v. 11/2025

SPECIAL MONITORING OF APPLIED RESPONSE TECHNOLOGIES FOR DISPERSANT OPERATIONS

Developed by:
National Response Team Science and Technology Committee, SMART Workgroup 2023

Images: Top, center and right (NOAA), bottom (Cui et al., 2020).

SMART is a living document.

SMART is a living document. In accordance with the intent of the original workgroup who developed the SMART protocols, the following represents an **update** to existing SMART protocol **specifically as it addresses dispersant operations**. A separate effort is being conducted by a National Response Team (NRT) workgroup focused on SMART protocols for in situ burns (ISB). The NRT dispersant workgroup has attempted to incorporate changes in technologies, accumulated experience, and operational improvements in our effort to update the SMART program and this document specifically as it addresses dispersant operations. It is our desire to continue to encourage future updates to the SMART manual for dispersant operations through multi-agency participation and recommend those activities are coordinated through the NRT Science and Technology (S&T) subcommittee. Comments and suggestions to improve the SMART program are welcome and should be provided to the NRT S&T.

SMART approval status

In November 2025, the workgroup submitted the updated document to the NRT for review and approval.

Acknowledgments

Gracious thanks are extended to the members of the SMART workgroup for their tireless efforts to generate this document, to the many reviewers who provided insightful comments, and to the Bureau of Safety and Environmental Enforcement for assistance in graphic design.

SMART is a Guidance Document Only

Purpose and Use of this Guidance:

This manual and any internal procedures adopted for its implementation are intended solely as guidance. The intent of the guidance is to support operational decision-making by the Federal On-Scene Coordinator (FOSC) during typical dispersant use operations within surface waters. The guidance is separate from monitoring requirements during subsurface dispersant applications, prolonged dispersant use and/or major discharge events >100,000 gallons in a 24-hour period (as per the 2023 National Oil and Hazardous Substances Pollution Contingency Plan (NCP) Subpart J final rule[1]). The guidance also differs from the 2013 NRT guidance document for atypical dispersant operations[2]. This SMART guidance does not constitute rulemaking by any agency and may not be relied upon to create 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 manual or its internal implementing procedures. Mention of trade names or commercial products does not constitute endorsement or recommendation for their use by the United States Coast Guard (USCG), the Bureau of Safety and Environmental Enforcement (BSEE), the National Oceanographic and Atmospheric Administration (NOAA), the Environmental Protection Agency (EPA), the Centers for Disease Control and Prevention (CDC), or the Government of the United States of America.

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[1] National Oil and Hazardous Substances Pollution Contingency Plan; Monitoring Requirements for Use of Dispersants and Other Chemicals; Final Rule. July 27, 2021; 86 FR 40234

[2] National Response Team; Environmental Monitoring for Atypical Dispersant Operations: Including Guidance for Subsea Application and Prolonged Surface Application; May 30, 2013, 25 pp.

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LIST OF ACRONYMS

BSEE	Bureau of Safety and Environmental Enforcement
CDC	Centers for Disease Control and Prevention
EPA	U.S. Environmental Protection Agency
ERT	Emergency Response Team
FOSC	Federal On-Scene Coordinator
GPS	global positioning system
ISB	in situ burn
NOAA	National Oceanic and Atmospheric Administration
NRT	National Response Team
OHMSETT	Oil and Hazardous Materials Simulated Environmental Test Tank
QA/QC	Quality Assurance/Quality Control
RRT	Regional Response Team
SAP	Sampling and Analysis Plan
SMART	Special Monitoring of Applied Response Technologies
SSC	Scientific Support Coordinator
TTP	Tactics, Techniques and Procedures
UC	Unified Command

INTRODUCTION

The Special Monitoring of Applied Response Technologies (SMART) program for in situ burn (ISB) and dispersant operations was developed and approved by the National Response Team (NRT) in 1997 and was updated in 2006. In accordance with the intent of the original workgroup who developed the SMART protocols, the NRT Science and Technology subcommittee formed a workgroup in 2021 to provide an update to the existing SMART protocol specifically as it addresses ISB and dispersant operations. While the original SMART program addressed **both dispersant** and **ISB** operations in one document, the 2021 workgroup recommended creating updated guidance on SMART protocols in **two separate documents**, one focused on monitoring for use of dispersants, the other focused solely on ISB operations. This document is intended to provide an update for the SMART program associated with **dispersant operations ONLY**.

National protocols designed to standardize monitoring are an important aid to the Federal On-scene Coordinator (FOSC) in fulfilling their responsibilities as defined in the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR Part 300). Protocols are also needed to provide guidance to, and oversight of, industries' monitoring of response efforts during spills. Accordingly, many of the nation's Regional Response Teams (RRTs) have established operational conditions and requirements for dispersant monitoring operations, including the widespread adoption of the SMART protocol. The essential objective of SMART protocols is to provide real-time, scientifically based data for the purpose of informing response decision making. Some regions have also designated specific pre-approval and exclusion zones for dispersant operations.

SMART dispersant monitoring protocols were used extensively during the response to the Mississippi Canyon 252 *(Deepwater Horizon)* in 2010, when ~156,000 gallons of dispersant were applied at the surface. As of the time of this revision, that was the largest use of dispersants in U.S. waters, and dispersants have not been used in the U.S. since. They have been considered for use in two incidents in the Gulf of Mexico, the Texas City Y response in 2014, and Green Canyon 248 response in 2016; but were not used in either. Worldwide, dispersants remain an important response tool, and in some nations, are the first response option.

Following Mississippi Canyon 252 *(Deepwater Horizon)*, procedural documents were developed by the U.S. Coast Guard (Special Monitoring of Applied Response Techniques (SMART): Tactics, Techniques, and Procedures (TTP), CGTTP 3-75.1, 22 Jul 2016) and NOAA (National Oceanic and Atmospheric Administration (NOAA), National Ocean Service, Office of Response and Restoration. NOAA SMART Data Processing and Evaluation Manual. Seattle: NOAA, 2016.) The U.S. Coast Guard and NOAA documents focus heavily on visual observation and fluorometry. Other regional guidance documents exist as well. Previous versions of the SMART Dispersant Operations document contained detailed procedures and reporting guidance, which are now detailed in the TTP and the NOAA SMART Manual referenced above.

