focused on identifying controlling mechanisms governing the spread and burning rate of a combustible liquid in an ice channel. Specifically, it focused on the influence of combustible liquid flash point, viscosity, channel width and channel height on the spread and burning rate of the liquid. The results were interpreted using a theoretical model developed as a part of this study. Phase two included lab-scale oil-spread and burning studies to analyze predictive models developed during phase one and evaluated additional parameters due to the increase in scale. This project was successfully completed and led to the development of a new project Burning of Crude Oil in Ice Cavities – II. The new study analyzes the impact of temperature, emulsification and weathering on ignition behavior, smoke point, lateral cavity formation, wicking agents and flame spread at bench-, intermediate-, and large-scale.

Burning of Crude Oil in Ice Cavities – II (Project 1036)
Contracting Agency: BSEE/Worcester Polytechnic Institute
Estimated Completion: September 20, 2016
The objective of the study is to experimentally investigate flammability of crude oil slicks in cold conditions. Specifically, the controlling parameters of ignition, flame spread, burning rate, and radiative fraction of heat release for oil spills in Arctic environmental conditions will be obtained. The approach taken is similar to an earlier study by WPI and sponsored by BSEE as Project 1007. A predictive model validated using intermediate and large-scale tests will also be developed. The results will improve the strategies and the net environmental benefit of, and by it the success of, oil clean-up after an accidental spill.

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Improved In-Situ Burning for Offshore Use (BSEE Project 1035, RDC Project 4704)
Contracting Agency: BSEE/RDC
Estimated Completion: May 2017
This project, co-funded by the USCG RDC and BSEE, began in February of 2014 and will continue through FY2017. The overall objective is to identify best practices for ISB use. The long term objective of this project is to ensure that a safe and efficient in-situ burn (ISB) process is developed for offshore spills. The immediate objective is to ensure that all lessons learned have been incorporated into guidance for future burns, confirm the state of any new developments, and conduct initial test burns in the burn tank at the Joint Maritime Test Facility (JMTF) at Little Sand Island in Mobile Bay, Alabama.

The first task of the project was to conduct an assessment of efforts undertaken since the Deepwater Horizon oil spill response and was completed in February, 2015. The assessment included a review of new technologies that have been developed and areas where further technology development is needed; new operational procedures and/or job aids that have been developed; and the after-action evaluation concerning the use of ISB during the Deepwater Horizon response.

The second task is to conduct test burns at the JMTD burn tank. In the past, the RDC has tested several types of fire boom and several types of igniters. Three burns were conducted November 13-19, 2015 at the JMTF. These burns were the first since 2003 to take place at this location, after a significant equipment and facility overhaul. This time, the RDC burned diesel fuel and the purpose of this burn is to develop burn test procedures so the burn pan is ready for full operational use. An additional optional task may be added to implement recommendations from the first two tasks.

Preliminary Technical Guidance and Literature Review to Assist in Evaluation of Wellhead Burning as a Blowout Response (Project 1063)
Contracting Agency: Naval Research Laboratory (NRL)
Estimated Completion: November 15, 2015
The long-term objective of this effort is to ensure safe and efficient oil spill response and recovery methods (as well as wellhead control measures) are developed and in place for potential offshore oil spills from man-made gravel islands in the federal waters off of Alaska. The immediate objective is to ensure that a thorough understanding of all historical, technical and scientific issues is gained in order to consider the case for using wellhead burning as a response tool to mitigate the effects of a well blowout from a gravel island. (Note: This work is not in-situ burning of oil contained within fire-booms; rather, it is the ignition of an uncontrolled release of oil and gas from an uncontained well directly at the wellhead after pressure control systems have failed.)

Offshore Oil Burn System via Floating Immersed Objects (Project 1068)
Contractor: Worcester Polytechnic Institute (WPI)
Estimated Completion: September 2017
The objective of this proof-of-concept study is to develop and refine a design of a simple and robust system to directly burn off oil slicks in booms at high efficiencies and with low emissions. The approach uses noncombustible and conductive immersed object to enhance the heat transfer from flames back to the fuel to achieve higher vaporization rates.

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The project will be carried out in three Phases:

Phase I: Small-scale (10 and 25 cm diameter burn pans): Determine how basic material and geometric parameters affect the heat transfer and mass loss rates. Effects of thickness, surface area and void volume of the metal mesh/wool blanket as well as the diameter, pitch, and material of the springs will be measured. Further investigation of the controlling parameters of heat and mass transfer including the height and number of springs will be analyzed.

Phase II: Intermediate-scale (70 cm diameter burn pan): Analysis and modeling of the 25 cm pan tests will be used to design the test parameters in Phase II. The data from Phase II will then be used as a guide for designing and conducting the large-scale tests.

Phase III: Large-scale (140 cm diameter outdoor burn pan): Experimental tests in a 140 cm pan will be used to evaluate the designed prototype burner for field use. The large-scale test will be a collaborative study with the USCG's Research and Development Center (R&D). The designed prototype will be tested in the USCG's test tank in Mobile, Alabama.

Quantitative Measurement of In-Situ Burn Efficiency and Rate
Contractor: Applied Research Associates
Estimated Completion: September 23, 2016
The objective of this proof-of-concept study is to develop and refine methods to directly measure the volume of oil burned and the burn rate in real time during *in-situ* burns (ISB) by integrating the direct thickness measurements using acoustic methods and surface area measurements derived from visible and infrared images.

The project will consist of the following overall tasks:

Task 1. Acoustic thickness measurement of burning oil: This task will include determining the speed of sound gradient as a function of temperature through the oil slick through direct measurements and modeling of the temperature gradient of burning oil. The effects of surface modulations caused by waves from various sea states or turbulence produced during burning operations will be determined. Thickness will be measured as a function of time.

Task 2: Image Analysis: Image processing algorithms to improve the accuracy of surface area measurements will be investigated to enable rapid, automated measurements including the effect of waves on the surface area measurements. Surface area of the burning oil will be measured as a function of time.

Task 3: System Integration: Thickness and surface area measurements will be integrated to calculate the burn efficiency and rate in real time.

Task 4: *In-Situ* Burning at Worcester Polytechnic Institute: The methods developed in the preceding tasks will be tested on larger-scale burns (1 meter diameter burn pans).

Task 5: *In-Situ* Burning at the United States Army's Cold Regions Research and Engineering Laboratory (CRREL): Tests to further develop the methods to measure ISB efficiency and rate of oil in ice will be performed in an outdoor facility.

Task 6 (Optional): *In-Situ* Burning in the Arctic: This optional task will be to determine the effects of real-world conditions on the methods developed to measure ISB efficiency and rate.

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Comparison of Physical and Chemical Characteristics of In-Situ Burn Residue and other Environmental Oil Samples Collected during the Deepwater Horizon Spill Response (Project 1010)
Contracting Agency: BSEE & NOAA
Completed: September 3, 2014
The objective of this project was to use the physical and chemical analysis of the BP *Deepwater Horizon* in-situ burning samples as a focal point for comparisons to the analyses of other oil and residue samples of relevance to the spill response. In particular, the pre- and post-burn sample results were compared to samples from three sources. The first set of samples came from the Macondo well source oil, the same source oil burned under controlled conditions at the NOAA/LSU chemistry support lab in Baton Rouge, Louisiana. The second set of samples came from tarballs trawled from the depths by deepwater shrimp nets in late 2010 and early 2011 north of the blowout location. The third set of samples came from *Deepwater Horizon* oil collected at sea, in marshes, and from beaches.

The results provided insights into the changes that occur to oil when it is burned and how the physical and chemical characteristics compare to other forms of oil encountered during a spill (e.g., emulsified surface oil, beach- and marsh-stranded oil, etc.). Analysis of burn residues and comparison to deepwater tarballs helped obtain an understanding of the longer-term fate of burned oil and identify potential impacts to pelagic and benthic environments and human activities like mid-water and bottom trawling. In addition to the physics and chemistry of the different oil types, the work examined candidate biomarkers used to "fingerprint" oil and residues to source materials and recommend those that appear to have the greatest utility for identifying the origins of burned and/or weathered oil.

