NRT

Environmental Monitoring for Atypical Dispersant Operations:

Including Guidance for
- Subsea Application
- Prolonged Surface Application

May 30, 2013

Chair

Vice Chair

Member Agencies

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PREFACE

During the *Deepwater Horizon* event in the Gulf of Mexico, dispersant was applied using novel techniques and in amounts never seen in U.S. waters. For the first time, dispersant was injected at the source of the release at depths of nearly a mile, and in quantities approximating three quarters of a million gallons. In addition, aircraft and vessels deployed dispersant to the surface at volumes topping 1,000,000 gallons over the course of the response, quantities unsurpassed in North America. Such atypical uses of dispersant during a response were neither envisioned nor incorporated into existing Regional Response Team (RRT) dispersant use plans, nor were they addressed in the existing Special Monitoring of Applied Response Technologies (SMART) monitoring program.

Therefore, the National Response Team (NRT) developed the *Environmental Monitoring for Atypical Dispersant Operations: Including Guidance for Subsea Application and Prolonged Surface Application* (approved May 30, 2013) to assist On-Scene Coordinators (OSCs) and RRTs in making incident-specific decisions regarding atypical dispersant use, including expedited decision making.

The *Environmental Monitoring for Atypical Dispersant Operations* is a living document envisioned to continue addressing monitoring challenges as they become necessary; and, as resources allow, other atypical dispersant applications. In its current version, this document contains the following:

- ***Subsea Application Guidance –*** generally applies to the subsurface ocean environment, focusing particularly on operations in waters below 300 meters and below the average pycnocline.

- ***Prolonged Surface Application Guidance –*** supplements and complements the existing protocols as outlined in the SMART monitoring program where the duration of the application of dispersants on discharged oil extends beyond 96 hours from the time of the first application.

The *Environmental Monitoring for Atypical Dispersant Operations* may be adopted and/or modified to address specific needs. The RRTs may also use this guidance to inform their planning and response activities in an ocean environment, consistent with national policy. This guidance does not negate existing pre-authorization plans developed in accordance with 40 CFR 300.910(a) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The NRT urges RRTs to actively engage with members of federal, state, local, tribal, and industry groups in using the guidance. The NRT's Science and Technology Committee expects that changing technologies, accumulated experience, and operational improvements will bring about revisions to the document.

Comments should be submitted to the attention of the NRT Science and Technology Committee Chair at NRTSandTCommittee@sra.com.

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The National Response Team (NRT) acknowledges and thanks the NRT member agencies, and state and federal agencies participating on the Regional Response Teams (RRTs), for their contributions in preparing this document.

Core contributing participation includes the following:

- U.S. Environmental Protection Agency
  - Office of Emergency Management
  - Office of Research and Development
- U.S. Coast Guard
  - Office of Marine Environmental Response Policy
  - Gulf Strike Team
- National Oceanic and Atmospheric Administration
  - Office of Response and Restoration
- U.S. Department of the Interior
  - Office of Environmental Policy and Compliance
  - Bureau of Ocean Energy Management
  - Bureau of Safety and Environmental Enforcement
- SRA International, Inc. (Contractor)
  - Energy, Environment, and Organizational Performance

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1.0 BACKGROUND AND OVERVIEW

1.1 Introduction

The *Environmental Monitoring for Atypical Dispersant Operations* provides a resource for the Regional Response Team (RRT), in accordance with 40 CFR 300.910 of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), when considering the atypical use of dispersants before and during an oil discharge. This document, developed by National Response Team (NRT) member agency representatives, is intended for use when responding to oil discharges and for RRT development of Regional Contingency Plans and expedited decision making addressing dispersant use of this nature.

The data generated by the measures below are meant for use as an operational response decision-making tool and not as a part of the long-term Natural Resources Damage Assessment (NRDA) data gathering efforts that may apply to the dispersant operation or other parts of the response. However, all of the data collected as a function of the guidance may be made available to NRDA personnel as soon as practicable.

While this document does not recommend specific cut-off points for dispersant applications (e.g., based on quantity of oil, amount of dispersant applied, duration of application), it does recommend "key indicators" the On-Scene Coordinator (OSC), and other decision makers should consider during dispersant monitoring and application activities. These key indicators should be revisited repeatedly throughout the incident to help determine whether and when dispersants should be applied or continue to be applied. Actions taken based on key indicator data should also consider the resource tradeoffs associated with dispersant use.

This document is intended solely as guidance, does not constitute rulemaking or limit future rulemaking in any way by any agency and may not be relied upon to create any right or benefit, substantive or procedural, enforceable by law or in equity, by any person. Any agency or person may take action at variance with this guidance. Mention of trade names or commercial products does not constitute endorsement or recommendations for their use by the U.S. Environmental Protection Agency (EPA), U.S. Coast Guard (USCG), U.S. Department of Commerce (DOC) including the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of the Interior (DOI) including the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE), or the Government of the United States of America.

1.2 Guidance Objectives

The monitoring guidance does not impose regulatory requirements on oil development and production companies or impose Oil Spill Response Plan (OSRP) requirements. It is intended for use as a planning tool by each RRT, to be tailored to regional-specific concerns, needs, and environmental considerations. RRTs should use the guidance when modifying or reviewing existing Regional Contingency Plans to address lessons learned from the *Deepwater Horizon* event.

The guidance provides recommendations to RRTs for making incident-specific decisions concerning atypical dispersant applications. Authorization of the use of dispersants is governed by 40 CFR 300.910 of the NCP. The guidance recommends sampling and monitoring protocols that should be in place when atypical dispersant use for applicable situations is authorized.

