Dispersant Effectiveness and Oil Distribution (Spatial and Temporal)

About

Dispersants are chemical agents used to break up oil into smaller droplets throughout the water column. Dispersants are applied to surface oil floating on water, or below the surface closer to an uncontrolled release of crude oil from a well blowout source. This series of fact sheets details monitoring requirements and how to apply the collected data to inform the use of dispersants under **Subpart J of the National Contingency Plan (NCP)**.

Description of the Requirement

The responsible party must consider available technologies to characterize the dispersant effectiveness and oil distribution, including trajectory; account for the condition of oil, dispersant, and dispersed oil components from the discharge location; and describe associated uncertainties. Refer to the regulatory requirement in the Code of Federal Regulations (CFR): **40 CFR 300.913(c)**.

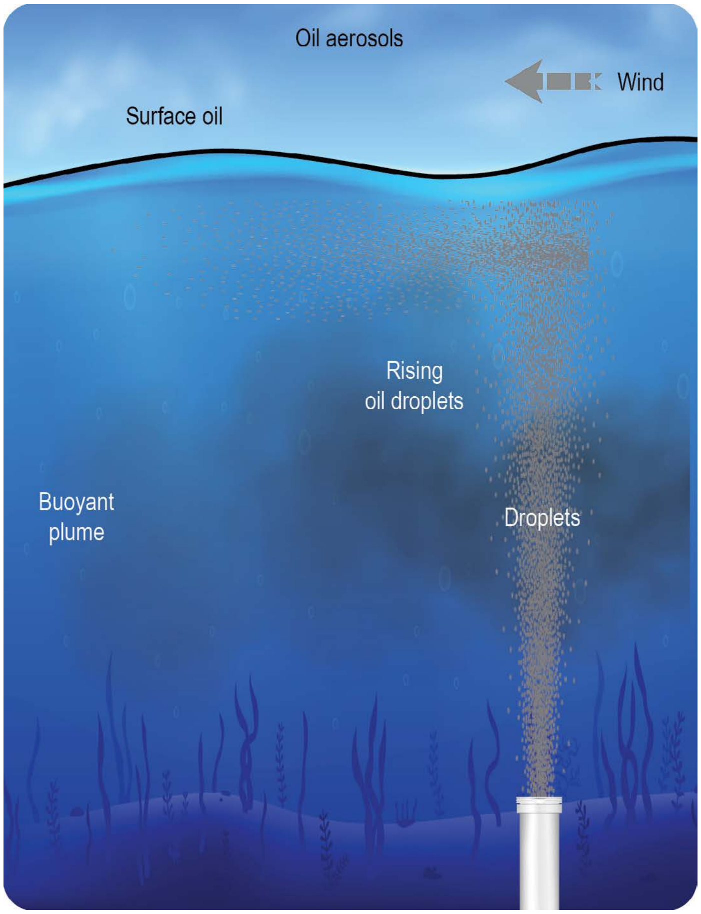
Dispersant Effectiveness and Oil Distribution

It is important to have a full assessment of an oil spill when making decisions about dispersant use (Figure 1), including:

- The location of the spill
- The horizontal spread and vertical depth of areas affected
- The condition of the oil (e.g., weathering)
- The locations of dispersed oil
- The effectiveness of the dispersant

Different sampling and analytical technologies, modeling methods, and visual observation techniques can provide an overall assessment of the oil spill and of potential effects on nearby ecosystems. Key factors to consider for a dispersant's potential impact are (1) dispersant effectiveness and (2) the distribution of the oil plume in the water column.

Figure 1: Diagram of an oil spill cross-section.



Credit: EPA

1. **Dispersant effectiveness** depends on the accuracy of its application, since not all the dispersant applied may ultimately encounter or integrate into the oil plume (operational effectiveness). Dispersant effectiveness also assesses the condition of the oil and the extent to which the dispersant reduces the size of the oil droplets (chemical effectiveness). Overall dispersant effectiveness is a combination of both operational and chemical factors.

2. **Oil distribution** assesses the trajectory of the physically and chemically dispersed oil plume, as well as how that trajectory may affect sensitive ecosystems.

Measuring and Reporting Dispersant Effectiveness and Oil Distribution

Dispersant effectiveness and oil distribution are generally reported as a combination of comparative analyses, modeling results, maps, and uncertainty analyses.

Dispersant operational effectiveness is usually described as an uncertainty because it is difficult to measure in the field. It is generally reported as the percentage of the dispersant that is incorporated into the oil (e.g., 50% incorporation rate) when used as an input for fate and transport models.

Dispersant chemical effectiveness is based on comparisons between water column data and oil droplet size distributions from the baseline and dispersed oil plumes. Differences between the two datasets can indicate the dispersant's performance – either positive or negative.