Multifunctional Herding-Sorbent Agents for Use in Icy Waters (Project 1071)
Contracting Agency: BSEE/PNNL
Estimated Completion: September 17, 2016
This project will evaluate the potential of three novel approaches to herd oil for in-situ burning or recovery operations, and the potential biodegradation of residues remaining. Specifically, this study will:

(1) Evaluate candidate treatments to enhance sawdust absorption of oil and decrease absorption of water, resulting in development of a candidate sawdust herding material.
(2) Evaluate the properties of the selected material developed in icy water
(3) Evaluate the ability of the agents to herd oil to a suitable thickness for burning, and conduct small burns to confirm that the agents will burn. The study will potentially conduct large scale burning tests pending the success of smaller scale tests.
(4) Evaluate the biodegradation of oil absorbed onto the sawdust agents, and the potential for pre-treating the sawdust with biodegradation agents.

Bioremediation

Biodegradability and Toxicity of Biodiesel Blends
Contracting Agency: EPA/NRMRL
Estimated Completion: 2014
While there are great benefits to using biodiesel as a fuel, its environmental fate and effects need to be evaluated and the risks associated with their use understood. There is a dearth of information on the states and conditions biodiesel and its blends have in the environment, their

fate, and their effects on aquatic organisms. The current understanding of the fate and effects of biodiesel and its various blends is inadequate to evaluate environmental risks from its use. Unlike petroleum diesel, biodiesel fuels are made from many sources, including soy oil, rapeseed/canola oil, reclaimed restaurant grease, fish oil, and rendered animal fats, each having different chemical compositions. This wide variability of biodiesel formulations may result in very different toxicological and environmental fates depending on the feedstock.

The objective of this work is to determine the biodegradability and biodegradation kinetics of different biodiesel blends (B0, B20, B40, B60, B80, and B100, corresponding to 100% petroleum diesel and 20-100% soybean oil fatty acid methyl esters). The second objective is to quantify the toxicity of the water accommodated fraction of the biodiesel blends as measured by the Microtox assay, which uses the bioluminescent bacterium *Vibrio fischeri* as the test species. Aerobic biodegradation kinetics experiments on the six soybean-oil based blends were successfully completed (soybean oil is predominantly characterized by 1 double bond in its fatty acid structure). The fatty acid methyl esters (FAMEs) of the biodiesel were found to undergo abiotic disappearance in the killed controls and the blanks, by hydrolysis of the FAMEs into free fatty acids (FFA) followed by polymerization in the presence of a putative catalyst. Work has also been completed on the aerobic biodegradation kinetics of flaxseed oil (characterized by predominantly 3 double bonds in the fatty acid structure). Work is continuing on the anaerobic biodegradation of flaxseed and soybean oil biodiesel and their blends. This research is scheduled to end in FY 2014. Four journal articles were produced from this project, and at least one more is scheduled for completion and publication by the end of FY 2014.

Alternative Chemical Countermeasures

Development of a Laboratory Protocol Testing the Effectiveness of Commercial Solidifiers in Cleaning Up Oil Spills on Water
Contracting Agency: EPA/NRMRL
Estimated Completion: 2016
The objectives of this laboratory study are: (1) to develop a protocol for testing the effectiveness of solidifying an oil slick on water using commercial solidifiers; (2) to evaluate the recovery of oil from solidified product; (3) to determine the mechanism of solidification; and (4) to quantify the effects of environmental conditions (temperature, salinity, mixing energy, degree of oil weathering, etc.) on the solidification process. These objectives will lead to a better scientific understanding of the solidification process so that interpretation of results of testing is facilitated. Good progress has been made in the laboratory, and results have been published in Sundaravadivelu et al., 2014 and 2015 and can be found in the publication list of this report. A round robin experiment was initiated in 2015 and results will be available in 2016. Final protocol delivery to EPA OSWER Office of Emergency Management (OEM) will be made before FY17.

Development of a Surface Washing Agent Protocol
Contracting Agency: EPA/NRMRL
Estimated Completion: 2016
The goal of this work is to develop a standardized and reproducible testing protocol to evaluate the shoreline cleaning efficiency of surface washing agents (SWAs). Oil removal efficiencies for SWA treatments are being compared to the washing efficiency of salt water without SWA. Since a good SWA should not disperse oil into water, the dispersability of each SWA is being evaluated separately using the baffled flask test (BFT). To date, the protocol experiments have

already been completed for a medium crude oil (Prudhoe Bay Crude or PBC), a light crude oil (S. Louisiana Crude or SLC), and a heavy refined oil, IFO180. The Headquarters program office, the Office of Emergency Management (OEM) asked if the protocol could be extended to larger media (like granite tiles) for more realistic application and testing of products, however reproducibility issues existed with using granite tiles. Experimental testing reverted back to the use of sand media and a round robin test was conducted in 2015. Final delivery of protocol and completion of this project will be in 2016.

Temporary Oil Spill Storage and Recovery in Alaskan Arctic Using Petrogel Technology (Project 1034)
Contracting Agency: BSEE/The Pennsylvania State University
Estimated Completion: March 31, 2016
Petrogel is a superabsorbent polymer that exhibits promising absorption capacity (40 times its weight in preliminary testing) as well as the potential for being effectively refined as a regular crude oil. The objective of this project is to advance the polymer "Petrogel" with a focus on the practical development and evaluation of Petrogel materials for use with Alaskan North Slope (ANS) crude oil in low temperature conditions. Its absorbency characteristics as well as methods for recovery of this absorbent will be tested at the Ohmsett facility in 2015 and 2016.

Enhanced Oil Recovery from Oil-Seawater Mixtures Through the Coupling of Magnetic Nanoparticles and Electrically Conducting Ultrafiltration Membranes (Project 1052)
Contracting Agency: BSEE/University of California, Riverside
Estimated Completion: October, 2015
The objective of this project is to develop a continuous oil/seawater separation process that can be deployed in arctic conditions aboard oil skimming vessels and can recover a majority of skimmed oil while producing an oil-free water stream that can be safely discharged. This separation technique relies on the coupling of electrically conducting ultrafiltration membranes with ferromagnetic nanoparticle-stabilized oil droplets allowing for efficient collection and separation of spilled oil without the need for storing vast volumes of contaminated water. The process involves the following steps:

1. The recovered oil/water mixture is mixed with ferromagnetic nanoparticles (MNs).
2. This mixture is sent through an ultrafiltration membrane to separate the oil from the water.
3. The separated oil is stripped of the MNs which can be reused.
4. The oil-free water could theoretically then be discharged.

This project will result in a bench scale oil/water separation treatment train, a preliminary techno-economic analysis for a full-scale oil/seawater separation process, and a preliminary engineering design package for a pilot-scale oil/seawater separation process

Oily Waste and Oil Disposal

Demonstration of a Polypropylene Packed Material for the Treatment of Solids in Shipboard Bilgewater (WP-201224)
Contracting Agency: USN/NSWCCD
Estimated Completion: 2016
The current USN Fleet has more than 170 oil/water separators (OWS) as primary treatment systems and 30-35 of these ships have membrane-based ultrafiltration systems for secondary treatment with more planned for backfit. The presence of solids or particulate matter in USN shipboard oily waste processing streams is known to negatively impact the operation and

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performance of oil pollution abatement equipment. Solids removal is a critical step in the treatment of ships' oily waste streams, e.g., bilgewater. Wastewater solids build up rapidly on currently available filters, resulting in frequent backflushing. Solids that are not properly managed contribute to increased maintenance requirements, system downtime, and associated costs that may otherwise have been avoided. Inspections of OWS' plate stack assemblies have shown that over time, unprocessed particulate matter accumulates in the system, reducing performance and requiring more frequent maintenance. Solids can also cling to oil droplets suspended in water, making the droplet neutrally or negatively buoyant and resulting in oil passing through the OWS and accumulating on the membrane faces. Clogging of the openings to the ceramic membrane lumens (axial channels through which the wastewater flows) has been a continuing problem. Solids blocking the lumen entrances can (1) severely reduce the membrane flow rate resulting in much lower bilgewater processing rates, (2) increase membrane regeneration frequency, and (3) require manual removal and cleaning of the membranes. These maintenance issues are directly attributable to the inability of current treatment system filters to reliably remove solids from the waste stream. The objective of this project is to demonstrate the ability of the Bacti-Twist Filter Media (BTFM) technology to retain solids from shipboard generated oily waste with measurement of key effluent quality parameters. The BTFM filter is a black spiral-shaped plastic media made of polypropylene material, which is hydrophobic, giving it the ability to attract the complex hydrophobic mixture of oil, fine solids, and surfactants present in bilgewater. The project will conduct laboratory and shipboard evaluations to validate the performance of the BTFM filter. In addition to performance, the evaluations will determine the system's reliability, operation, maintenance, and integration requirements.