1.3 General Scope and Assumptions

1) The guidance does not directly address the health and safety of spill responders or monitoring personnel, which is covered by the general site safety plan for the incident (as required by 29 CFR 1910.120). Field personnel should be trained under the Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) requirements, as appropriate.

2) It is important that the Unified Command (UC) agree on the sampling and monitoring objectives, goals, and associated procedures and plans early on in an incident. However, the UC may modify these objectives and goals based on incident-specific circumstances. Authorization of use for all dispersant applications must be done in accordance with 40 CFR 300.910 of the NCP. Decisions to apply dispersants, like all other decisions, should be documented.

3) The OSC, with the concurrence of EPA and, as appropriate, the states, and in consultation with DOC and DOI natural resource trustees, retains the authority to direct the collection of data and/or to grant temporary deviation from one or more of the sampling or monitoring recommendations if deemed necessary due to incident-specific circumstances, field observations, and/or input from key stakeholders and technical specialists.

4) The OSC should establish a Dispersant Environmental Monitoring Unit (DEMU), comprised of government, academia (as practical) and the Responsible Party's (RP's) technical specialists, as appropriate, to coordinate and oversee the implementation of sampling and monitoring activities. The DEMU should be established as a part of Environmental Unit (EU) unless otherwise directed by the OSC, and in consultation with the OSC's Scientific Support Coordinator (SSC).

5) This document is not designed to be a monitoring plan specific to an individual oil discharge event. It is designed to provide general guidance for the development of a sampling and monitoring plan tailored to the actual discharge, taking into account the needs of a particular region. As such, prior to any atypical dispersant application, the RP should develop a detailed sampling and monitoring plan in coordination with the DEMU.

6) The guidance does not provide training on monitoring for a specific technology. Rather, the guidance assumes that monitoring personnel are fully trained and qualified to use the equipment and techniques mentioned and to follow those guidelines.

7) While the guidance should inform such policies, it is not intended to preempt or replace any RRT agreements currently in place that address dispersant operations discussed below.

8) The guidance attempts to balance feasible, operationally efficient, and scientifically sound monitoring activities with the understanding that atypical dispersant applications necessitate specific considerations beyond those addressed by Special Monitoring of Applied Response Technologies (SMART).

9) The NRT intends to revise and improve the guidance based on lessons learned from the field, advances in technology, and developments in techniques as appropriate, but recommends using the best available technologies and practices.

10) Relevant definitions can be found in 40 CFR 300.5 of the NCP. To the extent that other terms are defined herein, it is solely for clarity of this guidance.

11) The RP or appropriate technical specialist should consult with the manufacturer to identify any dispersant-specific marker compounds for monitoring purposes and confirm its suitability for use. Information on dispersant-specific markers should be used to advise the OSC and incorporated into all monitoring plans.

12) The guidance encourages a joint effort between governmental and RP personnel when the RP has been identified and is acting as a coordinating member of the UC established for the response. All monitoring data collected should be directed to the DEMU. Data management should be overseen by the Federal Government with full transparency and data sharing within the UC and with the RP.

13) The guidance is not intended to provide action levels or specific ecological levels of concern. These levels should be developed during case-by-case discussions between the UC and key stakeholders. However, action levels and levels of concern should be compatible with the ecological risk screening tools recommended in the guidance in order for these tools to be most useful.

14) The guidance provides a framework for the collection, analyses, and dissemination of pertinent data to key stakeholders so resource-tradeoff decision making can be supported.

15) Sections 3.0 *Communications and Reporting*, 4.0 *Quality Assurance Project Plan*, 5.0 *Airborne Volatile Organic Compounds*, 6.0 *Ecological Toxicity Assessment*, and 7.0 *Action Levels* apply to all atypical dispersant applications addressed in this guidance.

1.4 Dispersant Environmental Monitoring Unit (DEMU)

1) The DEMU, under the direction of the OSC, coordinates and oversees the implementation of the sampling and monitoring activities set forth in this guidance and, as appropriate, any additional sampling and monitoring activities required by circumstances of the particular response.

2) The DEMU is established within the EU under the Planning Section of the UC (see Figure 1), unless otherwise directed by the OSC. The DEMU is co-led by EPA and NOAA.

3) The SSC directly coordinates with the DEMU to ensure an unfiltered data flow to the OSC and government decision-makers, including the EPA representative and the federal Natural Resources Trustees.

4) As required, the DEMU will establish and operate task forces, in coordination with the Dispersants Group in the Operations Section, in order to facilitate sample collection, analysis and reporting.

5) The RP, when identified, has primary responsibility for sampling and monitoring activities during a response to a spill incident under the direction of the OSC, including financial and logistical support for the DEMU and any subordinate task force activities.