Oil distribution is based on visual observations, sampling and analytical data, and modeling results. For example:

- Imagery technology can map and visualize the extent of the oil spill.
- Remote-sensing technology can collect data before and after dispersant application, and inform the assessment of fate and transport of the oil plume.
- Trajectory models predict the location and behavior of the oil plume based on water currents and other field data, and are depicted as two-, three-, or four-dimensional (including time) representations (Figure 2).

Narratives describing the uncertainties surrounding the dispersant effectiveness and oil distribution analyses should be part of reporting. Reporting should also describe potential effects and interactions with nearby ecosystems.

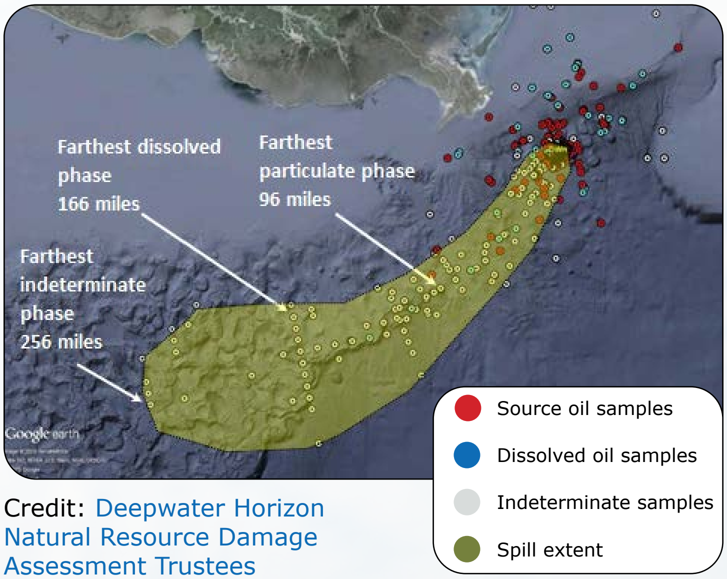
Using Dispersant Effectiveness and Oil Distribution Data

The main purpose of dispersant effectiveness information is to support dispersant use decisions by characterizing the oil plume, describing its movement, and determining the potential or actual effects on nearby ecosystems.

Decision Points for Responders

Dispersants change the size and shape of the oil plume and increase the surface area of oil that is available to interact with the environment. Dispersant use decisions should balance the risks and benefits to ecosystems likely to be affected by undispersed or dispersed oil. In consultation with subject matter experts, understanding the entire scope of the oil spill, the predicted movements of the plume, and the current and predicted effectiveness of dispersant use can help the On-Scene Coordinator assess whether dispersant application should begin, continue, continue with modifications, or cease.

Figure 2: Plume modeling predicts the transport of oil in spill incidents.



Credit: Deepwater Horizon Natural Resource Damage Assessment Trustees

Dispersant Effectiveness

In general, comparisons between data on the background water column conditions, baseline oil plume, and dispersed oil plume help inform the use of dispersant in a response. For example, a droplet size distribution analysis showing smaller oil droplets in the dispersed oil plume relative to the baseline oil plume (untreated oil) may be an indication of the dispersant effectiveness for that application.

Parameters that do not measure dispersant performance directly may still signal when conditions may or may not be optimal for dispersant use. These include:

- **Changes to the viscosity of the oil.** An increase in oil viscosity typically decreases the effectiveness of a dispersant.
- **Weathering.** Weathering changes the oil's chemical composition and physical characteristics, decreasing low molecular weight compounds that are more easily biodegraded and making oil more difficult to disperse (Figure 3).
- **Presence of oil-in-water emulsions** (i.e., weathered oil that mixes with water). A substantial presence of emulsions typically decreases the effectiveness of the dispersant and diminishes the biodegradation of the oil.

Oil Distribution

Oil distribution information signals where the oil plume is, assessing the horizontal and vertical boundaries of the dispersed oil plume, as well as the direction where the oil plume is likely to travel. The majority of the sampling can focus on known or suspected locations and depths of the dispersed oil. This sampling can inform where oil response activities are needed, including where protective measures should be considered for sensitive ecosystems. Likewise, oil distribution analyses can highlight sensitive ecosystems that may encounter either the dispersed or undispersed oil plume. See the Ecological Receptors Fact Sheets for more information about ecosystem considerations.

Figure 3: Weathered oil.

Credit: Deepwater Horizon Natural Resource Damage Assessment Trustees

Additional Resources

NCP Product Schedule
Lists dispersant products and data submitted to EPA as required by NCP Subpart J.

NCP Product Schedule Technical Notebook
A compilation of product bulletins summarizing data requirements and test results for dispersant products listed in EPA's NCP Product Schedule. The Technical Notebook includes information on dispersant application methods, toxicity and effectiveness, and physical properties.

Oil Spill Emergency Response – Monitoring the Use of Dispersants Fact Sheets
- Characterization of Ecological Receptors – Habitats
- Characterization of Ecological Receptors – Toxicity

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