The laboratory validation testing has been completed and data analysis is currently in progress. Preliminary data results indicate that the BTFM technology is successful in removing the problematic solids that lead to clogging of the ceramic membrane lumens. The BTFM technology will be recommended for shipboard validation testing. The BTFM filter will provide Armed Forces ships with a filter media system that would allow the ships to process their oily waste without being hindered by solids. Maintenance for an OWS with the BTFM will be lower than one without the technology. The filter will reduce the frequency of solids clogging membranes and membrane face plugging events. The filter should also help decrease the manpower requirement and costs associated with operating and maintaining the OPA treatment systems. The life of the primary and secondary treatment stages will be longer with the BTFM filter.

INJURY ASSESSMENT AND RESTORATION

Environmental Impacts and Ecosystem Recovery

Deepwater Horizon Natural Resource Damage Studies
Contracting Agency: NOAA, NRDA, DWH Trustees
Estimated Completion: April 2016
Nearly 200 studies assessed the impacts of the BP Deepwater Horizon spill and response to natural resources and human uses in the Gulf of Mexico. These studies are listed at http://www.gulfspillrestoration.noaa.gov/oil-spill/gulf-spill-data/ and data is continuing to be posted on DWH Data Integration Visualization Exploration and Reporting (DIVER) at https://dwhdiver.orr.noaa.gov/.

Improving injury assessment techniques for marine oil spills in the Arctic: Field testing high priority ephemeral data collection guidelines
Contracting Agency: NOAA/ORR/ARD
Estimated Completion: 2014
This research contributes to a broad effort by NOAA's Office of Response and Restoration, Assessment and Restoration Division to plan for Natural Resource Damage Assessment (NRDA) in the Arctic by helping to improve exposure and injury assessment techniques. In the event of an oil spill in the Arctic, a high priority for NRDA, during the first few days and weeks after the spill, would be shore-based ephemeral data collection to assess pre-impact conditions and exposure and injury to resources in, or associated with the nearshore areas. Along much of the high arctic coast, nearshore areas include sheltered lagoons and the shorelines of the barrier islands that delimit lagoons. These habitats are highly productive and at risk of being impacted by a marine oil spill. The Assessment and Restoration Division has been developing high priority ephemeral data collection guidelines, a subset of which were field tested at nearshore sites on the North Slope in July, 2013. Sampling protocols for environmental media and organisms that were tested included: water, ice, sediment, benthic invertebrate, fish and fish bile. In the event of a spill, these samples would be analyzed for polycyclic aromatic hydrocarbon (PAH) or PAH metabolites to evaluate exposure to oil chemicals, as well as for assessment of injury endpoints in exposed resources. In addition to protocol testing, this work evaluated methods and levels of effort required for sampling and contributed to identifying appropriate, reasonable and defensible exposure and injury endpoints for NRDA in the Arctic. High Arctic ephemeral data collection protocols were updated with new information garnered from field testing and will be going through additional peer review and refinement. Having reviewed and validated ephemeral data collection protocols for baseline sampling and NRDA helps assure that high priority data of sufficient quality and quantity for NRDA is collected during the early phase of an oil spill.

Bowhead Whale Baleen efficiency testing in water, with oil, and with dispersed oil
Contracting Agency: NOAA/ORR/ERD, NOAA/ NMFS/OPR, North Slope Borough, BSEE/OHMSETT, WHOI (NOAA/NMFS grantee)
Estimated Completion: 2016
This cooperative research project evaluates the effects of oil, dispersed oil, and dispersant on the physical performance characteristics of bowhead and humpback whale baleen. The experiments utilize baleen provided by the North Slope Borough Wildlife Department and National Marine Fisheries Service (NMFS)/Woods Hole Oceanographic Institute (WHOI), facility time and crude oil provided by BSEE, and dispersant provided by OSRL. The study will provide basic new information to cetacean biologists and resource managers, assess the impacts of oil and dispersed oil on feeding behavior, and provide inputs for modeling the bioenergetics of baleen whales.

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Enbridge Oil Spill Natural Resource Damage Assessment
Contracting Agencies: NOAA, USFWS and other trustees
Estimated Completion: On-going
NOAA and the USFWS are coordinating with co-trustees and Enbridge, to collect information as part of the NRDA for an oil spill in the Kalamazoo River. The purpose of the NRDA is to determine the appropriate type and amount of restoration needed to compensate the public for injuries to or lost use of their natural resources from the oil spill and associated response activities. The spill occurred on July 25, 2010 when a 30-inch diameter pipeline ruptured and released diluted bitumen, a heavy form of crude oil, into a tributary creek of the Kalamazoo River in Marshall, MI. This type of oil is also referred to as "tar sands oil." Enbridge, the owner and operator of the pipeline, estimated that approximately 843,000 gallons spilled. Oil traveled approximately 40 miles downstream in the Kalamazoo River. Containment and absorbent booms were placed and the oil did not pass Morrow Lake, located about 10 miles east of Kalamazoo, MI. http://www.darrp.noaa.gov/greatlakes/enbridge/index.html

Evaluation of Gulf of Mexico oceanographic observation networks impact assessment on ecosystem management and recommendation
Contracting Agency: NOAA RESTORE Act Science Program, University of Miami
Estimated Completion: 2017
This research team will work with resource managers to expand observing system evaluation techniques typically focused on observations of ocean circulation to include biogeochemistry and ecosystem observations in order to provide recommendations on the full suite and location of observations needed for monitoring and managing the Gulf of Mexico. This contract was awarded in August, 2015.

Environmental Restoration Methods and Technologies

Beaver Butte Creek Gasoline Spill Restoration Plan Implementation and Habitat Improvement
Contracting Agency: NOAA, USFWS, and Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO)
Estimated Completion: On-going
A tanker truck and trailer, loaded with approximately 10,300 gallons of unleaded gasoline, jackknifed and became separated. The tanks on both the tanker truck and trailer ruptured and approximately 5,388 gallons of unleaded gasoline were spilled. A majority of the gasoline flowed overland and was released directly into Beaver Butte Creek just above the confluence with Beaver Creek on the reservation of the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO). The spill resulted in direct impacts to Chinook salmon, steelhead, and other natural resources. Riparian vegetation was also impacted.

NOAA, USFWS, and CTWSRO, as Trustees, worked together to develop a Restoration Plan and Environmental Assessment, which was finalized in 2009. Using funds from the settlement with the company responsible for the spill, the Trustees have chosen a range of restoration projects to improve conditions for steelhead trout and Chinook salmon throughout the Beaver Creek watershed. The restoration plan focuses on steelhead in particular because they are an endangered species, already on the brink of extinction.

Implementation of the Restoration Plan began in 2011 with construction of the Lower Quartz Creek Riparian Fencing Project. In 2012 two in-stream restoration projects were constructed on the main stem of Beaver Creek and two more fencing projects were built in the Quartz Creek watershed. Project implementation and monitoring is on-going and will continue for the next several years.

Human Safety and Health

Development of a Real-time Monitoring Protocol for Assessing Volatile Organic Compounds (VOC) Impacts on Response and Cleanup Workers' Safety during Dispersant Operations (Project 1006)
Contracting Agency: BSEE/Louisiana State University
Completed: December 4, 2014
The objective of the proposed research was to develop real-time and passive monitoring protocols to effectively determine the impact of dispersant use and VOC release, in both surface and subsurface applications, on oil spill response worker safety. A series of bench-scale laboratory studies was performed to determine mass balance of airborne benzene, toluene, ethyl benzene, and xylenes (BTEX) components within a baffled-flask microcosm following addition of the dispersant COREXIT 9500 to a South Louisiana crude oil. This was followed by a series of macro-scale laboratory studies to determine mass balance of BTEX components within an 85 liter flow-through tank system for analysis and modeling of VOC concentrations in the air and water boundary layers surrounding an oil slick prior to and following dispersant application. A series of high-pressure static vessel laboratory studies wasperformed to determine mass balance of BTEX components within a one liter stainless steel pressure vessel to simulate VOC dissolution in oil plumes at various depths and pressures following subsurface dispersant application. Finally, a series of test-tank studies was conducted at Ohmsett to determine real-time analysis of VOCs in water and air phase after South Louisiana crude oil is chemically dispersed into the water column. After analysis of all of the data, in cooperation with NOAA and USCG, recommendations and countermeasures to optimize dispersant use for VOC control and worker safety were developed.