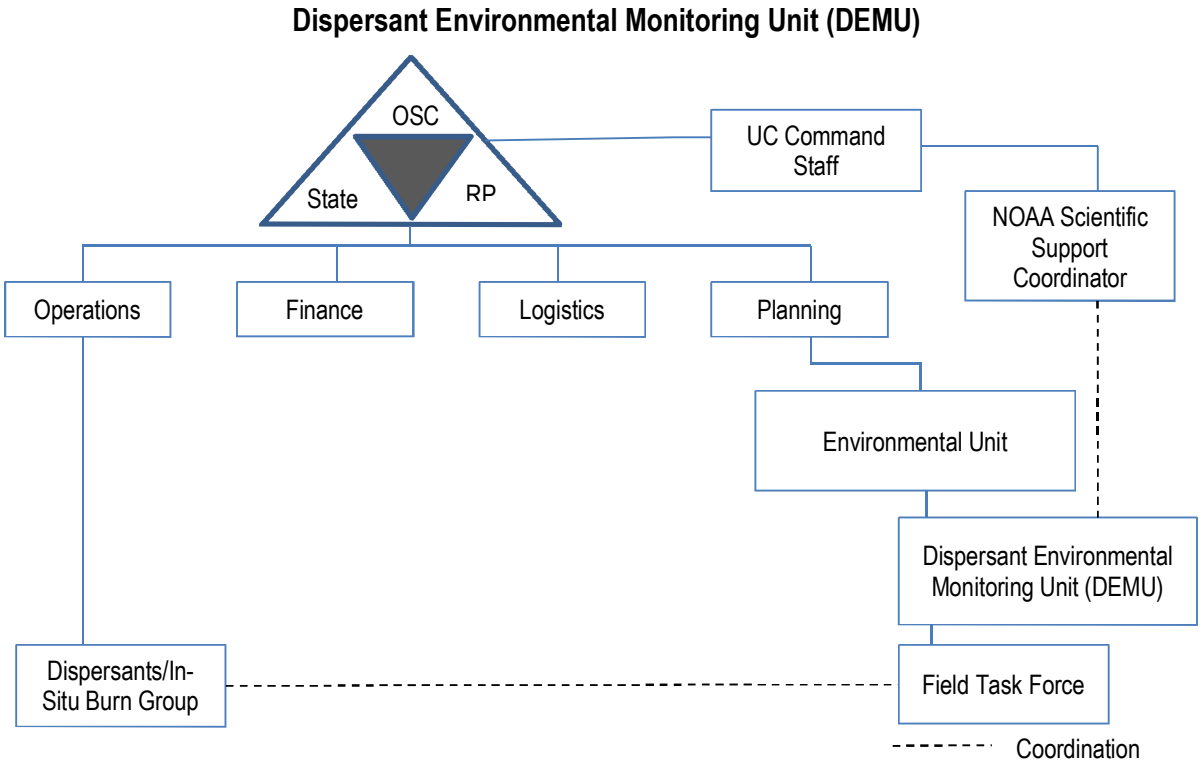

Figure 1: Dispersant Environmental Monitoring Unit (DEMU) Organization and Coordination

2.0 MONITORING GUIDANCE

2.1 Subsea Application Guidance

2.1.1 Background and Overview

Introduction

The *Subsea Application Guidance* was developed by NRT member agency representatives for RRT use in responding to and planning for oil discharges. This guidance is designed to assist

OSCs and state and federal agencies participating in the authorization, continued observation, and monitoring of subsea applications on oil discharges.

Subsea Application Guidance General Scope and Assumptions

1) The *Subsea Application Guidance* is intended for use on oil discharges originating from oil exploration, production and/or transmission facilities (e.g., in cases where there is a loss of well control).

2) These recommendations generally apply to dispersant use in response to subsea discharges at depths greater than 300 meters and below the average pycnocline.

3) The DEMU, in accordance with incident-specific objectives, should coordinate the development and implementation of a sampling and monitoring plan prior to the deployment of any subsea dispersants.

2.1.2 Pre-Incident Subsea Monitoring Recommendations

RRTs and Area Committees should know what resources (e.g., recreational, economic, biological, ecological) are potentially at risk in areas where subsea dispersant use may be considered. To better inform the resource tradeoffs in the decision making process of the response, RRTs and Area Committees should also consider the risks to resources that may be affected if subsea dispersants are not used. Among the sources of information that may be used to identify resources at risk are the following:

- National Environmental Policy Act (NEPA) Environmental Impact Statement(s);
- Exploration Plans;
- Development and Production Plans or Development Operations Coordination Documents;
- Population and community level ecology data;
- Relevant models (e.g., circulation, ecological, trajectory);
- Subject matter experts; and/or
- Any other relevant documents in which biological resources are identified.

2.1.3 Subsea Application Monitoring Recommendations

The sampling and monitoring plan for subsea dispersant applications should include the following:

- Site Characterization;
- Source Oil Sampling;
- Water Sampling and Monitoring; and
- Sediment Sampling and Monitoring.

Site Characterization

1) Best estimate of the oil discharge flow rate, periodically reevaluated as conditions dictate, including a description of the method, associated uncertainties, and materials;

2) Best estimate of the discharge flow rate of any associated volatile petroleum hydrocarbons, periodically reevaluated as conditions dictate, including a description of the method, associated uncertainties, and materials;

3) Identity of and rationale for the dispersant to be used, including the recommended dispersant-to-oil ratio for the intended application;

4) Description of the methods and equipment to be used for dispersant injection and application, including a plan for observation (not limited to visual);

5) Actual injection rate of the dispersant in gallons/minute; and

6) Estimated total length of time of dispersant injection.

Source Oil Sampling

For an incident-specific authorization, it is important for the OSC to have specific chemical data on the source oil, and samples collected for fingerprinting profile analysis before directing subsea dispersant application. Additional samples may be collected and stored for future analysis. The DEMU should coordinate sampling of the source oil, including associated volatile petroleum hydrocarbons (e.g., methane) and production fluids (e.g., drilling fluids), as soon as possible. Sample collection should be as follows:

1) Collect representative source oil samples at the source of the oil discharge, securing the samples in three or more Seewald Samplers or equivalent isobaric gas-tight samplers.[1]

2) Conduct chemical analyses, consistent with gas chromatography-mass spectrometry (GC-MS) analysis (see Water Sampling and Monitoring below, item 5.c.i). Document the methods and analyses used to fingerprint the source oil so as to distinguish between the oil associated with subsea discharge and other potential sources of oil (e.g., seeps, pipelines) to the maximum extent practicable.