In the 15 years since Mississippi Canyon 252 *(Deepwater Horizon)*, dispersants and dispersed oil have been heavily studied within laboratories and test tanks, including testing of various sensors and sensor suites in large scale testing facilities such as the BSEE Oil and Hazardous Materials Simulated Environmental Test Tank (OHMSETT) facility. This document acknowledges existing protocols and procedures while still allowing flexibility for additional and emerging sensing technologies.

The original intent of the SMART program was to establish a surface monitoring system for **rapid collection** and **reporting of real-time, scientifically based information**, in order to assist the FOSC or

Unified Command (UC)[3] with **decision-making** during dispersant operations in surface waters. This continues to be the guiding principle of SMART, where protocols are envisioned for surface dispersant operations which are not regulated under 40 CFR 300.913 considered atypical (subsurface application, prolonged surface application > 96 hours or major discharge events > 100,000 gallons per 24-hour period).

SMART provides guidance on monitoring methods, equipment, personnel training, and command and control procedures that are designed to strike a balance between the operational demands for rapid response and the FOSC or UC's need for feedback from the field to make informed decisions based upon operational data. While the technology, tools, or methods used for SMART operations may change based upon advances in scientific knowledge and technology, the overall **design and objectives** established in the original protocol remain the same. As stated in the original SMART protocol, the SMART program for dispersant operations should be considered a living document and future updates should be made in accordance with significant advances in applicable science.

The specific guidelines, procedures, and methods developed for SMART dispersant operations as outlined in this document may be adopted for other hazardous substance responses. In addition, SMART-type monitoring or technologies that enhances or provides timely and scientifically based information to the FOSC or UC may be developed for additional alternative oil spill response techniques or could be adapted to other chemical spills into fresh or marine water.

General Information on Dispersant SMART Protocols

A. General Considerations and Assumptions

There are several considerations[4] that guided the initial and current workgroup in developing and updating the SMART guidelines:

1. SMART, in general, is designed for use at oil spills in both inland and coastal zones, as described in the National Oil and Hazardous Substances Pollution Contingency Plan. However, Dispersant SMART is not designed for inland use.

2. SMART does not directly address the health and safety of spill responders or monitoring personnel, because this is covered by the general site safety plan for the incident (as required by 29 CFR 1910.120).

3. SMART does not provide complete training on monitoring for a specific technology. Rather, the program assumes that monitoring personnel are fully trained and qualified to use the equipment and techniques mentioned and to follow the SMART guidelines.

4. SMART attempts to balance feasible and operationally efficient monitoring with solid scientific principles.

[3] There may be some instances where the FOSC has authority and preauthorization to proceed with, continue, or discontinue dispersant operations. For the purposes of this document, there is no intentional distinction as to whether the SMART protocols are specifically designed for the FOSC or the UC. Rather, the protocols are intended to serve command decision making wherever it occurs under applicable authorities, jurisdiction, etc.
[4] Some considerations are adapted or borrowed from the USCG RDC 2014 report entitled *Modernization of Special Monitoring of Applied Response Technologies (SMART) Technology and Methods*. https://apps.dtic.mil/sti/pdfs/ADA613265.pdf

5. In general, SMART guidelines are based on the roles and capabilities of available federal, state, and local teams, and Scientific Support Coordinators (SSC) provided by the National Oceanic and Atmospheric Administration (NOAA), the U.S. Environmental Protection Agency (EPA), or State agencies. The SSC most often fills the role of Technical Specialist mentioned throughout the document. However, other organizations may have qualified staff to serve/assist in this role (USCG Strike Team, OSROs). Users may adopt and modify the dispersant protocols to address specific needs and availability of resources.

6. SMART uses the best available and/or appropriate technology that is operationally practical. SMART represents a living document and should be revised and improved based on lessons learned from the field, advances in technology, and developments in techniques.

7. SMART **should not** be construed as a regulatory requirement but has been well-established as a best practice available for the FOSC or UC to assist in decision-making. While every effort should be made to implement SMART or parts of it in a timely manner, **dispersant operations should not be delayed solely** to allow the deployment of the SMART teams, particularly in instances where these operations are authorized or approved by the FOSC in accordance with applicable regulations specified in the National Contingency Plan; or area or regional contingency plans; or, where other incident or location-specific monitoring protocols have been established for dispersant operations.

8. SMART is not intended to replace private efforts in monitoring response technologies but is written for adoption and adaptation by any private or public agency. Furthermore, users may choose to tailor the dispersant protocols to specific regional needs. While currently addressing monitoring for dispersant operations, SMART may be expanded to include monitoring guidelines for other response technologies.

9. It is important that the FOSC or UC agree on the monitoring objectives and goals for any response countermeasures early on in an incident. This decision, like all others, should consider tradeoffs associated with the implementation of the strategy and should be documented. The monitoring objectives drive whether a response requires Tier I, II, and/or III level of monitoring. In many cases, Tier I will be sufficient for meeting objectives.

B. Document Organization

This document is intended to outline SMART protocols associated with surface dispersant operations only and is not to be confused with atypical dispersant monitoring requirements specified in NCP Subpart J (40 CFR Part 300.913**)**. The SMART dispersant document is divided into three sections:

Section 1: Background Information provides a brief overview of the response technology being used, defines the primary purpose for monitoring, and discusses monitoring assumptions.

Section 2: Monitoring Procedures provide general guidelines on what, where, when, and how to monitor; information on organization; information flow; team members; and reporting of data.

Section 3: Provides detailed information to support and expand Sections 1 and 2.

MONITORING DISPERSANT OPERATIONS

1. BACKGROUND

1.1 Mission Statement

The primary objective of SMART for dispersant operations is to provide timely, scientifically based information to the FOSC and, where appropriate, the UC for the purpose of decision making related to dispersant operations. Specifically, SMART for dispersant operations is designed to provide the FOSC/UC with relevant and timely data regarding floating and submerged oil to assess and evaluate potential impacts on sensitive resources during dispersant use. While it is assumed that the decision to **initiate** dispersant operations is made prior to the collection of SMART data, the SMART protocol outlines essential elements that should be considered when planning for dispersant use. The protocol technologies can also be used for the monitoring or surveillance of floating oil and naturally dispersed submerged oil without the use of chemical dispersants.

The intent of this revision to the SMART protocol is to enhance and update the process, and to provide a resource for readily available tools and procedures that can be used to gather useful information for the purpose of decision making related solely to dispersant operations and planning. They are not intended to replace any established protocols or procedures outlined in area or regional plans or applicable regulations, nor replace any protocols or procedures to address health and safety of the spill responders or monitoring personnel.