Sociological and Economic Impacts

Indicators and assessment framework for ecological health and ecosystem services
Contracting Agency: NOAA RESTORE Act Science Program, Texas A&M University Corpus Christi
Estimated Completion: 2017
This research will develop and test a set of ecological and ecosystem service indicators, including their link to human wellbeing, and an approach for using them based on specific management needs in the Gulf of Mexico. This contract was awarded in August, 2015.

ED_001324_00007486-00148

To: Principe, Vanessa[Principe.Vanessa@epa.gov]
From: Wilson, Gregory
Sent: Mon 12/7/2015 5:54:40 PM
Subject: RE: Comments on IAA No. E12PG00037 Draft - Dispersant Effectiveness, In-Situ DSD and Modeling to Assess SSDI as Deepwater Blowout Response Option / Evaluation of Fluorescence to Improve Forensic Response Tools
E12PG00037_Draft Final Report_sept2015_VP_GW.docx

My comments

From: Principe, Vanessa
Sent: Wednesday, November 25, 2015 2:05 PM
To: Wilson, Gregory <Wilson.Gregory@epa.gov>
Subject: Comments on IAA No. E12PG00037 Draft - Dispersant Effectiveness, In-Situ DSD and Modeling to Assess SSDI as Deepwater Blowout Response Option / Evaluation of Fluorescence to Improve Forensic Response Tools

G:

Here are my comments. Some of the highlights in the text were just to my understanding/questions – not important.

I have very few comments on the Fluorescence section of this report, as it is definitely over my head. That said, I did read through it and have some suggestions in the opening sections regarding DWH statements/characterization of decision-making, and in a couple places beyond that section.

Take or disregard as you see fit, V

To: Principe, Vanessa[Principe.Vanessa@epa.gov]; Wilson, Gregory[Wilson.Gregory@epa.gov]
Cc: Mason, Steve[mason.steve@epa.gov]; Smith, Monica[smith.monica@epa.gov]; Foster, Althea[Foster.Althea@epa.gov]; Ruhl, Christopher[Ruhl.Christopher@epa.gov]; michael.k.sams@uscg.mil[michael.k.sams@uscg.mil]
From: Crossland, Ronnie
Sent: Tue 11/8/2016 8:07:22 PM
Subject: Material from last RRT6 Dispersant Exercise
RRT6-ART Evaluation Job Aid_Dispersants_071816_clean.docx
SSDI Approval Package V1.pdf
PPT presentation V4.pdf
AppxC Resources at Risk Northern GOM NOAA-RPI Apr 2016.pdf
OPS Plan Package V3-Clr.pdf
SIMA for RRT6.pdf

Vanessa and Greg,

Mike Sams and I thought we would share material from our most recent RRT6 dispersant exercise.

Thanks,

Ronnie

DRILL- DRILL- DRILL Resources at Risk for the northern Gulf of Mexico (GOM)

[Section I and II are incident-specific]

III. Oil type, behavior and effects to impacted species

Louisiana crude is a light crude that has an API of 37. It has moderate concentrations of toxic compounds and is moderately volatile. Observations during aerial surveys indicate that the crude oil readily emulsifies (both during its 5,000 ft rise to the water surface and by wave action on the sea surface). Thick emulsified oil occurs as large patches (tens of meters in diameter), long streamers, and smaller tarballs. Large areas of sheens are associated with the emulsified oil. The oil could concentrate in convergence zones, in patches of Sargassum (where sea turtles and birds may also concentrate).

Oil that reaches nearshore and coastal areas will mostly be weathered crude oil from the well. These relatively large accumulations of emulsified oil can heavily coat intertidal areas. The emulsified oil could also become mixed with sand, either in the surf zone or after stranding onshore. These oil:sand mixtures are heavier than water and could accumulate as submerged oil mats in nearshore areas off Gulf sand beaches. They can become buried by the movement of offshore bars, be buried within the beaches, and persist for years. The oil can become trapped in and form thick deposits along fringing marsh shorelines. The stability of the emulsions, once stranded on the shoreline and sheltered from wave action, is uncertain. One possibility is that the emulsion could break, releasing liquid oil that could be only moderately weathered (emulsification slows weathering processes such as evaporation and dissolution). The release of liquid oil inside the marsh fringe or on beaches could cause significant additional impacts to benthic, water-column, and water-surface resources in these shallow water habitats. Animals may not avoid the weathered emulsified oil, particularly if it does not provide any indication of hazards (e.g., it might not smell oily, could look like natural debris), and animals could still attempt to feed in the open areas between the patches that would still have some sheen. Further away from the source, tarballs (oil <10 cm in diameter), tar patties (oil >10 cm), and occasional tarmats may strand along the shoreline. These oil deposits could range in texture from soft, emulsified oil to semi-hardened outer layers. The oil may adhere to aquatic vegetation, birds, fur-bearing mammals, and reptiles. Oil coming ashore will be weathered so oil effects are likely to be a result of coating and smothering of shoreline resources, ingestion of tarballs by sea turtles, and the persistence of oil in sediments.

Background on Potential Effects

The impacts arising from oil spills on aquatic species in open waters likely varies by species and with the rate at which oil partitions and dilutes in the water column, and with the co-occurrence of sensitive life stages and both physically and chemically dispersed oil. Species that may be at increased risk of exposure to chemically dispersed oil are those entrained within and traveling with the water mass containing the chemically dispersed oil (e.g., small species,

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embryos, larvae, zooplankton), followed by slow-moving species and life stages. Highly mobile species (e.g., adult shrimp, pelagic fish) may be less likely to be exposed to high concentrations of chemically dispersed oil due to dilution and avoidance.

Toxicity Studies

Exposure of aquatic species, and in particular early life stages, to physically and chemically dispersed oil can lead to lethal and non-lethal but ecologically important impacts (Teal and Howarth, 1984; Albers, 1995; NRC, 2005), but the onset of these impacts depends on several factors including oil concentrations and exposure duration. A growing body of literature (e.g., Carls *et al.*, 1999; Heintz *et al.*, 1999; Heintz *et al.*, 2000; Incardona *et al.*, 2004; Incardona *et al.*, 2005; Incardona *et al.*, 2011; Incardona *et al.*, 2013; Mager *et al.*, 2014; Esbaugh *et al.*, 2016) has shown that under controlled laboratory conditions fish embryos exposed for several hours post hatch to low oil concentrations (>1 mg/L oil, dissolved polycyclic aromatic hydrocarbons [PAHs] in the low μg/L range) develop gross abnormalities, with permanent impacts potentially causing reduced survival later in life (Incardona *et al.*, 2013). These impacts have been documented under laboratory conditions on embryos of pelagic species (i.e., yellowfin tuna [*Thunnus albacares*], Southern bluefin tuna [*T. maccoyii*], yellowtail amberjack [*Seriola lalandi*], and mahi mahi [*Coryphaena hippurus*]), some of which occur in the Gulf of Mexico (Incardona *et al.*, 2014; Mager *et al.*, 2014; Esbaugh *et al.*, 2016). However, the impacts arising from oil spills on fish embryos in open waters and their recruitment to the larval stages likely varies with the rate at which oil partitions and dilutes in the water column, as well as with the co-occurrence of fish embryos and the chemically dispersed oil. As a point of reference, a large proportion of water samples (75%) collected during the *Deepwater Horizon* oil had total PAH concentrations <1 μg/L, though water samples in the immediate vicinity of the wellhead had concentrations >1,000 μg/L (Boehm *et al.*, 2016). In contrast to these sensitive life stages, juveniles and adults are generally highly mobile and may only be temporarily exposed to chemically dispersed oil given their ability to move in and out of the water masses containing the entrained oil.

One of the greatest limitations in understanding the potential impacts related to dispersant use in open waters is the lack of data derived using relatively realistic exposure conditions. Even greater uncertainties and data limitations exist on the potential impacts of subsea dispersants. Despite these limitations, toxicity data from controlled laboratory studies could provide conservative estimates of potential impacts. Toxicity data are commonly reported as lethal or effects median concentrations (LC50 and EC50, respectively[1]). With regards to dispersants alone, data based on spiked exposures[2] show that most data fall within the slightly to practically

[1] The LC50 is the concentration lethal to 50% of the exposed test population, while the EC50 is the concentration that causes an adverse non-lethal effect to 50% of the exposed test population. As a general rule, the smaller the LC50 or EC50 values, the greater the toxicity.