3) If methane is present in the discharge, use an *in situ* methane detection method that provides sufficient sensitivity to detect changes in the environment in which the device is operating. Given that the biodegradation of methane may contribute to oxygen depression, understanding methane concentrations can inform the key indicator factors for dissolved oxygen. The sensitivity of the device(s)/method(s) to low concentrations of methane should be used as a factor in determining device selection, relative to other available devices and/or methods.

[1] Refer to http://www.whoi.edu/oceanus/viewArticle.do?id=89768&sectionid=1000

4) Include in the analysis an estimated rise rate through the water column for non-dispersed oil to the surface as a function of droplet size, density (or specific gravity) along the thermal gradient of the water column, and kinematic viscosity.

Water Sampling and Monitoring

Understanding the fate and concentrations of chemically and physically dispersed oil in the water column is critical. To accomplish this, a combination of hydrodynamic modeling, real-time data, and discrete water sample analysis is vital to ensure decision makers have the information necessary to authorize the continuation or modification of subsea dispersant operations. As with all dispersant operations, data retrieved and analyzed from water column measurements is intended to help decision makers and key stakeholders consider dispersant operations as a part of the broader oil discharge mitigation effort and weigh the risks associated with continuing the operation against those injuries the operation is intended to minimize. The DEMU should coordinate the reporting of water column measurements described below.

1) *Oceanographic Data.* Identify and implement a plume model with a validated methodology to predict the location and behavior of the subsurface oil plume, which is critical to properly monitor oil fate, dispersant effectiveness, and water column concentrations. Provide a subsea current analysis that characterizes the subsurface circulation, bathymetry, and oceanographic conditions, critical to model accurately. Note that subsea plume behavior forecasting and sample collection targeting may be improved by the installation of Acoustic Doppler Current Profilers (ADCPs) on the ocean floor with the capability of real-time telemetry.

2) *Microbial Oxidation.*
    a. *Dissolved oxygen* is an indicator of potential injury in the subsea ecological system. An increase in organic carbon loading enhances microbial activity, thereby increasing respiration and depleting oxygen. The monitoring plan should be particularly sensitive to signs of hypoxia. The DEMU should coordinate the analyses of *in situ* dissolved oxygen (DO) using industry standard sensing devices calibrated using Winkler titrations. In addition, water samples should regularly measure *ex situ* DO using Winkler titrations to verify measurements from industry standard sensing devices, particularly at depths where evidence of oxygen depression is indicated or predicted as a function of the dispersant operation.
        - **Key Indicator:**
            - Approaching hypoxia (e.g., 2 milligrams per liter or as appropriate for the region).
    b. *Carbon dioxide* is another potential indicator of microbiological activity in the subsea environment and may help distinguish between microbial activity associated with hydrocarbon consumption and naturally occurring dissolved oxygen drawdown. The DEMU may require, if practicable, the use of a properly calibrated *in situ* carbon dioxide sensor (e.g., Contros HydroC™ carbon dioxide sensor or equivalent instrument) to quantify carbon dioxide formation from biodegradation.
        - **Key Indicator:**
            - Confirmatory data.

3) *Oil Droplet Size Distribution* is an indicator of dispersant effectiveness and can be used to inform plume modeling. The DEMU should coordinate the deployment of a droplet size analyzer, such as, but not limited to, a Laser In-Situ Scattering and Transmissometry (LISST). It should be capable of reaching the depth of the sea floor from the vessel(s) for continuous sampling of surface water during transits, to provide droplet size counts information, which potentially distinguishes between dispersed and non-dispersed oil. A particle size distribution analysis focused on droplet size ranging from at least 2.5 to 100 μm should be conducted, with measurements for droplet size distribution between 2.5 and 2,000 μm, if practicable, for trajectory analysis. A baseline analysis should be conducted to determine droplet size distribution prior to dispersant application.
    - **Key Indicator:**
        - Observations of relative significant changes in the droplet size range indicating dispersant effectiveness.

4) *Continuous Water Column Data* is useful for providing a continuous data stream and background information for other data obtained. In addition, fluorometric data should be used to help track and model the dispersed plume. The DEMU should ensure that a sufficient number of vessels are equipped with the Conductivity, Temperature, Depth recorder (CTD) rosette package with one or more properly calibrated fluorometer(s), targeted to the type of oil discharged and capable of operating at depth (including to the sea floor) in which the dispersed oil plume may travel. A 2-way communication cable spooled to the ship should be used to ensure that profile data can be viewed as the rosette package is deployed to appropriate depths.
    - **Key Indicator:**
        - Observations of relative significant changes in the fluorometric output indicating the possible presence of a dispersed plume.
        - Identification of the pycnocline and the thermocline.

5) *Discrete Water Sampling.* The DEMU, should coordinate the development of Standard Operating Procedures (SOPs) for collecting water samples throughout the range of the water column, including background or reference samples that address the spatial distribution of dispersed oil using applicable analytical methods. Oceanographic monitoring should be conducted while collecting water samples (see item 1 above), if practicable and as appropriate.
    a. Take discrete water samples at depths specified in the sampling and monitoring plan. The CTD rosette package (see item 4 above) should be capable of collecting discrete samples in the water column using a sufficient number of Go-Flo sampling bottles, or equivalent, with a volumetric capacity to provide water samples for all analyses, and using the live feed data stream. If practicable, vessels should have onboard GC with flame ionization detector (FID) capability to determine total petroleum hydrocarbons (TPHs).
    b. Conduct an oil analysis to determine the effects of the dispersed oil plume on aquatic life (e.g., toxicity) through standard testing methodologies. The analysis should be designed and implemented to determine whether the dispersed oil will persist in the

water column and the likelihood the dispersed oil will come in contact with the benthos community.

