Summary of EPA's Plume Monitoring and Assessment Plan for Subsea Dispersant Application

Note: This monitoring and assessment plan for full-scale subsea application of dispersants will not be implemented until initial testing demonstrates the effectiveness of subsea dispersant application.

Purpose: The purpose of this plan is to monitor the movement and properties of a dispersed oil plume and to determine any ecological effects associated with the plume.

The Plan is broken down into two phases:

Phase I: Starts when the subsea application of dispersants is initiated, and focuses on:

a) confirming the location and extent of the subsurface plume,
b) determining how much oil remains in the dispersed plume and,
c) collecting oceanographic data to validate the models of plume movement

Phase II: Data collected during Phase II will be used to determine whether the dispersed plume is toxic to aquatic life. Phase II consists of:

a) water sampling to determine the presence and amount of dispersed oil,
b) oceanographic data to characterize the physical properties of the water column such as dissolved oxygen and oceanographic currents and,
c) chemical and biological monitoring within and outside the dispersed plume which will examine parameters such as dissolved oxygen concentrations and the toxicity of the plume to aquatic life using toxicity testing.

Criteria to Shutdown Dispersant Application:

This plan also defines the evaluation criteria for determining whether application of subsea dispersants should be shut down. These criteria include:

1) a significant reduction of dissolved oxygen,
2) the results of numerous toxicity tests and,
3) the evaluation of the conditions above in addition to other factors including shoreline, surface water, and other human health and ecological impacts.

Quality Assurance and Sampling Plan Requirements:

This monitoring and assessment plan requires that data collection management and analysis follows accepted standards to ensure that data is of the highest quality. Additionally, the plan outlines the criteria that must be included in all sampling and monitoring plans to ensure consistency and accuracy in the sampling process.

Additional Reporting Requirements:

This monitoring and assessment plan includes additional requirements that BP must follow including but not limited to the notification of testing or application; a description of methods and equipment used to inject the dispersant, and plume modeling to ensure that samples are taken from the correct location. All data will be given to the US Coast Guard and EPA within 24 hours of the information being received.

Plume Monitoring and Assessment Plan for Subsea Dispersant Application
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I. Phases of Testing

Dispersed oil plume

Phase I monitoring will determine dispersed plume concentration and transport. Phase II monitoring, which will be sustained and more comprehensive, will address plume fate and effects on the ecosystem based on the results of Phase I and iterative hydrodynamic modeling output.

Timing: Phase I monitoring will begin when subsea application is initiated. It will require the R/V Brooks McCall or equivalent on location outfitted, and manned.

Phase I Monitoring Objectives –

1. Confirm location and extent of the subsurface plume.
2. Determine how much oil (total PAH) remains in the dispersed plume.
3. Collect physical oceanographic data to validate the sub-surface dispersed plume model.

Phase II Monitoring

Phase II will use information collected and iterative model results to determine sample grids for ecosystem monitoring.

II. Methodology:

Phase 1. Detection and delineation of dispersed plume:

EPA recommends the fluorometer to determine the vertical and horizontal extents of the subsurface plume. Frequency of transects will be determined upon validation of the dispersed plume model. The Plan must show how the fluorometer is to be implemented in order to obtain the extent data. The Gulf Strike Team also possesses a Turner C-3 towable fluorometer for surface monitoring, if necessary. EPA requests that a bubble turbidimeter be used as well, if possible. These procedures are for near surface measurements only, not deep the sea.

NOTE: A towed fluorometer is the preferred method for this effort. If one cannot be procured, then more conventional methods will be employed (i.e., water samples from rosette samplers)

The first phase of sampling should determine the factors needed to calculate dispersion effectiveness, namely, % oil, % water, % dispersant. This phase of sampling should determine the factors to predict buoyancy; namely bubble sizes,

density (or specific gravity) along the thermal gradient of the water column, and kinematic viscosity are needed.

Phase 2. Daily Collection of the Following Parameters Until Further Notification[1]

A. Water column sampling collection

EPA will need a more thorough oil analysis to determine whether the dispersed plume is toxic to aquatic life. EPA will also need to know whether the dispersed oil will hang in the water column and eventually come in contact with the benthos as it approaches land. (Phase 1 may tell us this.)

Water samples will be taken to test for the presence of dispersed oil and droplet size and should be used to supplement the fluorometer data above, if needed. Droplet size will be determined using high resolution microphotography – pending depth rating.