[2] Spiked or spiked flow-through tests are tests that address the dilution that occurs in open waters by reproducing under laboratory conditions rapid changes in concentrations within the water column.

nontoxic range[3], with most data falling within the practically nontoxic range. Even for sensitive species, most toxicity values for COREXIT 9527 and COREXIT 9500, regardless of exposure conditions, are >20 mg/L, falling within the range of what is considered slightly toxic. Similarly, the reported toxicity of South Louisiana crude oil chemically dispersed with COREXIT 9500 from 96-h (LC50s and EC50s combined) constant static exposure[4] ranges from 4.84 to 18 mg THC/L (n=8 records) (NOAA/ERD, 2015), falling within the moderately to slightly toxic range.

Potential Levels of Concern

Derivation of potential thresholds of concern could be achieved by the use of Species Sensitivity Distributions (SSDs). SSDs are cumulative distributions of toxicity data that allow for comparisons of the relative sensitivities of aquatic species dispersed oil, and they are useful in that they could be used to calculate the 5th percentile Hazard Concentration (HC5), or concentrations assumed to be protective of 95% of all species in the SSD. While HC5 values may not be necessarily protective of all aquatic organisms, and particularly of those known to be most sensitive to oil, their derivation is often conservative enough to a large range of sensitivities. Conservative estimates HC5s for COREXIT 9527 and COREXIT 9500 are 8.38 mg/L and 4.04 mg/L, respectively, falling within the moderately toxic range. However, these concentrations are assumed to be worst case, as exposure concentrations under standard dispersant applications (ASTM, 2010a; ASTM, 2010b) are not expected to remain constant in the water column, and at any given moment are likely below these concentrations. Based on modeled information of toxicity data (96-hr exposures) for South Louisiana crude oil, the conservative HC5 estimate is 0.97 mg THC/L with a 95% confidence interval of 0.63-1.49 mg THC/L (Bejarano and Barron, 2014). These values fall within the upper and lower ends of the highly toxic and the moderately toxic range, respectively. As a point of reference the range of oil concentrations in the chemically dispersed underwater plume range from non-detectable levels to 6,130 mg/L, with a geometric mean of 1.09 µg/L (Boehm *et al.*, 2011). Given that this oil release is smaller in volume (6,500 bbl/d) than the estimated release rate of the *Deepwater Horizon* oil spill (ca. 50,000-60,000 bbl/d[5]), the THC concentrations would be expected to be lower.

Potential Impacts

As describe above, HC5 values could be used as surrogate for threshold concentration, with the lower confidence value for South Louisiana crude oil (0.63 mg/L; 96-hr exposures) serving as a conservative threshold to assess potential impacts to the most sensitive life stages. While these concentrations may be possible, it is unlikely that these concentrations would remained elevated for a long period given the dilution that may occur within the water column. Although

[3] Toxicity LC50 and EC50 categories for aquatic organisms are as follows: Very highly toxic <0.1 mg/L, Highly toxic 0.1-1 mg/L, Moderately toxic >1-10 mg/L, Slightly toxic >10-100 mg/L and Practically nontoxic >100 mg/L Source: http://www2.epa.gov/pesticide-science-and-assessing-pesticide-risks/technical-overview-ecological-risk-assessment-0

[4] Exposures that do not account for the natural dilution that occurs in open waters.

[5] Source: Oil Budget Calculator Deepwater Horizon (http://www.restorethegulf.gov/sites/default/files/documents/pdf/OilBudgetCalc_Full_HQ-Print_111110.pdf)

short exposures have the potential to negatively impact embryos, natural mortality of larvae is high, and the projected plume is limited in geography compared to most larval distributions. Therefore, impacts on entire populations are unlikely. However, given that early life stages of several species (**Table 1**) may be present in the area and their spatial distribution overlap with the water mass containing chemically dispersed oil, it is expected that a portion of each species' cohort would be exposed. Because most other aquatic groups (i.e., sea turtles, marine mammals) are able to swim through water mass containing chemically dispersed oil, potential impacts are likely minimal. A greater risk of exposure may result from inhalation of volatile compounds and smothering at the water surface.

Table 1. List of representative species in the offshore area of interest with early life stages at risk of potential exposure to the water mass containing chemically dispersed oil.

Species	Spatial Overlap with Early Life Stages	Potential Impacts
White and brown shrimp	Spawning inshore of the area of interest; eggs and larvae may be present	Early life stages in shelf waters may be exposed and experience mortality. It is not likely that a large proportion of the population is exposed to oil, given the timing and location of the spill relative to these species' habitats.
Blue crab	Spawning inshore of the area of interest; eggs and larvae may be present	
Bluefin tuna, yellowfin tuna	Spawning in the area; eggs and larvae are present	Early life stages may be exposed and larval mortality can occur. Given that natural mortality rates are high, population level impacts are unlikely.
Swordfish	Larvae may be present year-round in the area	Early life stages may be exposed. It is not likely that a large proportion of the population is exposed to oil, given the timing and location of the spill relative to these species' habitats.
Other pelagic species (e.g., dolphinfish, blackfin tuna, blue marlin, dolphinfish, wahoo, whale shark, white marlin, amberjack, mackerel)	Early life stages may be present in the area; spawning mostly in a different geography.	
Red grouper, scamp, and red, lane, gray and vermilion snapper	Spawning in the area; eggs and larvae may be present	

IV. Shoreline Resources at Risk

Shorelines in the area of impact consist of barrier islands (including Breton, Cat, Ship, Horn, Petit Bois, Dauphin, Santa Rosa, Okaloosa Islands) with mainly fine-medium grained sandy beaches. Mainland shorelines are primarily salt marshes with interspersed pockets of fine- to medium-grained sand beaches. Fresh- and brackish-water marshes may be present in some areas depending on localized freshwater input. Manmade shorelines (riprap, seawalls) are also present

in developed areas. Some sheltered flats are present and may be exposed dependent on wind conditions. Riprap jetties are present at the mouth of Destin inlet (East pass) and Perdido Pass.

Because of the broken nature of the interior shoreline, the thick emulsified oil patches and tarballs could penetrate deeply beyond the outer "shoreline" depending on wind conditions, into areas that are very shallow, muddy, and difficult to access. The emulsified oil will readily adhere to marsh vegetation and could form thick bands on the vegetation as water levels vary. There is also the possibility that the emulsions could break after stranding on the marsh and release liquid oil, which could spread over a much larger area than the footprint of the emulsified oil patches.

Emulsified oil deposited on fine-medium grained beaches is unlikely to penetrate deep into the sediment (<4 mm); however, depending on local conditions, accumulation of sand may result in rapid burial of stranded oil. Some of the barrier islands have a low elevation and could be overwashed during high wind conditions. If oil was present at that time, it could be transported across the islands and either buried in the washover fan or deposited in the marshes on the leeward side of the island. On outer sand beaches, the tarballs and tar patties will collect in debris lines near the high tide mark. Depending on the tides and the concentration of tarballs in the water, the collection zone may be from less than a meter to several meters wide. There may also be scattered tarballs across the rest of the beach face, but in much lower concentrations. The outer shell of the tarball may be heavily weathered by the time it reaches these beaches, making it less sticky with less of a tendency to pick up sediments. However, the inside of the tarball may still be relatively fresh, so if pressure is applied, the outer skin will rupture and the tarball may adhere to whatever it is in contact with. Also when stranded out of the water, the daytime heating may melt the tarballs causing them to adhere to whatever surface they are on at the time. Depending on the beach cycle, the tarballs and patties can become buried during depositional cycles. Therefore, rapid removal is important.

Oil may adhere to rough surfaces, such as riprap and seawalls, leaving a band at the high-water line. In the riprap areas, emulsified oil and tarballs may collect in the crevices between the rocks; there is often debris in these crevices, which can also become oiled, which can be a source for chronic reoiling.

V. Biological Resources at Risk

<u>Threatened, Endangered, and Special Concern (T/E) Species</u>

Birds

Louisiana - Brown pelican (LA SE, over 8,500 pairs) are present and nesting on and around the Chandeleur Islands. Red knot (FT) are present on the shores of the Chandeleur Islands.