c. Water sample analysis should include:
    i. GC-MS analysis of aliphatic hydrocarbons, monocyclic (e.g., benzene, toluene, ethylbenzene, and xylene up to C_3-benzenes), polycyclic, and other aromatic hydrocarbons (PAHs) including alkylated homologs (e.g., 2-, 3-, and 4-ring PAHs (C_0-C_4-naphthalenes, C_0-C_3-fluorenes, C_0-C_3-dibenzothiophenes, C_0-C_4-phenanthrenes-anthracenes, C_0-C_4-naphthobenzothiophenes, C_0-C_2-pyrenes-fluoranthenes, C_0-C_4-chrysenes, and the pyrogenic PAHs)), and hopane and sterane biomarker compounds, TPH, and volatile organic compounds;
    ii. Dispersant constituents;
    iii. Ultraviolet (UV)/visible fluorescence for fluorescence intensity ratio (FIR). The RP should conduct spectrofluorometric analyses on discrete water samples using the two fixed emission wavelength spectrofluorometers (e.g., 340 and 445 nm) targeted to the source oil or a scanning spectrofluorometer on board ship to determine the FIR; and
    iv. Turbidity.

- **Key Indicators:**
    - Comparison of water sample data to ecological toxicity (ecotoxicity) benchmarks for aquatic organisms in order to assess potential toxicity risks.
    - Comparison to available Species Sensitivity Distribution (SSD) curves (see Section 6.0 *Ecological Toxicity Assessment*).
    - The FIR ranges that indicate effective chemical dispersion of the oil.

<u>Sediment Sampling and Monitoring (i.e., physical, chemical, and biological)</u>

Under certain circumstances sediment sampling and monitoring may be necessary for operational response decision making. Sediment sampling can be a means of gathering additional information on subsea dispersant effectiveness and oil transport by means of sedimentation. If the OSC, with the concurrence of EPA and, as appropriate, the states, and in consultation with DOC and DOI, determines sediment sampling and monitoring is warranted, the DEMU should coordinate the development of SOPs for collecting sediment samples, including reference areas (i.e., located in the same geographic area with similar characteristics but not impacted by the discharge). These SOPs should address the spatial distribution of dispersed oil using applicable analytical methods. In addition, observations on benthic fauna should be collected and analyzed (i.e., comparing the species composition and percentage impacted by dispersed oil or subsea dispersant to reference area analyses). The sampling and monitoring plan should include appropriate sediment sampling for quantitative analysis including, but not limited to, oil when applicable.

1) Sediment sampling and monitoring should include analysis of sediment from reference areas to serve as benchmark information. This information should be collected prior to any exposure to oil or direct application of dispersant.
    a. The analysis of reference data should include, but is not limited to, water and sediment in the immediate vicinity of the discharge, in the direction of likely transport (i.e., a direction that may periodically shift due to changes in the subsea currents), and in any direction toward the shoreline(s).

        - **Key Indicators:**
            - Observation of relative differences between samples for reference areas and potentially impacted areas.

2.2 Prolonged Surface Application Guidance

2.2.1 Background and Overview

Introduction

The *Prolonged Surface Application Guidance* is designed to supplement the existing monitoring protocols outlined in SMART where the duration of the application of dispersants on discharged oil extends beyond what was originally envisioned by SMART, the need for which was demonstrated during the *Deepwater Horizon* event. This guidance is designed to assist the OSC and those state and federal agencies participating in the authorization and monitoring of dispersant applications on oil discharges on the surface of the water.

Prolonged Surface Application Guidance General Scope and Assumptions

1) The *Prolonged Surface Application Guidance* is intended to supplement and not replace SMART protocols. This guidance assumes SMART monitoring activities through Tier 3 have already been deployed by the UC.

2) This guidance defines prolonged dispersant operations as **any operation expected to exceed 96 hours[2] or that has already exceeded 96 hours from the time of the first application of any dispersant.**

3) Monitoring should be implemented within 96 hours of an oil discharge where prolonged surface application of dispersants is anticipated, or earlier at the direction of the OSC.

4) Surface application of dispersants should be inclusive of dispersant applied via aircraft or vessel to the sea surface and either impacting or potentially impacting the upper 10 meters of the water column. In the event the SSC believes oceanographic circumstances justify monitoring to a greater depth, this definition may be expanded to include the water column from the surface to the mix layer.

[2] Timeframe based on 96 hours being a common exposure duration used in toxicological studies of dispersants.

2.2.2 Prolonged Surface Application Monitoring Recommendations

SMART Protocols

This guidance assumes that SMART protocols will be used for initial confirmation of dispersant effectiveness and deployed at the earliest time practicable for the response conditions. Additional guidance offered in this document focuses on issues not currently considered by the existing SMART program and should be considered as a supplement to and not a replacement for the existing SMART program.

Assessment of the Potential Dispersibility of Oil

In a prolonged dispersant operation, despite the possibility of a continuous source of fresh oil, it is likely that some portion of floating oil will eventually weather[3] to the point where dispersants no longer have the desired effect. By delineating an outer boundary, mission planners can better target aerial sorties and, by defining visual characteristics of non-dispersible oil, can improve the on-site pilot/spotter target determination. Having a better understanding of the oil characteristics under environmental conditions and providing trained spotters better visual cues will result in more appropriate targets selected, less chemical dispersant applied to poor quality targets, and greater stakeholder confidence that the dispersant used will be applied in the most effective manner.

Weathering of oil will not be entirely homogeneous throughout the impact area due to variations in temperature, wind speed, sea state, etc. However, it may be possible to define the outer limit of dispersibility by field testing, and to correlate it to appearance and/or modeling. SMART protocols were designed to evaluate the chemical effectiveness of a specific dispersant sortie on a specific target under existing environmental conditions. It was never intended to provide insight into oil at various stages of weathering that might result from a long, continuous release that might require a prolonged response.