1.2 Overview of Dispersants

Chemical dispersants combine with oil and break a surface slick into small droplets that are mixed into the water column by wind, waves, and currents. The key components of a chemical dispersant are one or more surface-active agents, or surfactants. The surfactants reduce the oil-water interfacial tension, thus requiring only a small amount of mixing energy to increase the surface area and break the slick into droplets.

Several actions must occur for a surface oil slick to be chemically dispersed:

- The surfactant must be applied to the oil in an appropriate ratio;
- The surfactant must mix with the oil or move to the oil/water interface;
- The molecules must orient properly to reduce interfacial tension;
- Turbulent energy (i.e., waves) must be present to form oil droplets; and
- The droplets must not re-coalesce significantly.

Dispersants can be applied to surface slicks by air from airplanes and helicopters, or by boat. They are applied in lower volumes than the oil being treated.

1.3 Monitoring Dispersant Application

When dispersants are used during spill response, the Unified Command needs to know whether the operation is effective in dispersing the oil. SMART dispersant monitoring module is designed to provide the Unified Command with real-time feedback on the efficacy of aerial dispersant application. **SMART does not monitor the fate, effects, or impacts of dispersed oil.**

Dispersant operations and the need to monitor them vary greatly. Therefore, SMART recommends three monitoring options:

1. **Tier I - *Above* Water Monitoring.** Tier I employs any monitoring from above the water surface. This includes simplest operations, such as visual monitoring, as well as remote sensing surveillance from drone, aircraft, or satellite. In many cases, Tier I monitoring will provide sufficient confirmation of dispersant efficacy.

2. **Tier II - *On* Water Monitoring.** Tier II combines visual monitoring with on-water teams conducting real-time water column monitoring at a single depth, with water-sample collection for later analysis. **While fluorometry remains the most used method currently, other approaches may be considered (*e.g.,* particle size analyzers, acoustics).**

3. **Tier III - *In* Water Monitoring.** Tier III expands on-water monitoring to meet the potential information needs of the Unified Command. It may include monitoring at multiple depths, the use of a portable water laboratory, and/or additional water sampling. Tier III monitoring might for example include the redeployment of the monitoring team to a sensitive resource (such as near a coral reef system) as either a protection strategy or to monitor for evidence of exposure. Data collected in Tier III of the SMART dispersant protocol may also be useful for evaluating the dilution and transport of the dispersed oil. Any Tier III operation will be conducted with additional scientific input from the Unified Command to determine both feasibility and help direct field activities. The SSC or other Technical Specialists would assist the SMART Monitoring Team in achieving such alternative monitoring goals.

SMART establishes a monitoring system for rapid collection and reporting of real-time, scientifically based information, to assist the Unified Command with decision-making during dispersant operations. SMART recommends monitoring methods, equipment, personnel training, and command and control procedures that strike a balance between the operational demand for rapid response and the Unified Command's need for feedback from the field to make informed decisions. Tier I provides relatively quick, qualitative information about the efficacy of the dispersant operations, and may be all that is necessary. Tier II and Tier III monitoring provide quantitative data, but require additional processing time, and more involved logistics.

2. MONITORING PROCEDURES

2.1 General Considerations

Dispersant application has a narrow window of opportunity. Time is of the essence and timely notification is critical. It is imperative that the monitoring teams and technical advisors are notified of possible dispersant application and SMART monitoring deployment as soon as they are considered, even if there is uncertainty about carrying out this response option. Prompt notification increases the likelihood of timely and orderly mobilization of monitoring resources.

The characteristics of the spill and the use of dispersants determine the extent of the monitoring effort and, consequently, the number of teams needed for monitoring. The SMART dispersant operations tier system is depicted in Figure 1. The NRT acknowledges that technologies are continually advancing. Thus, Section 2.8; Table 1 provides an example of a range of monitoring technologies as well as the hyperlink to a living document resource to be updated as needed. For small-scale dispersant applications, a single visual monitoring team may suffice. For large dispersant applications several visual (Tier I) and water-column (Tiers II and III) monitoring teams may be needed.