Mississippi - Brown pelican (MS SE) and snowy plover (MS SE, nesting) are present on Mississippi barrier islands and Mississippi mainland shorelines. Brown pelican are also present on Mississippi nearshore waters.

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Alabama - Least bittern (AL State Protected (SP)), white ibis (AL SP, nesting in locations east of Mobile Bay), mottled duck (AL SP, nesting), northern harrier (AL SP) are present on the back sides of AL barrier islands. Reddish egret (AL SP) are present on and around AL barrier islands and in nearshore waters west of Mobile Bay. Snowy plover (AL SP) is present on islands surrounding Dauphin Island Bay, and it is nesting on Pelican Island, a large sandbar south of Dauphin Island. Wilson's plover (AL SP) is present and nesting on islands surrounding Dauphin Island Bay and Pelican Island. American oystercatcher (AL SP) is present and nesting on Pelican Island and ocean beaches east of the mouth of Mobile Bay. Willet (AL SP) is present and nesting on the west end of the Mobile Point peninsula and is present on islands surrounding Dauphin Island Bay and ocean beaches east of the mouth of Mobile Bay. Black skimmer (AL SP), common tern (AL SP) and gull-billed tern (AL SP) are present and nesting on Pelican Island. Caspian tern (AL SP) are present on the back sides of AL barrier islands, islands surrounds Dauphin Bay, and beaches at the west end of the Mobile Point peninsula. Royal tern (AL SP) is present in nearshore waters west of Mobile Bay and in waters on the back side of barrier islands east of Mobile Bay. Sandwich tern (AL SP) is present on ocean beaches east of the mouth of Mobile Bay. Seaside sparrow (AL SP) is present and nesting on the islands north of Dauphin Island Bay.

Florida - Black skimmer (FL Species of Special Concern (SSC)), brown pelican (FL SSC), and least tern (FL ST) are present throughout the Florida potential impact area. Piping plover (FT, FL ST) are present on ocean beaches and the back sides of barrier islands throughout the Florida potential impact area. Reddish egret (FL SSC, occasional) and snowy egret (FL SSC, occasional) are present in lagoons/ponds? behind the beach east of Destin. Snowy plover (FL ST) are present and nesting on beaches of barrier islands from the FL/AL border to the east end of Santa Rosa Island.

Reptiles

Five species of endangered or threatened sea turtles inhabit the Gulf of Mexico. Of those, Kemp's ridley (FE, LA E, MS E, AL SP) , leatherback (FE, LA E, MS E, AL SP) and loggerhead (FT, LA T, MS E, AL SP) are most likely to be present in offshore waters near the source of the spill. Turtles are most likely to be encountered in offshore waters (> 5.6 km from shore), and less than 100 m in depth, and are more frequently sighted from spring to fall. Loggerhead turtles are known to frequent oil production platforms. Juvenile turtles are often found associated with *Sargassum* mats, where oil can also accumulate. Nearshore, Kemp's ridley are abundant, loggerheads are common, Green (FE in Florida, FT elsewhere; LA T, MS E, AL SP) are occasional visitors, leatherbacks are rare, and hawksbill (FE, LA E, MS E, AL SP) are very rare or rare.

Sea turtle nesting season is in progress. Nesting occurs in the area of impact, and is summarized below:

- Loggerheads nest on beaches east of Ship Island, MS in low-medium concentrations
- Greens nest in low concentrations on beaches in Alabama and Florida

- Kemp's ridley nest in Alabama in low concentrations
- Leatherback nesting has occurred in the Panhandle of Florida but is rare

Diamondback terrapins (AL SP) can be found along the gulf shoreline in the area of impact.

Direct contact with oil may irritate the eyes, mouth, and nostrils of turtles. Turtles may also ingest tarballs while foraging.

Fish

Gulf sturgeon (FT, LA E, MS E, AL SP) and smalltooth sawfish (FE) may be present in the GOM in the area of impact. Most sturgeon are migrating upstream at this time of year; however, some may remain in coastal areas. Juvenile and adult sawfish may be present in coastal areas and on the continental shelf off of the Florida coast. Both species are demersal and are not common around the spill site, so impacts are likely to be limited. Populations of Alabama shad (AL SP) occur in coastal waters likely to be impacted. Adults return to saltwater habitats in Apr-May after spawning upstream.

Marine mammals

Of the 29 species of marine mammals known to occur in the Gulf of Mexico, all are protected and six (sperm, sei, fin, blue, humpback and North Atlantic right whales) are listed as endangered under the ESA. Of these, only the sperm whale is considered to commonly occur, in the northern Gulf of Mexico. Areas beyond the 100 m isobath are important habitat for endangered Sperm whale (FE, LA E). West Indian manatee (FE, LA E, MS E, AL SP), occurs primarily in Florida bays, estuaries and coastal waters but their range appears to be expanding, and could also be present in sheltered waters in Alabama, Mississippi, and Louisiana. The primary risk of oil spills to marine mammals is inhalation of volatile compounds from fresh oil and ingestion of oiled prey.

Terrestrial mammals

The Perdido Key Beach Mouse (FE, AL SP) is present on beaches and in dune habitats on Perdido Key. Alabama Beach Mouse (FE, AL SP) can be found on beaches from Fort Morgan to Gulf State Park in Alabama. Mice can ingest tarballs and encounter subsurface oil while burrowing, exposing them to the toxic components of oil.

<u>Other Birds</u>

Offshore birds

High concentrations of common tern occur offshore in the impact area. Other offshore bird species present in the area include: Audubon's shearwater, band-rumped storm-petrel, black-capped petrel, brown booby, herring gull, laughing gull, Leach's storm-petrel, long-tailed jaeger, magnificent frigatebird, masked booby, pomarine skua, red-billed tropicbird, sooty tern, Wilson's storm-petrel.

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Nearshore and shoreline birds

Louisiana - American oystercatcher (26 pairs), least tern (123 pairs), and Wilson's plover (164 pairs) are present and nesting on the Chandeleur Islands. Over 5,000 pairs of terns are present and nesting on the southern Chandeleur Islands. Scaup (100,000s) occur nearshore just east of the Chandeleurs Islands. American white pelican (10s) may be present immediately around the Chandeleur Islands. "Nearshore" birds present in waters off Louisiana extend to the edge of the continental shelf and include: gulls, magnificent frigatebird, parasitic jaegar, pomarine skua, royal tern, and sandwich tern.

Mississippi - Birds present on and immediately surrounding Mississippi barrier islands include nesting marsh birds (clapper rail, king rail, least bittern), shorebirds (American oystercatcher [nesting], killdeer, sanderling, semipalmated plover [nesting], willet [nesting], Wilson's plover [nesting]), terns (black skimmer, gull-billed tern [nesting], least tern, royal tern, sandwich tern), raptors (bald eagle [nesting], osprey [nesting]), gulls, wading birds (black-crowned night-heron [nesting], cattle egret, great blue heron, great egret, green heron, little blue heron, reddish egret, snowy egret, tricolored heron, yellow-crowned night-heron [nesting]), dabbling ducks, and migratory songbirds. Many of the same species are found along the mainland shoreline of Mississippi, including several species of shorebirds, raptors, and several species of gulls and terns. Birds present in Mississippi salt marshes include the aforementioned wading bird and marsh bird species, marsh-obligate passerines, rails, and several species of waterfowl (including blue-winged teal, Canada goose [nesting], hooded merganser [nesting], mottled duck [nesting], and wood duck [nesting]). Nearshore birds in Mississippi include gulls, terns, waterfowl and sea ducks, common loon, and pied-billed grebe.

Alabama - Birds present on and immediately surrounding Alabama barrier islands include brown pelican, nesting marsh birds (clapper rail, king rail, sora), shorebirds (black-bellied plover, black-necked stilt, killdeer [nesting], least sandpiper, lesser yellowlegs, sanderling, semipalmated plover, solitary sandpiper, stilt sandpiper, western sandpiper), gulls (Bonaparte's gull, herring gull, laughing gull, ring-billed gull), raptors (bald eagle, osprey), wading birds (great blue heron [nesting], great egret [nesting], green-backed heron [nesting], green heron [nesting], snowy egret [nesting], tricolored heron), and waterfowl (mallard, Canada goose [nesting]). Many of the same species are found along the mainland shoreline of Alabama, including raptors, gulls, terns, and marsh birds. Birds present in Alabama salt marshes include the aforementioned wading bird and marsh bird species, rails, and waterfowl. Nearshore birds in Alabama include gulls, terns, raptors, brown pelican, magnificent frigatebird, northern gannet (common), common loon, horned grebe, and pied-billed grebe.