The DEMU should examine the extent to which the oil in question remains susceptible to the selected dispersant under the actual field conditions. The DEMU can then provide site-specific guidance based on visual characteristics (i.e., predominately changes in color), geographic, or other cues. This examination can be informed by additional data generated from laboratory weathered and tested oil coupled with oil fate modeling.[4] Recommended modeling and field approaches are as follows:

1) *The Modeling Approach.*
    a. The oil in question should be weathered in the laboratory and tested as to its dispersibility using the same test employed by the DEMU field task force.
    b. As oil viscosity is an indicator of its dispersibility, measurement of increases in viscosity under artificial weathering conditions and comparison of these data to findings in the field can help calibrate predictive fate models.

[3] Oil "weathering" describes the process of changes in the oil chemical and physical condition as a result of evaporation, photo-oxidation, water entrainment, and other factors.
[4] One such model is the NOAA *ADIOS-2*.

2) *The Field Approach.*
    a. Verify oil dispersibility based on weathering as a function of distance from the source and/or appearance.
    b. Using a boat equipped with dispersant spray arms and dispersant of the same type used for surface application, apply dispersant to previously untreated oil. Application rates, dispersant to oil ratios, and mixing times should resemble field operations as closely as possible.
    c. If time and logistics allow, try increasing the sampling mixing time for more viscous oils and emulsions.
    d. Shipboard equipment should include a field effectiveness test (such as SINTEF-FET and the Australian Nat-DET plan), a particle analyzer (such as a LISST), and a handheld thermal imaging camera to measure temperature differentials between effective and less effective dispersant/oil interactions.
    e. Samples of the treated and untreated oil should be obtained for both laboratory and shipboard analysis.
    f. Shipboard analysis and monitoring should include measurements of viscosity and effectiveness, as well as full photo documentation of oil before and after treatment.

3) *Reporting and Documentation.*
    a. The results of the field tests should be reported to the DEMU as soon as possible, or at least daily.
    b. *Spotters Guide.* Compile the results of field tests and laboratory analysis into a spotter's guide for use by both the DEMU and the SMART Spotters. The guide may include:
        i. Photographs of oil where dispersants are known to be effective and/or oil that is considered too weathered to be dispersed;
        ii. Geographic boundaries beyond which the oil is too weathered to be dispersed;
        iii. Model outputs; and
        iv. Other useful information.

<u>Water Column Loading and Assessment</u>

In the event of prolonged application of dispersant on the surface of the water in response to an oil discharge, personnel should be concerned about increasing concentrations of chemically dispersed oil in the water column. The UC should be prepared to implement SMART Tier 3 protocols. Further, the DEMU should deploy a field task force specifically and exclusively responsible to monitor and quantify water column loading over the timeframe of the approved dispersant operation. The field task force should use the same type of equipment and methods as those used by tactical SMART teams implementing SMART Tier 3 sampling protocols, including any additional methods and/or equipment (e.g., particle size analyzers) instructed by the UC. The protocols should compare water column data gathered as part of the application mission, taken at the highest probable concentration of chemically dispersed oil (immediate post application of the dispersant), with data collected 24 hours later. The data comparison should also include data gathered from samples collected in designated reference areas away from the dispersant operation.

1) *Sample Area.*
    a. Dispersed oil sampling should be conducted in the predicted plume of the oil that was dispersed 24 hours earlier. The DEMU should utilize trajectory and oceanographic models and, if appropriate, oil surrogates such as drogues and drifters, to guide the field task force to the most likely location of the plume.
    b. In order to not potentially contaminate the samples collected 24 hours following dispersant application with freshly dispersed oil, avoid water column loading sampling in areas where dispersant needs to be applied because of the presence of surface oil.

2) *Reference Areas.*
    a. Identify several suitable reference areas that are not impacted by the dispersant operation; it is not necessary that the reference areas be outside the oil-impacted area, provided chemical dispersants have not been used in the general vicinity.
    b. Sampling methods and equipment used in the reference areas should be the same as those employed in the study area.

3) *Sample Collection.*
    a. All sampling should be conducted in the manner prescribed by the SMART Tier 3 monitoring protocol and/or any supplemental protocols, including specifically the collection of discrete water samples at several depths up to 10 meters for laboratory for analysis.
    b. Carefully track both the location of the sampling and the time, and adjust as necessary to account for expanded monitoring depths.

4) *Water Column Loading Data Analysis.*
    a. Fluorometric and particle size data should be provided daily for analysis, processing, and dissemination to the UC and key decision makers. The UC may also want to consider collecting UV/visible fluorescence data to determine the FIR as an additional measure of dispersant effectiveness.
        i. Data should be charted to display a minimum of three data plots, including for immediate post application, for 24-hours post application, and for reference areas to confirm dispersant effectiveness.
    b. Discrete water samples should be analyzed within 24 hours, on-board ship if possible, using a GC with FID or MS detectors, to determine TPH and resolvable constituents. Because of the heterogeneous nature of oil in the water column, it is recommended that multiple samples be composited for analysis.

3.0 COMMUNICATIONS AND REPORTING

Effective communications and timely reporting of sampling and monitoring data is critical to inform decisions regarding the continued relative benefit of using a dispersant. Timely reporting is also crucial for effective communications with the general public. Sampling data and monitoring results addressed in the sampling and monitoring plan, including any additional or modified data requests approved by the UC, should be reported to the DEMU. The DEMU

technical specialists should review and interpret the data and formulate recommendations for use in operational decision-making. The DEMU should report to the OSC those analyses relative to established action levels that would trigger modifications in the operation, including any "shut down" criteria. The OSC should communicate this information to the RRTs and the NRT as appropriate, through the RRT.