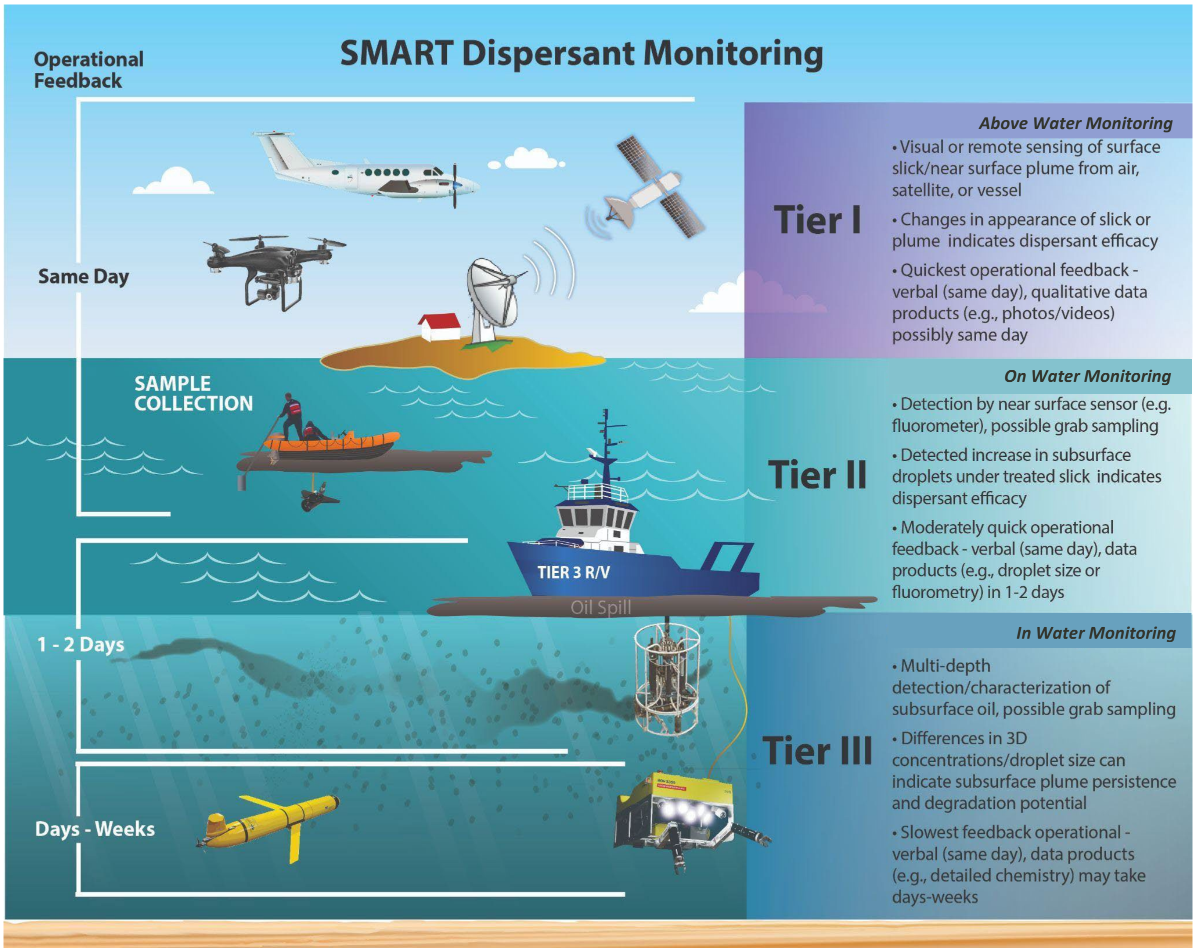

Figure 1 *Three tiers of SMART surface dispersant operations. Monitoring nomenclature used in previous versions of SMART were visual (Tier I), in water (Tier II) and expanded in water (Tier III).*

Guidelines and references designed to aid in determining the extent of potential impacts from dispersant operations are included in Section 3. Again, it is important to note that these SMART protocols are **not** designed to replace or contradict any existing regulations, but rather serve as a tool for acquiring timely, scientifically based data to aid in decision making.

2.2 Tier I – *Above* Water Monitoring

Tier I recommends visual observation by a trained observer, but it may also be accomplished by remote sensing tools (e.g., UAS with electro-optic sensor, satellite imaging) under some circumstances. A trained observer, using visual aids, can provide a general, qualitative assessment of dispersant effectiveness. Use of guides such as the NOAA *Dispersant Application Observer Job Aid* is recommended for consistency. Observations should be photographed and videotaped to help communicate them to the Unified Command, and to better document the data for future use.

When available, visual monitoring may be enhanced by advanced sensing instruments such as infrared thermal imaging or UV-Vis reflectance. These and other devices can provide a higher degree of sensitivity in determining dispersant effectiveness. Examples of some monitoring technologies are listed within Section 2.8; Table 1.

Visual monitoring is relatively simple and readily done. It can be sufficient in providing confirmation on the effectiveness of dispersant operations. However, above water observations do not always provide detailed information on the extent of oil dispersion. Tier II provides a near real-time method using water column monitoring via a direct reading instrument and water sampling.

2.3 Tier II – *On* Water Monitoring

To confirm the visual observations, if necessary, a monitoring team may be deployed to the dispersant application area. SMART defines it as Tier II monitoring, which can be conducted by Strike Teams and/or other trained and qualified personnel.

Tier II recommends single depth monitoring between 1 to 2 meters, depending on sea state. Discrete grab samples of oil and water may be collected in concert with in-situ monitoring. Grab samples are used to determine direct comparisons between field instruments and laboratory verifications. In-situ monitoring offers the ability to collect many data points over spatial and temporal scales, filling data gaps between the grab samples

A water-column monitoring team composed of at least one trained technician and a support person is deployed on a suitable platform. Under ideal circumstances, the team collects data in three primary target locations: (1) background (under no oil); (2) under untreated oil slicks prior to dispersant application, and (3) under dispersant-treated oil. Data can be collected in real-time using automated continuous sensors or manually operated field instruments. Any data and grab sample information should be recorded in sampling logs to allow the results to be communicated, near real-time, to the appropriate technical specialist in the Unified Command (TTP, 2016; NOAA SMART Manual, 2016) (refer to Section 3 of this document). Data are used for documentation and scientific evaluation.

The field team should record the time, instrument readings, and any relevant observations at selected time intervals. Global Positioning System (GPS) instruments are used to ascertain the exact position of each reading. Fluorometry is widely used due to ease of operation and the sensitivity of the measurement to the dissolved aromatic oil hydrocarbons. In addition to fluorometry, other real-time techniques (e.g., optical scattering and acoustics) can measure the presence of suspended oil droplets in plumes. Examples of some monitoring technologies are listed within Section 2.8; Table 1.

2.4 Tier III – *In* Water Monitoring

Tiers I and II provide feedback to the Unified Command on the effectiveness of dispersant application. If dispersants are effective and additional information on the movement, dilution, or persistence of the dispersed oil plume is desired, then SMART Tier III procedures may address this need. Examples of some monitoring technologies are listed within Section 2.8; Table 1.

Tier III follows Tier II procedures but collects information on the transport and dispersion of the oil in the water column. It helps to verify that the dispersed oil is diluting toward background levels. Tier III is simply an expanded monitoring role that is intended to meet the needs of the Unified Command.

Tier III monitoring may be conducted as follows:

- Multiple depths with one instrument: This monitoring technique provides a cross-section of relative concentrations of dispersed oil at different depths, measuring the dilution of dispersed oil down to background levels. When transecting the dispersant-treated slick (as outlined for Tier II), the team stops the vessel at location(s) where elevated readings are detected at 1 meter and, while holding position, the team monitors and collects samples at multiple increments down to a maximum depth of 10 meters. Readings are taken at each water depth, or continually, and the data recorded both automatically in the instrument data logger and manually by the monitors as specified by the Monitoring Group Supervisor or as indicated in a written sampling plan developed by the Dispersant Technical Specialist.

- Transect at two different depths: This technique also looks at changes in concentration trends but uses two monitoring instruments at different depths as the monitoring vessel transects the dispersed oil slick while making continuous observations. It is done as follows:

  Monitoring is conducted at two different depths, 1 and 5 meters, or any two water depths agreed upon by the FOSC or the Unified Command. Two sampling setups and two separate monitoring instruments are used on a single vessel. The vessel transects the dispersant- treated slick as outlined in Tier II, except that data are now collected simultaneously for two water depths. The data are recorded automatically in the instrument data loggers and manually by the monitors as specified by the Monitoring Group Supervisor or the sampling plan developed by the Dispersant Technical Specialist. Comparison of the readings at the two water depths may provide information on the dilution trend of the dispersed oil.