Florida - Birds present on and immediately surrounding Florida barrier islands include shorebirds (black-bellied plover, dunlin, sanderling, semipalmated plover, short-billed dowitcher, willet [nesting], Wilson's plover), terns (Forster's tern, common tern, royal tern), gulls (laughing gull, ring-billed gull), double-crested cormorant, osprey. Many of the same species are found along the mainland shoreline of Florida, including osprey and several species of gulls and terns. Birds

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present in lagoons behind beaches east of Destin include bald eagle, gull-billed tern, shorebirds (least sandpiper, lesser yellowlegs), and wading birds (great blue heron, great egret, green heron, yellow-crowned night-heron). Nearshore birds in Florida include gulls (laughing gull, ring-billed gull), terns (common tern, royal tern), and osprey.

Oil can adhere to the feathers reducing insulation, water buoyancy, and water repellency, leading to sickness or death from hypothermia and/or drowning. Diving birds, such as cormorants and loons, are usually at high risk during oil spills because they spend nearly all their time on the water surface. Wading birds, shorebirds, dabbling ducks, gulls, and terns, can also be severely impacted by oil in some cases. Wading birds and some shorebirds may be directly oiled and can become oiled on the upper body and feathers by coming in contact with oiled vegetation or wrack. Direct oiling of birds reduces the buoyancy, water repellency, and insulation provided by feathers, and may result in death by drowning or hypothermia. Preening of oiled feathers may also result in ingestion of oil resulting in irritation, sickness, or death. Bird oiling may continue even after the floating oil slicks have been removed, depending on the extent of oiled habitat. Oil brought back to the nests by adult birds may kill or injure eggs and young birds. All species can potentially ingest oil while feeding. Wading birds and marsh birds (i.e. American bittern) eat small fish, insects, and crustaceans and may be at risk of coming in contact with oil on the water or oiled marsh vegetation while feeding.

Other Marine Mammals

Offshore - A small population of Bryde's whale, the only baleen whale to commonly occur in the Gulf, inhabits the shelf break region in the northeastern Gulf. Pods of transient Killer whales have been sighted with increasing frequency over the past several decades in the Gulf of Mexico, including off the Mississippi Delta. Other species that may be found in the vicinity of the spill site include: Blainville's beaked whale (common), Clymene dolphin (low), Cuvier's beaked whale (common), Dwarf sperm whale (common), False killer whale (rare), Fraser's dolphin (Rare), Gervais' beaked whale (common), Killer whale (low), Melon-headed whale (common), pantropical spotted dolphin (abundant), pygmy killer whale (low), pygmy sperm whale (common), Risso's dolphin (common), Rough-toothed dolphin (low), Short-finned pilot whale (common), spinner dolphin (low), striped dolphin (common). Little information is available on the reproduction and calving of offshore whales and dolphins in the Gulf. However, a number of species do breed and calve in winter through early summer.

Nearshore and inshore - Atlantic spotted dolphins may be present on the shelf. Bottlenose dolphin are abundant and common in bays, estuaries and inter-bay passes in the northern Gulf of Mexico, and have less opportunity to avoid oil than do offshore whales and dolphins. Bottlenose dolphin may breed and calve throughout the year.

The primary risk of oil spills to toothed whales and dolphins is inhalation of volatile compounds from fresh oil. Bottlenose dolphins exposed to oil during the Deepwater Horizon Oil Spill have

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shown hormonal abnormalities and high incidences of lung disease from inhaling the toxic components of oil. Oil may foul the baleens of baleen whales if they encounter oil while feeding.

Terrestrial mammals

Muskrats, nutria and other small mammals can be found in brackish-freshwater marshes. The Santa Rosa Beach mouse is present on Santa Rosa Island. Unless exposed to the oil for prolonged periods, mortality is not expected. Terrestrial mammals are at risk of oiling of fur and ingestion during attempts to clean themselves.

Habitats

Offshore - The spill source is in an area of high habitat suitability for deepwater coral species. Known deepwater coral ecosystems are in the impact area, including Viosca Knolls. DeSoto Canyon is a large geologic feature in the impact area that harbors many deepwater reefs and other benthic communities. Due to the high habitat suitability, other deepwater coral reef systems that have not yet been discovered may be in the impact area as well. Sargassum is found on the top of the water column, and has higher concentrations in summer months in the GOM.

Inshore - Seagrass is present on the sound side of the Chandeleur Islands, the Mississippi barrier islands and Dauphin Island, and in the lower portion of Perdido Bay. Seagrass may be present at other locations in addition to these.

Deepwater corals exposed to oil suffer mortality of the portions of colonies exposed, and the fauna dependent on the corals are likely impacted as well, though less is known of these impacts. Care should be taken to leave seagrass beds undisturbed during cleanup, so that the grasses can grow back during the summer growing season. It is doubtful that the oil will be mixed into the substrate, unless there is a lot of disturbance during clean up. It is possible that fauna hiding or living in the grass will be exposed to and impacted by the oil.

Invertebrates

Offshore - Deep benthic environments support unique invertebrate communities, including brittle stars, red crab, hermit crabs, red shrimp, squat lobsters, isopods, sea pends, sea cucumbers, anemones and sponges.

Shelf - Commercially valuable invertebrates likely to be impacted by the spill include white shrimp and brown shrimp. Brown shrimp spawning may be occurring in waters between 46-90m deep, Brown shrimp spawn from Sep-May, and the peak months are Sep-Nov and Apr-May. White shrimp are abundant and spawning from May-Nov, and are generally found in waters less than 30m deep. Blue crab spawning is ongoing throughout the summer and larvae may be present. Females are found in high abundance in shallow areas of the Gulf of Mexico during the

spawning season as they release their eggs. Squid may be spawning in the water column Mar-Nov. Pink shrimp may be present.

Inshore - Extensive oyster beds occur on the sound side of the barrier islands in the area of impact, particularly in Mississippi Sound. Oyster spawning is triggered by rising temperatures and salinities, and typically begins in May and runs through Nov. Brown shrimp are abundant in estuarine waters late summer through fall. Larval white shrimp and blue crab will begin moving inshore in May-Jun to estuarine nursery areas. Blue crabs may be present in nearshore and inshore waters.

Early life stages (eggs, larvae) of invertebrates are sensitive to exposure to the toxic components of oil, which could have both immediate and delayed impacts to the populations. Shrimp eggs are pelagic and buoyant; however, later larval stages have the ability to regulate their position vertically throughout the water column.

Fish

Offshore - Bluefin tuna are abundant and spawning in the vicinity of the spill source through May; eggs and larvae may be present in the area of impact. Yellowfin tuna are also spawning in the area from May-November and swordfish larvae may be present year-round, however neither have been observed in high densities in the spring. Dolphinfish may be spawning year round. Pelagic species such as blackfin tuna, blue marlin, bluefin tuna, dolphinfish, swordfish, wahoo, whale shark, white marlin, yellowfin tuna are present in offshore waters. Early life history stages of these species may be present.

Demersal fish species likely present in the vicinity of the release site are likely to include sixgill shark, eels and cusk-eels.

Shelf - Many species of reef fish are present on the continental shelf in the area of impact, including commercially important snapper and grouper species. Larval duration for most of these species is approximately a month, and larvae are pelagic. Grouper species that may be spawning in the area of impact include (spawning months in parentheses): red grouper (May-Jul) and scamp (Mar-May). Snapper species spawning in area of impact include: Red snapper (Mar-Nov), lane snapper (Mar-Aug), gray snapper (Jun-Nov), and vermilion snapper (Apr-Nov). A summary of 17 years of SEAMAP data indicates that higher larval abundances have been observed in fall samples compared to spring (Mar-May) surveys for most snapper species, whereas groupers have only been observed in the spring in low densities.

Several species of coastal sharks can be found in the nearshore and shelf waters of the northern Gulf of Mexico, arriving in May and remaining until the fall. Shallow coastal waters are important pupping grounds for some of these species, including Atlantic sharpnose shark, Blacktip shark, finetooth shark, scalloped hammerhead, and possibly lemon sharks. Other shark species present include whale, bull, great hammerhead, shortfin mako, and spinner sharks.