The DEMU should coordinate the design and implementation of a communication plan that addresses the UC established incident-specific goals and objectives. In response to a release and prior to the application of any dispersant, the DEMU should submit this communication plan to the OSC for review and approval, and should begin implementation upon notice from the OSC.

The communication plan should include a protocol addressing sample tracking, data management, data format, and mutually accessible digital data storage determined by the UC. A mutually accessible digital data storage protocol should be established. All data collected and/or analyzed by the RP or the government (with the exception of data and/or analysis strictly associated with NRDA or legal investigations) will be available to both the RP and the government.

The communication plan should also address data reporting, both for field data provided to the DEMU, and for analyses supported by that data provided to the OSC and key decision makers. Key indicator data for "shut down" criteria should be reported daily to the RRT with jurisdiction, and any agreed upon specific key indicators and/or benchmark data, as requested by the RRT with jurisdiction. These key indicators/benchmark data may be reported to the NRT, as appropriate, through the RRT.

All relevant sampling and monitoring results from field analytical teams and onshore laboratories, including collection methods and sampling locations, should be reported daily to the DEMU for review and evaluation. However, the UC may approve alternative reporting periods for specific sampling and monitoring activities based on its priorities, the time restrictions required for various analyses, and the time sensitivity of the measurement or data relative to future operational decisions. If practicable, real-time monitoring information and visual observations (e.g., trained aerial spotters) should be reported. Anomalies observed in the field, in the analysis, or resources at risk as well as key indicator data approaching defined action levels should be reported to the DEMU as soon as possible.

DEMU data reports should characterize the site, dispersant effectiveness, oil behavior, and any other relevant information specific to the incident. The reports guide operational decision-making and help communicate recommendations to pertinent stakeholders. Data analyses should be informed by, for example:

1) Droplet size distribution and FIR, which account for other key factors namely percent oil, percent water, and percent dispersant. The droplet size distribution analysis should include a discussion and analysis on the number mean diameter (NMD) and/or the volume mean diameter (VMD).

2) The actual amount of dispersant applied for the previous 24-hour period, in hourly intervals.

3) Variations in the planned subsea dispersant application plus or minus 10 percent of the previous daily average.

4) Water column loading and measurement reports.

5) Dispersing potential assessment reports and recommendations.

6) Updated subsea transport estimate of oil, dispersant, and dispersed oil plumes using the most current trajectory modeling as available.

4.0 QUALITY ASSURANCE PROJECT PLAN

The sampling and monitoring plans should include a Quality Assurance Project Plan (QAPP)[5] to address sample collection methodology, handling, chain of custody, and decontamination procedures to ensure the highest quality data will be collected and maintained. Discrete samples should be tested at a laboratory approved by the OSC, with the concurrence of EPA and, as appropriate the states, and in consultation with DOC and DOI. Triplicate samples should be collected and tested. All samples should be archived for potential future analysis. Where technically practicable, all samples should be at least 1 liter.

The QAPP should include the following components and criteria:

1) An introduction that identifies project objectives and the project staff.

2) A site description and background.
    a. The site description should include bathymetry, subsea currents (including temporal variations), and other relevant geological features.
    b. The site description should include relevant oil seeps or other potential sources of contamination (e.g., recent oil discharges), and relevant oil and/or natural gas infrastructure (e.g., oil platforms, subsea pipelines).

3) A description of the sampling and monitoring recommendations.
    a. A brief overview of sampling activities, data quality objectives, and health and safety implementation strategies (frequently, this references another specific document, but should be included in the QAPP).
    b. The actual sampling and/or monitoring approach, to ensure data repeatability and consistent procedures. The approach should describe sampling, monitoring, and field quality control (QC) procedures; spoil or waste disposal procedures resulting from this effort; and specimen/data handling issues.
    c. Management procedures to document how the samples will be procured, handled, and delivered. Address the expeditious and timely transport of samples to laboratories

[5] The QAPP should be consistent with EPA's QA/R-4 and 5 (http://www.epa.gov/quality/qa_docs.html).

where necessary, in order to minimize delays due to weather or other operational delays.

d. Instructions to address sample preservation (including acidification issues), containers, and hold times.

4) The analytical approach to determine what laboratory tests will be run, any special instructions, how the data will be verified, and how the data will be reported.

5) Quality assurance (QA) to address chain of custody procedures, field records including logs, and qualitative data handling, including photographs.

6) If multiple atypical dispersant applications are implemented, the DEMU is responsible for ensuring the effective coordination of all recommendations. The results from the monitoring plan should be provided daily to the OSC.

5.0 AIRBORNE VOLATILE ORGANIC COMPOUNDS

Volatile organic compounds (VOCs) should be measured in the vicinity of fresh oil. While this document does not specifically address worker safety, the data collected in this effort should be reported to the DEMU and the natural resource trustees to assess overall exposure to birds, marine mammals, and reptiles, all of whom breathe at the air–water interface. VOC data collected on a regular basis should be shared with the OSC and the natural resource trustees for the purposes of gauging potential environmental impacts to trustee resources.

1) The DEMU should address the need to monitor within the vicinity of the surfacing oil plume, including individual constituents of the VOCs.

2) The DEMU should coordinate the development of a diagram identifying the time and location of all VOC samples taken, and its reporting as instructed by the UC. The diagram should also identify any potential sources that may contribute to VOCs (e.g., vessel exhaust, oil collected on containment vessels).