- Water quality parameters: In addition to instrument data, the Unified Command may request that water physical and chemical parameters be measured. This can be done by using a portable lab or submersible sensors to measure water temperature, conductivity, dissolved oxygen content, pH, and turbidity. These data can help explain the behavior of the dispersed oil. The turbidity data may provide additional information on increased concentrations of dispersed oil if turbidity is elevated. The other physical and chemical parameters measure the characteristics of the water column that could possibly affect the rate of dispersion.

- Water sample collection: As in Tier II, water samples are collected, but in greater numbers to help validate instrument readings.

Calibration and documentation used for Tier II are valid for Tier III as well, including the use of a check standard to verify instrument response. Because of the increased complexity of Tier III, a Dispersant Technical Specialist (e.g., member of the scientific support team) may be on location to assist the monitoring efforts.

2.5 Using and Interpreting Monitoring Results

Providing the Unified Command with objective information on dispersant efficacy is the goal of Tier I and II dispersant monitoring. When visual observations and on-water column monitoring confirm that the dispersant operation is not effective, the Unified Command may consider evaluating further use. If, on the other hand, visual observations and/or water column monitoring suggest that the dispersant operation is effective, dispersant use may be continued.

Of note, continuous sensor readings may not stay steady at a constant level but may vary widely, reflecting the patchiness and inconsistency of the dispersed oil plume. Persons reviewing the data should look for trends and patterns providing good indications of increased hydrocarbon concentrations above background Monitoring technologies have unique levels of sensitivity, dependent on instrument design. Previous version of SMART provided a general guideline that a fluorometer signal increase in the dispersed oil plume of five times or greater over the difference between the readings at the untreated oil slick and background (no oil) is a strong positive indication. Depending on sensitivity, technologies may not reflect a five-fold increase to be indicative of effective dispersion. This should not be used as an action level for turning on or off dispersant operations. **The final recommendation for turning a dispersant operation on or off is best left to the judgment of the Technical Specialist charged with interpreting the data. The Unified Command, in consultation with the Technical Specialist, should agree early on as to the trend or pattern that they would consider indicative or non-indicative of a successful dispersant operation.** This decision should be documented.

2.6 SMART as Part of the ICS Organization

SMART activities are conducted by a Dispersant Monitoring Group, in the Operations Section. Data processing and interpretation are conducted by a Dispersant Monitoring Team, which may be part of the Environmental Unit, or if size and complexity warrant, a separate group under planning. The Dispersant Monitoring Team works closely with the Dispersant Monitoring Technical Specialist, usually a NOAA SSC or a member of the NOAA Scientific Team. Possible configurations for Tier I and Tier II/III SMART Monitoring are shown in Figure 2, below. Structure pertains to subsections under the command post, where the Dispersant Operations Group is under the Operations Section and the Environmental Unit is under the Planning Section.

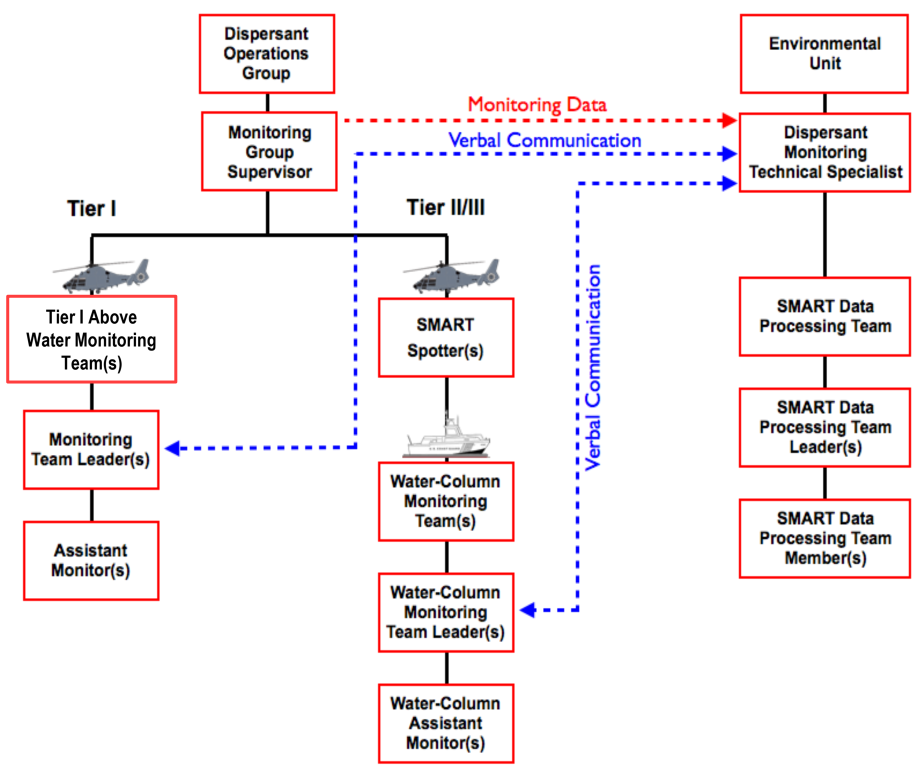

Figure 2 *Possible communication configurations for Tier I and Tier II/III SMART monitoring.*

2.7 Information Flow and Data Handling

Verbal communication of monitoring results should flow up from the monitoring teams to the Dispersant Group Monitoring Supervisor, who transmits it to the Dispersant Monitoring Technical Specialist or the SMART Data Processing Team Lead, as appropriate. The Dispersant Monitoring Technical Specialist reviews the data and provides an evaluation of dispersant efficacy to the Unified Command. Data processing and quality assurance will be conducted in accordance with procedures described in the NOAA SMART Data Processing and Evaluation Manual, with adaptations for technologies not included in that manual as appropriate.

2.8 SMART Technologies Section

The NRT acknowledges that technologies are continually advancing. Thus, Table 1 provides an example of a range of monitoring technologies as well as a hyperlink to a living document resource that is updated as needed. Technologies are categorized by monitoring objectives and criteria. Listed are the common deployment platforms for each technology. Four decision-making considerations (ease of use, time to deploy, data processing and delivery, and need for skilled personnel) are provided. Considerations are color and number coded as a general guide to help select technologies that align with specific operational needs of a spill. It is important to note that for small-scale dispersant applications, a single visual monitoring team may suffice. For large dispersant applications several visual (Tier I) and water-column (Tiers II and III) monitoring teams may be needed.