Many forage species begin spawning in coastal waters in the spring and continue through the fall, including anchovies, sardines, mullet, and herrings.

Other species that may be spawning (and therefore have eggs or larvae present) in nearshore waters include: Atlantic tripletail (May-Sep), White trout (Mar-Oct), Squid (Mar-Nov), Ballyhoo (Mar-Jul), Atlantic spadefish (Apr-Sep), Great barracuda (Apr-Oct), Kingfishes (Apr-Aug), Florida pompano (larvae present through May), Great barracuda (Apr-Oct), amberjack and Spanish mackerel (Apr-Oct), spotted seatrout (Apr-Sep).

Inshore - Marsh habitats are extremely productive and support high biodiversity and abundance of resident estuarine fish. Estuarine areas are important nursery grounds for many commercial species, including snappers, groupers. Inlets and passes are often sites of fish spawning.

Larval and juvenile stages of fish are at a greater risk from the toxic components of oil. Embryonic and larval exposure to PAHs from crude oils has been linked to cardiac defects in pelagic fish species, such as yellowfin tuna. Oil mixed into the water column can adhere to the gills of a fish, causing lethal or sublethal effects.

VI. Human-Use Resources

[The area of interest] is within the bluefin tuna Habitat Area of Particular Concern (HAPC) for spawning bluefin tuna.

Species with Essential Fish Habitat in shelf and offshore near the waters of spill include whale shark, bigeye thresher shark, bluefin tuna, skipjack tuna, longbill spearfish, swordfish, white marlin, roundscale spearfish, yellowfin tuna, silky shark, angel shark, blue marlin, longfin mako shark, oceanic whitetip shark,scalloped hammerhead shark, finetooth shark, bignose shark, bull shark, shortfin mako shark, bluefin tuna, longbill spearfish, sailfish, spinner shark, blacknose shark, smooth dogfish, Atlantic sharpnose shark, sandbar shark, and tiger shark.

Federally designated Essential Fish Habitat (EFH) is present in coastal and inshore waters for stone crab, shrimp, reef fish, red drum, coral, and coastal migratory pelagic species.

The area of impact is a productive commercial fishing area and a popular recreational fishing destination. Should the oil make landfall, it has the potential to impact economically important amenity beaches in Mississippi, Alabama, and Florida.

Management Areas present in the area of impact include Gulf Islands National Seashore, Bon Secour NWR, Breton NWR, and numerous state-protected areas. Critical habitat occurs in the area and is summarized by species below:

- Loggerhead sea turtle - Beaches on Horn and Petit Bois Islands, the Alabama shoreline east of Mobile Bay, and Perdido Key. Marine critical habitat occurs in the GOM offshore of the spill site.
- Perdido Key Beach Mouse - Perdido Key

- Alabama Beach Mouse - sites present in Bon Secour NWR and Gulf State Park
- Piping Plover - many of the barrier islands west of Mobile Bay and along Mississippi Sound, Fort Morgan, some sites on Santa Rosa Island
- Gulf sturgeon - Mississippi Sound, Pascagoula Bay, Pensacola Bay and tributary rivers.

References

Albers, P. H. (1995). Petroleum and individual polycyclic aromatic hydrocarbons. *Handbook of ecotoxicology* **2**.

ASTM (2010a). *ASTM Standard F1737/F1737M-10. Standard Guide for Use of Oil Spill Dispersant Application Equipment During Spill Response: Boom and Nozzle Systems.* West Conshohocken, PA, ASTM International.

ASTM (2010b). *ASTM Standard F1738-10. Standard Test Method for Determination of Deposition of Aerially Applied Oil Spill Dispersants.* West Conshohocken, PA, ASTM International.

Bejarano, A. C. and M. G. Barron (2014). Development and practical application of petroleum and dispersant interspecies correlation models for aquatic species. *Environmental Science & Technology* **48**(8): 4564-4572.

Boehm, P. D., L. L. Cook and K. J. Murray (2011). Aromatic hydrocarbon concentrations in seawater: Deepwater Horizon oil spill. *International Oil Spill Conference Proceedings (IOSC)*, American Petroleum Institute. abs371.

Boehm, P. D., K. J. Murray and L. L. Cook (2016). Distribution and Attenuation of Polycyclic Aromatic Hydrocarbons in Gulf of Mexico Seawater from the Deepwater Horizon Oil Accident. *Environmental Science & Technology.*

Carls, M. G., S. D. Rice and J. E. Hose (1999). Sensitivity to fish embryos to weathered crude oil: Part I. Low-level exposure during incubation causes malformations, genetic damage, and mortality in larval Pacific herring (*Clupea pallasi*). *Environmental Toxicology and Chemistry* **18**(3): 481-493.

Esbaugh, A. J., E. M. Mager, J. D. Stieglitz, R. Hoenig, T. L. Brown, B. L. French, T. L. Linbo, C. Lay, H. Forth and N. L. Scholz (2016). The effects of weathering and chemical dispersion on Deepwater Horizon crude oil toxicity to mahi-mahi (*Coryphaena hippurus*) early life stages. *Science of The Total Environment* **543**: 644-651.

Heintz, R. A., S. D. Rice, A. C. Wertheimer, R. F. Bradshaw, F. P. Thrower, J. E. Joyce and J. W. Short (2000). Delayed effects on growth and marine survival of pink salmon *Oncorhynchus gorbuscha* after exposure to crude oil during embryonic development. *Marine Ecology Progress Series* **208**: 205-216.

Heintz, R. A., J. W. Short and S. D. Rice (1999). Sensitivity of fish embryos to weathered crude oil:Part II. Increased mortality of pink salmon (*Oncorhynchus gorbuscha*) embryos incubating downstream from weathered Exxon Valdez crude oil. *Environmental Toxicology and Chemistry* **18**(3): 494-503.

Incardona, J. P., M. G. Carls, H. Teraoka, C. A. Sloan, T. K. Collier and N. L. Scholz (2005). Aryl hydrocarbon receptor-independent toxicity of weathered crude oil during fish development. *Environmental Health Perspectives*: 1755-1762.

Incardona, J. P., T. K. Collier and N. L. Scholz (2004). Defects in cardiac function precede morphological abnormalities in fish embryos exposed to polycyclic aromatic hydrocarbons. *Toxicology and Applied Pharmacology* **196**(2): 191-205.

Incardona, J. P., T. K. Collier and N. L. Scholz (2011). Oil spills and fish health: exposing the heartof the matter. *Journal of Exposure Science and Environmental Epidemiology* **21**(1): 3-4.

Incardona, J. P., L. D. Gardner, T. L. Linbo, T. L. Brown, A. J. Esbaugh, E. M. Mager, J. D. Stieglitz, B. L. French, J. S. Labenia and C. A. Laetz (2014). Deepwater Horizon crude oil impacts the developing hearts of large predatory pelagic fish. *Proceedings of the National Academy of Sciences* **111**(15): E1510-E1518.

ED_001324_00007500-00013

Incardona, J. P., T. L. Swarts, R. C. Edmunds, T. L. Linbo, A. Aquilina-Beck, C. A. Sloan, L. D. Gardner, B. A. Block and N. L. Scholz (2013). Exxon Valdez to Deepwater Horizon: Comparable toxicity of both crude oils to fish early life stages. *Aquatic toxicology* **142**: 303-316.

Mager, E. M., A. J. Esbaugh, J. D. Stieglitz, R. Hoenig, C. Bodinier, J. P. Incardona, N. L. Scholz, D. D. Benetti and M. Grosell (2014). Acute embryonic or juvenile exposure to Deepwater Horizon crude oil impairs the swimming performance of mahi-mahi (*Coryphaena hippurus*). *Environmental science & technology* **48**(12): 7053-7061.

NOAA/ERD (2015). *Chemical Aquatic Fate and Effects (CAFE) Database. Version 1.1 [Computer Software]. National Oceanic and Atmospheric Administration, Emergency Response Division, Office of Response and Restoration, Seattle, WA.*: 40 + Appendices.

NRC (2005). Oil Spill Dispersants: Efficacy and Effects, National Academy Press, Washington, DC p.

Teal, J. M. and R. W. Howarth (1984). Oil spill studies: a review of ecological effects. *Environmental Management* **8**(1): 27-43.

ED_001324_00007500-00014