3) The DEMU should coordinate the recording of the meteorological conditions (particularly wind speed) with all VOC measurements.

4) The DEMU should coordinate the collection and analyses of corresponding representative water samples and report the individual VOC constituents.

6.0 ECOLOGICAL TOXICITY ASSESSMENT

The DEMU, in consultation with the UC, should develop an ecological toxicity (ecotoxicity) assessment plan that incorporates ecotoxicity benchmarks derived by using a Species Sensitivity Distribution (SSD). SSDs are a probability distribution of the sensitivity of a group of species to a toxicant.

1) The toxicity plan should use the best available technology at the time of the response.

2) Monitoring for ecotoxicity should occur concurrently with dispersed oil sampling for fluorometry, particle size, and water quality (e.g., DO). Ecotoxicity may be assessed by comparing TPH concentrations in water samples collected at appropriate depths to TPH-based ecotoxicity benchmarks (EBs). The ecotoxicity assessment should also be performed in areas where no dispersant has been applied to allow determination and comparison of ecotoxicity from physically dispersed and chemically dispersed oil.

3) EBs should be derived using the SSD approach and made available to the UC. SSDs should be developed for representative oils (e.g., crude oils) using existing acute toxicity values for mortality or immobility (e.g., 48-hr and 96-hr lethal concentration, 50 percent (LC_{50})) where sufficient species diversity is available (e.g., toxicity data for 10 or more species). The EBs should be computed from the fifth percentile of the SSD as the HC_5 (hazard concentration, 5 percent). EBs may be developed for specific oils or for oil types (e.g., crude, middle distillate, heavy oil). Chronic toxicity benchmarks may be derived by applying a safety factor to the acute toxicity EBs. The development of the actual safety factors should be the responsibility of the approving authorities (including the federal natural resource trustees) with input from appropriate technical specialists.

4) Water samples collected for comparison of aqueous TPH concentrations to EBs should be analyzed within 24 hours of collection and reported within 48 hours of analysis to the UC, via the DEMU.

5) The UC may also consider additional ecotoxicity testing methods, in consultation with subject matter experts, to monitor whole water samples with considerations for:
    a. Site conditions (e.g., location of the discharge, weather conditions at the discharge, field water temperature);
    b. Operational relevance;
    c. Field ecological receptors at risk;
    d. Test organism availability; and
    e. Availability of testing equipment and/or laboratories.

    All sample collection and testing should be conducted using standardized sampling and test protocols. If standardized protocols cannot be followed due to existing conditions or alternate tests/methods are available, the test methods proposed for use should first be specifically approved through the OSC, with the concurrence of EPA and, as appropriate, the states, and in consultation with DOC and DOI.

7.0 ACTION LEVELS

1) The RRT in the incident specific authorization plan may establish action thresholds relative to the key indicators from monitoring operations. The OSC may propose new or alternative

action thresholds to the RRT. These thresholds and the actions they elicit should consider dispersant, oil, and dispersant mixed with oil toxicity data available on the NCP Product Schedule and SSDs for the chemical dispersant in use and other appropriate references, including region-specific toxicity data that may have been required by the RRT as part of a preauthorization process. These action thresholds should consider as much as practicable, region-specific biological data and input from the Scientific Support Coordinator, local resource managers, and other subject matter experts.

2) The actions prescribed, along with modifications in the operation, may include "shut down" criteria. These criteria should relate to specific key indicators and/or UC defined benchmarks in conditions such as, but not limited to, dramatic changes in dissolved oxygen, total petroleum hydrocarbon levels remaining in the water column after a defined period of time, persistent water column toxicity, and species of particular sensitivity (e.g., endangered species, whales, and rafting birds) moving into the area. **Any "shut down" criteria developed should consider the resource tradeoffs associated with dispersant use.**

APPENDIX A: ACRONYMS

ADCPs – Acoustic Doppler Current Profilers
BOEM – Bureau of Ocean Energy Management
BSEE – Bureau of Safety and Environmental Enforcement
CFR – Code of Federal Regulations
CTD – Conductivity, Temperature, and Depth Recorder
DEMU – Dispersant Environmental Monitoring Unit
DO – Dissolved Oxygen
DOC – (U.S.) Department of Commerce
DOI – (U.S.) Department of the Interior
EBs – Ecotoxicity Benchmarks
EU – Environmental Unit
EPA – (U.S.) Environmental Protection Agency
FID – Flame Ionization Detector
FIR – Fluorescence Intensity Ratio
GC-MS – Gas Chromatography-Mass Spectrometry
HAZWOPER – Hazardous Waste Operations and Emergency Response
HC – Hazard Concentration
LC – Lethal Concentration
LISST – Laser In-Situ Scattering and Transmissometry
NCP – National Oil and Hazardous Substances Pollution Contingency Plan
NEPA – National Environmental Policy Act
NMD – Number Mean Diameter
NOAA – National Oceanic and Atmospheric Administration
NRDA – Natural Resources Damage Assessment
NRT – National Response Team
OSC – On-Scene Coordinator
OSHA – Occupational Safety and Health Administration
OSRP – Oil Spill Response Plan
PAH – Polycyclic Aromatic Hydrocarbons
QA – Quality Assurance
QAPP – Quality Assurance Project Plan
QC – Quality Control
RP – Responsible Party
RRT – Regional Response Team
SMART – Special Monitoring of Applied Response Technologies
SOP – Standard Operating Procedure
SSC – Scientific Support Coordinator
SSD – Species Sensitivity Distribution
TPH – Total Petroleum Hydrocarbons
UC – Unified Command
USCG – United States Coast Guard
UV – Ultraviolet
VMD – Volume Mean Diameter
VOC – Volatile Organic Compounds