Table 1 *Example of the Advanced Sensing Instruments table that is intended to be a 'living' document residing at this hyperlink. (hyperlink to be added here).*

Lighter Less effort/ skill/ time				Darker More effort/ skill/ time
1	2	3	4	5

MONITORING CRITERIA / MONITORING OBJECTIVES	SPILL SPECIFIC PARAMETERS	INSTRUMENT, SENSORS, or ANALYSIS	DEPLOYMENT PLATFORMS	DECISION-MAKING CONSIDERATIONS: Time to Deploy	Ease of Use	Data Processing & Delivery	Skilled Personnel
Surface Oil Location	Presence/ Absence	Optical and SAR satellites	Satellite	1	3	4	5
		Remote Sensing*	Aircraft, vessel	2	3	3	5
		Visual Observation - Human eye	Aircraft, vessel	1	1	1	2
	Footprint/ Spatial Extent	Remote Sensing*	UAV	2	4	3	5
		Visual Observation - Human eye	Aircraft, vessel	1	1	1	2
Droplet Size Distribution	Particle Size	Laser diffraction particle size analyzer	Vessel, AUV, ROV, glider	2	3	3	4
		Holographic, silhouette or standard lens cameras		3	3	3	5
Oil in Water Column	Dissolved Oil	Field GC/MS	Vessel, AUV, ROV, glider	4	4	4	5
		Fluorescence Sensor		2	2	3	3
		Discrete GC/MS	Land-based laboratory	1	2	4	5
	Particulate Oil	Turbidity Sensor	Vessel, AUV, ROV, glider	1	1	2	2
		Laser-diffraction particle size analyzer		3	3	4	4
		Holographic, silhouette or standard lens camera		4	4	4	5
		Acoustics	AUV, ROV, glider	4	4	4	5
		Discrete GC/MS	Land-based laboratory	1	2	4	5
Representativeness of Oil Spill Location	Water Quality	Density	Vessel, AUV, ROV, glider	1	1	2	2
		Conductivity		1	1	2	2
		Oxygen		1	1	2	2
		pH		1	1	2	2
		Temperature		1	1	2	2
		Turbidity		1	1	2	2

* Visible and infrared multispectral, hyperspectral, thermal, microwave, and laser fluorosensors

3. IMPLEMENTING SMART

This section describes various procedures, organizational structure, and observational guidelines for implementing SMART. Specific procedures are described in detail within the NOAA SMART Data Processing and Evaluation Manual (NOAA, 2016), where printable forms to support the implementation of SMART Dispersant Monitoring are available. This section is designed to assist response personnel in implementing the SMART protocol. Procedures may be modified as required to meet the stated objectives.

3.1 Roles and Responsibilities

1. Tier I

Monitoring Group Supervisor – Directs above water monitoring field activities. A Monitoring Group Supervisor may not be needed for a Tier I deployment. In these cases, the Above Water Monitoring Team monitor may perform the duties of the Monitoring Group Supervisor.

Above Water Monitoring Team – Collects above water monitoring data in accordance with SMART Tier I procedures.

- *Monitor (Team Leader)* – Qualitatively measures dispersant effectiveness from above water monitoring and communicates results to the Monitoring Group Supervisor.
- *Assistant Monitor(s)* – Assists the Monitor as directed and provides photo, visual, or other appropriate documentation of dispersant effectiveness. There may be more than one Assistant Monitor, depending on the size and complexity of the SMART process.
- *Dispersant Monitoring Technical Specialist (TS)* – Receives Tier I field data, performs QC/QA, makes the final evaluation on the effectiveness of the dispersant application and then makes recommendations to Unified Command. Processing of the Tier I field data generally does not require the use of a dedicated SMART processing team.

2. Tier II and Tier III

Monitoring Group Supervisor – Directs water-column monitoring field activities and communicates monitoring results to the TS.

SMART Spotter – Directs on-water monitoring activities and coordinates with dispersant spray operations. SMART spotting is best done from an air platform.

Water-Column Monitoring Team – Collects monitoring data from a vessel in accordance with SMART Tier II & III procedures.

- *Monitor (Team Leader)* – Oversees on-water monitoring activities and may operate fluorometers and other water-column monitoring equipment as needed.
- *Assistant Monitor(s)* – Assists Monitor as directed. Provides photo and visual documentation of dispersant effectiveness. Completes all logs, forms, and labels for recording water column measurements, water quality measurements, interferences, and environmental parameters.
- *Dispersant Monitoring Technical Specialist* – Makes the final evaluation on the effectiveness of the dispersant application and makes recommendations to Unified Command.

- *SMART Data Processing Team* – Receives the field data from the Monitoring Group Supervisor, performs data QA/QC and data processing, then delivers the results to the TS for evaluation.

3.2 Command, Control, and Data Flow

In general, dispersant monitoring operations take place as an integral part of the Incident Command System (see Figure 3).

Dispersant monitoring operations are tactically deployed by the Operations Section Chief or deputy, in cooperation with the Dispersant Monitoring Technical Specialist in the Planning Section. The Monitoring Group Supervisor provides specific on-scene directions to the monitoring teams during field deployment and operations.

The observation and monitoring data flow from the Monitoring Teams to the Monitoring Group Supervisor. After initial QA/QC the Group Supervisor passes the data to the Dispersant Monitoring Technical Specialist for Tier I operations, or to the SMART Data Processing Team Lead for Tier II/III operations. Following any necessary processing, the Dispersant Monitoring Technical Specialist makes a recommendation to the Unified Command about continuing or ceasing dispersant operations.

ICS organizational structures are scalable, and specifics of how the SMART operations are organized will vary dependent on specifics of the incident. An example structure is shown below.