Water samples at depth will be taken with a rosette sampler that can collect large enough samples for chemical analysis. Samples should be collected by rosette samplers at various depths inside and outside the plume and measured by a scanning spectrofluorometer using an excitation wavelength of 280 nm and emission wavelengths of 340 and 445 nm. For use on an oceanographic vessel, having two spetrofluorometers each operating at one specific emission wavelength obviates the need for quiescent conditions required for a scanning spectrofluorometer. Frequency of transects will be determined upon validation of the dispersed plume model. These measurements should be made daily for the duration. EPA also needs to see a desired range of numbers, in order to note if the dispersion process requires modification.

B. Other measurements within the plume:

1. Concentration of oil via extraction of water samples followed by UV-visible spectrophotometry (wavelengths of 340, 370, and 400 nm),
2. Total PAH via GC/MS (the latter analysis need only be done on a daily basis and later on a weekly basis using method EPA 8270D Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS). Test Methods for Evaluating Solid Waste, Physical/Chemical Methods; Publication SW-846, 3rd Edition; U. S. Environmental Protection Agency: Washington, DC, 2007, http://www.epa.gov/waste/hazard/testmethods/sw846/pdfs/8270d.pdf.
3. Verification of DO depletion in the plume by Winkler titration of water samples and measurement of inorganic carbon (IC) in the plume (water samples). The importance of the latter two measurements is the fact that the dispersed oil will exert an oxygen demand in the water column, and this will show up in the DO and IC profile.

[1] See Appendix A for further background

C. Physical oceanographic data collection:

CTD - Initial Conductivity Temperature and Depth (CTD) measurements will be conducted to determine water column stratification or other physical oceanographic parameters that will help determine depth of samples collected and further validate the model. The CTD probe will have dissolved oxygen (DO) and turbidity sensors – pending adequate depth rating.

Current - Numerous Acoustic Current Doppler Profiler (ACDP) units are deployed throughout the area of interest. Data will be applied to this monitoring effort, as appropriate.

D. Chemical and Biological Monitoring Tests
EPA requires measurement of dissolved oxygen (DO) concentrations at various locations from within and outside the dispersed oil plume at three different transects.

a. Historically, DO concentrations have averaged about 4 mg/L based on extensive historical oceanographic measurements.
b. Sampling of the submerged emulsion poses special problems because the samples will be pressurized at up to 150 atmospheres. The water samples will de-gas when brought to the surface. Pressurized water samples should be collected according to reference ASTM Publication No. 148-1 and USGS Water Supply paper No. 1454.
c. It is recognized that normal dissolved oxygen (DO) probes will be instantly biofouled by oil and rendered useless. Consequently, Winkler titrations will be performed in the field and values relayed to Area Command.

The following 24 hour biological assay must be conducted in addition to the DO measurements: Rotoxkit assay to estimate the acute toxicity to the marine rotifer, *Brachionus plicatilis*, compared to non-plume samples. An optional test should be done if it is possible: a sea urchin fertilization test using water samples from pre- or non-impacted and impacted sites. Samples should be taken from within and outside the plume.

III. Evaluation Critieria to Determine Operational Shut-Down of Deep Sea Dispersant Application:

The Federal On-Scene Coordinator will immediately convene the Regional Response Team when the following conditions are met to determine whether subsea dispersant application should be shut down:

1. If there is a significant reduction in DO from background to below 2 mg/L.

2. If EPA's interpretation of the toxicity test reveals excessive exertion of a toxic response. To determine a measurable toxic response, a rangefinder test must

first be performed since the collection of the sample will be directly from the toxic plume, and any sample from the plume will likely kill 100% of the test population. Therefore, the rangefinder must first be conducted to determine an order of magnitude dilution that gives a measurable response. Then, a more refined dilution procedure must be done to get the final LC50 answer. This result is then compared to a NOAA plume model that would predict when or where exertion of that toxic response would take place. EPA will interpret the results of both toxicity tests to enable determination of a shutdown decision.

The RRT will evaluate the conditions above, in addition, to all relevant factors including shoreline, surface water, and other human health and ecological impacts, to determine whether sub-surface dispersant application should be shut down.

IV. Limitations to Address

1. Timely transport of samples to labs, which must be done via boat, may be subject to weather and/or operational delays.
2. Sampling in the deep sea environment may pose challenges due to equipment limitations and malfunction.