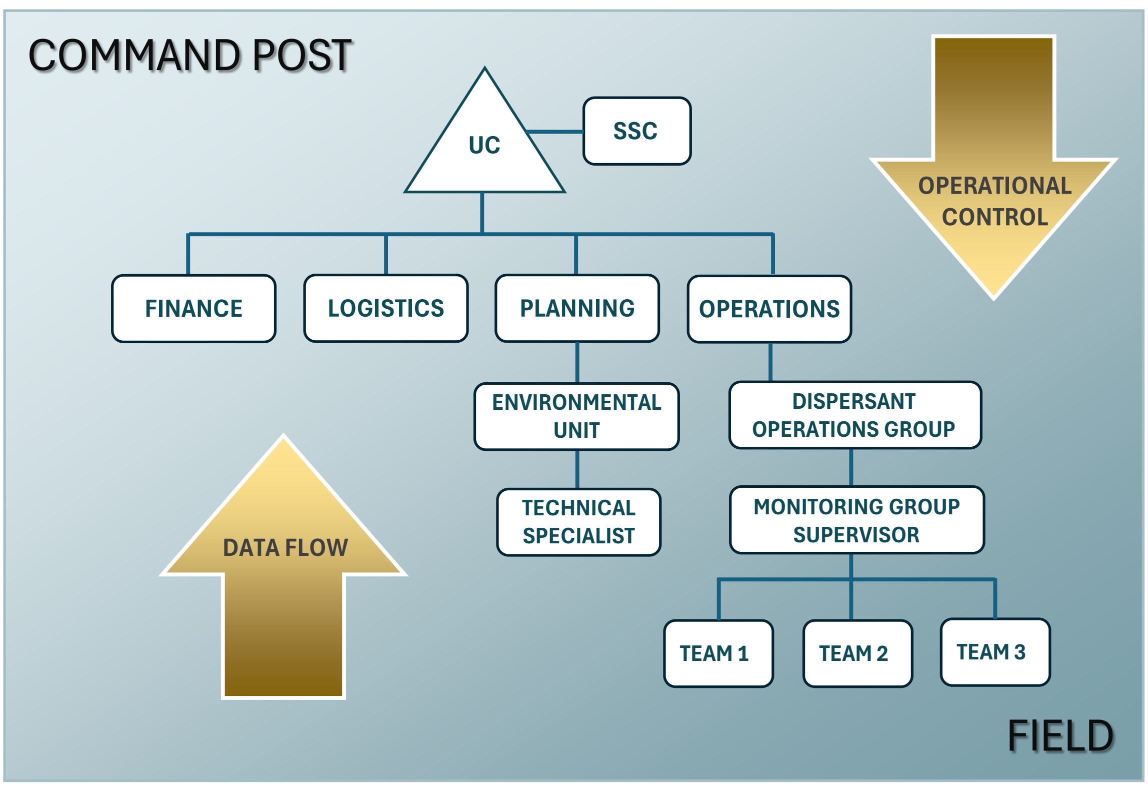

Figure 3 *Dispersant Monitoring Operations as part of the Incident Command System.*

3.3 Dispersant Observation General Guidelines

1. Goal

The goal of above water monitoring is to identify oil, visually or using remote sensing technology, to assess efficacy of dispersants applied to oil, and report the observations to the Unified Command with recommendations. The recommendations may be to continue, to modify, or to evaluate further monitoring or use because dispersants were not observed to be effective.

2. Guidelines and Pointers

Reporting Observations

- The above water monitor or visual observer does not make operational decisions, e.g., how much dispersant to apply, or when and where to apply it. These decisions are made at the Operations Section level, in accordance with dispersant use authorization, and the observer makes observations based on those decisions.
- Different visual observers at the same site may reach different conclusions about how much of the slick has been dispersed. For that reason, a comprehensive standard reporting criterion and use of a common set of guidelines for visual monitoring is imperative. Use of the NOAA *Dispersant Application Observer Job Aid* is highly encouraged.

Oil on the Water

- Oil surface slicks and plumes can appear different for many reasons including oil or product characteristics, time of day (different sun angles), weather, sea state, rate at which oil disperses. The use of the NOAA *Open Water Oil Identification Job Aid for Aerial Observation* is highly recommended for visual monitoring.
- Low-contrast conditions (e.g., overcast, twilight, and haze) make visual observations difficult.
- For best visual monitoring viewing, the sun should be behind the observer and with the aircraft at an altitude of about 200 - 300 feet flying at a 30-degree angle to the slick.

Dispersant Applications

- During dispersant application, it may be impossible to determine the actual area of thickest oil concentrations, resulting in variable oil/dispersant application rates. This could lead to variations in the effectiveness of application. The above water (Tier 1) observer should report these conditions.
- Initial applications may have a herding effect on the oil. This would cause the slick to appear to be shrinking when, in fact, it is the dispersant "pushing" the oil together. Due to this effect, in some cases, the oil slick may even disappear from the sea surface for a short time.
- After dispersant application, there may be color changes in the emulsified slick due to reduction in water content and viscosity, and changes in the shape of the slick, due to the de-emulsification action of the dispersant.
- Many trials have indicated that dispersants apparently modify the spreading rates of oils, and within a few hours treated slicks cover much larger areas than control (untreated) slicks.
- In some situations, especially where there may be insufficient mixing energy, oil may resurface.

Effective/Ineffective Applications

- Dispersed oil plume formation may not be instantaneous after dispersant application. In some cases, such as when the oil is emulsified, it can take several hours. A dispersed oil plume may not form at all.
- The appearance of the dispersed plume can range from brown to white (cloudy) to no visible underwater plume (hence, the reason Tier II may be necessary).
- Sometimes other things such as suspended solids may resemble dispersed oil.
- The visibility of the dispersed plume will vary according to water clarity. In some cases, remaining surface oil and sheen may mask oil dispersing under the slick and thus interfere with visual observations of the dispersed oil plume.
- Dispersed oil plumes are often highly irregular in shape and non-uniform in concentration. This may lead to errors in estimating dispersant efficiency.
- If a visible cloud in the water column is observed, the dispersant is working. If a visible cloud in the water column is not observed, it is difficult to determine whether the dispersant is working.
- If there are differences in the appearance between the treated slick and an untreated slick, the dispersant may be working.
- Boat wakes through oil may appear as a successful dispersion of oil; however, this may be just the vessel wake breaking a path through the oil (physically parting the oil), not dispersing it.

3. Reporting SMART Dispersant Observations and Evaluations

Printable Forms for documenting SMART Dispersant Monitoring visual observations and Data Evaluations can be found in Appendix A of the NOAA SMART Data Processing and Evaluation Manual (NOAA, 2016).

- A1 – Blank full-size, copy-ready USCG Unit Log - ICS 214-CG form
- A2 – Blank full-size, copy-ready Tier I Photo Log
- A3 – Blank full-size, copy-ready Dispersant Application Observation Reporting Form
- A4 – Blank full-size, copy-ready SMART Tier I Data Quality Assessment and Review Form
- A5 – Blank full-size, copy-ready Dispersant Operations Summary Form (template for reporting)

Note: The Dispersant Application Observation Reporting Form can also be found in the NOAA Dispersant Aerial Observers Job Aid

3.4 Water Column Monitoring for Dispersants: Performance Requirements

SMART does not require nor endorse a specific instrument or brand for dispersant monitoring. Rather, SMART specifies performance criteria, and instruments meeting them may be used for monitoring.