V. Quality Assurance and Sampling Plan Requirements

Sample collection methodology, handling, chain of custody and decontamination procedures will follow accepted standards to ensure the highest quality data will be collected. Discrete samples will be tested at an approved lab(s). Samples are tested in a statistically significant manner. All samples (or as practicably possible) should be archived for potential future analysis. Where technically possible, all samples should be at least 100 ml. If these results are to be used as the basis for a longer-term monitoring plan, then more information on sampling frequency would be necessary. This would require further evaluation.

Sampling/Monitoring Plans must include the following key criteria:

1. An Introduction, to include project objective and project staff
2. A brief site description and background
3. A description of the Sampling Approach and Procedures, to encompass:
    a. A brief overview of sampling activities, data quality objective and health and safety implementation strategies (frequently, this references another specific document, but must be included).
    b. The actual sampling and/or monitoring approach, to ensure repeatability and consistent procedures. Describe sampling, monitoring, sampling and field QC procedures, spoil or waste disposal procedures resulting from this effort, as well as specimen/data handling issues.
    c. Sample management – how the sample will be procured, handled, and delivered

d. sample instructions- preservation, containers, and hold times

4. The analytical approach – what lab tests will be run, any special instructions, how the data will be verified, and how data will be reported.
5. Quality Assurance- custody procedures, field records including logs, chain of custody, qualitative data handling including photographs.

VI. Additional Reporting Requirements

At least 24 hours prior to the testing, use and/or application of any sub-surface dispersants, BP shall provide a *Dispersant Application Plan* that identifies the dispersants to be used, describes the methods and equipment used to inject the dispersant, plume model to assure representative sampling, proposed method of visual observation, process for determining the effectiveness of subsurface injection, the specific injection rate (i.e., gallons/minute), the total amount to be used for the duration of the test, the total length of time that dispersant is injected, and the plan for sampling and monitoring, as approved by the Unified Command Environmental Unit. Dispersants must be on the approved product schedule and suitable for this use.

All data including, but not limited to, real time monitoring and laboratory data and sampling results associated with daily sampling for surface and sub-surface dispersant application, documented observations, photographs, video, and any other information related to dispersant testing, shall be provided to the United States Coast Guard (USCG) On-Scene Coordinator and the Environmental Protection Agency (EPA) Regional Response Team (RRT) representative within 24 hours of the information being received.

Appendix A –Background for Phase II Methodology for Informational Purposes

The fact that many organic compounds fluoresce at specific excitation and emission wavelengths is the basis for identifying many of the components of crude oil in seawater. When subject to excitation at 245-280 nm, polycyclic aromatic hydrocarbons (PAH) fluoresce over wavelengths of 310 to > 400 nm, depending on the number of aromatic rings in the structure. Only one group has examined the 2D UV Fluorescence Spectroscopy (UVFS) spectra of oil treated with chemical dispersants, the Ken Lee group at Fisheries and Oceans Canada (DFO). They found that a fixed excitation wavelength of 280 nm works best for fluorescence of PAHs in crude oil, and two different emission wavelengths, one at 340 nm for 1-and 2-ring PAHs and the other at 445 nm for 3-ring and higher PAHS, provide an excellent fingerprint for differentiating chemically dispersed oil from non-dispersed oil. As oil gets dispersed due to the action of a chemical dispersant, the peak height at 445 nm becomes highly pronounced relative to the peak height at 340 nm. Thus, computing the ratio of peak height at 340 to the peak height at 445 gives a direct measurement of the degree of dispersion that has taken place as a result of applying a dispersant to an oil.

The effect of oil dispersion on UVFS spectra can be expressed in terms of an emission ratio, so that dispersion can be tracked without having to measure oil concentration. The

spectral changes associated with the application of dispersant can also be calibrated to quantify increasing oil or oil plus dispersant. The fact that UVFS and UVA data are comparable at an emission intensity of 445 nm or over the whole spectrum of intensities (from 300 - 500 nm) indicates that the fate of higher molecular weight (> 3-ring) PAH fractions - the more “dispersible” fraction of an oil slick - will provide a good idea of the fate of the oil as a whole during the dispersion process. Given that higher molecular weight PAHs may be associated with many of the persistent (or chronic) toxic effects of crude oils on marine organisms, the ability of UVFS to track “dispersible” fractions would make it a particularly useful tool in studies of the long-term toxic effects of dispersed oil.