1. Instrument package must be field rugged and portable. Instrument package must be able to operate from a vessel or small boat under a variety of field conditions, including air temperatures between 5 and 35°C, water temperatures between 5 and 30°C, seas to 5 feet, humidity up to 100%, drenching rain, and even drenching sea spray. The criteria for field deployment should be limited by the safety of the field monitoring team and not instrument package limitations.
2. Instrument package must be able to operate continuously in real-time or near-real time mode by

analyzing seawater either in-situ (instrument package is deployed in the sea) or ex-situ (seawater is continuously pumped from a desired depth).

3. Monitoring depth must be controllable to between 1 meter and 3 meters. Discrete water sampling for post-incident laboratory validation is required at the same depths as actual instrument monitoring. Note, actual analysis of water samples collected may or may not be required by the FOSC.
4. Instrument must be able to detect dispersed crude oil in seawater. To allow a wide range of instruments to be considered, no specific detection method is specified. If fluorometry is used, the excitation and emission wavelengths monitored should be selected to enhance detection of crude oil rather than simply hydrocarbons to reduce matrix effects (for the Turner AU-10, long wavelength kits developed for oil detection are preferred over the short wavelength kits developed by the manufacture for other applications).
5. Instrument must be able to provide a digital readout of measured values. Given that different oils that have undergone partial degradation due to oil weathering will not provide consistent or accurate concentration data, measured values reported as “raw” units are preferred for field operations over concentration estimations that might be misleading as to the true dispersed oil and water concentrations.
6. In addition to a digital readout (as defined above), the instrument must be able to digitally log field data for post-incident analysis. Data logging must be in real-time, however downloading of achieved data is not required until after the monitoring activity, i.e., downloading the raw data to a computer once the boat returns from the field operation is acceptable.
7. For instrument validation prior to operational use, the instrument must have a minimum detection limit (MDL) of 1 ppm of dispersed fresh crude oil in artificial seawater and provide a linear detection to at least 100 ppm with an error of less than 30% compared to a known standard. The preferred calibration oils are Bryan Mound Crude, South Louisiana Crude or Prudhoe Bay Crude which have been previously or currently utilized for EPA’s dispersant effectiveness testing for the NCP Product Schedule. Similar dispersible crude oils may be used if availability is a limitation (diesel fuel is not a suitable substitute). Some method of instrument calibration or validation is required on-scene prior to any operational monitoring for Quality Assurance/Quality Control (QA/QC).

3.5 Water Column Monitoring for Dispersants: Field Guidelines

1. Tier II Monitoring Operations Procedures

Monitoring the water column for dispersant efficacy includes three parts:

- Water sampling for background reading, away from the oil slick.
- Sampling for naturally dispersed oil, under the oil slick but before dispersants are applied.
- Monitoring for dispersed oil under the slick area treated with dispersants.

Background, no oil

Enroute to the sampling area and close to it, the sampling boat performs a monitoring run where there is no surface slick. This sampling run at 1-meter depth (or deeper depending on sea state conditions) will establish background levels before further sampling.

Under untreated oil (i.e., naturally dispersed)

When reaching the sampling area, the sampling boat makes the sampling transects at 1-meter depths across the surface oil slick(s) to determine the level of natural dispersion before monitoring the chemical dispersion of the oil slick(s).

Under dispersant-treated oil

After establishing background levels outside the treated area, the sampling boat intercepts the dispersed subsurface plume. The sampling boat may have to temporarily suspend continuous sampling after collecting baseline values in order to move fast enough to intercept the plume. The sampling boat moves across the path of the dispersed oil plume (roughly perpendicular to the dispersant spray path) to a point where the center of the dispersed plume can be predicted based on the size of the treatment area and the locations of new coordinates. The sampling boat may have to be directed by an aerial asset to ensure correct positioning over the dispersed slick.

When conducting the monitoring, the transects consist of one or more "legs," each leg being as close as possible to a constant course and speed. The recommended speed is 1-2 knots. The monitoring team records the vessel position at the beginning and end of each leg.

The instrument data may be reviewed in real time to assess the relative enhanced dispersion of the water-soluble fraction of the oil. Figure 4 shows an example of how the continuous flow data may be presented.

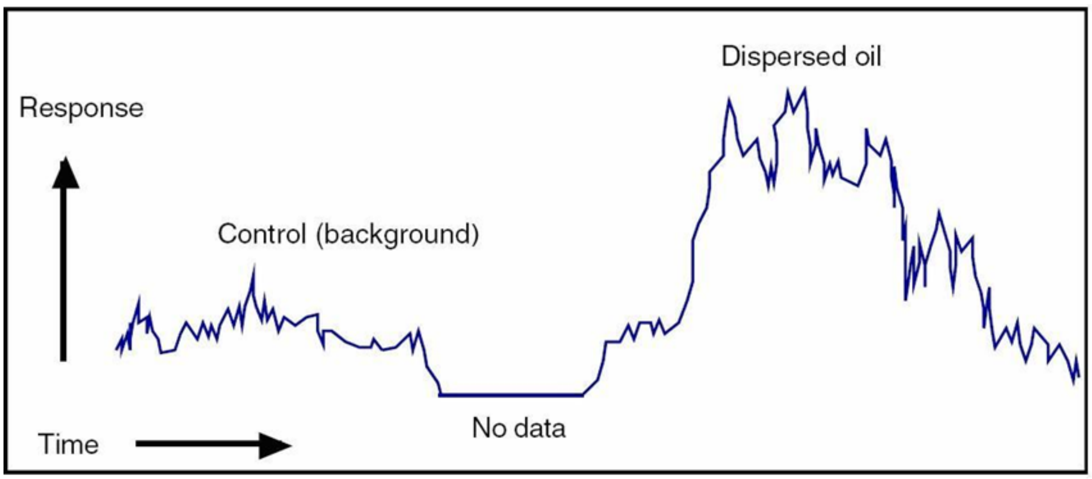

Figure 4 *Example of a graphical presentation of fluorescence data.*

2. Tier III Monitoring Operations

If monitoring indicates that dispersant application is effective, the Unified Command may request that additional monitoring be done to collect information on the transport and dilution trends of the dispersed oil. Tier III may be conducted to address this information need. Tier III is highly flexible. Any Tier III operation will be conducted with additional scientific input from the Unified Command to determine both feasibility and help direct field activities. The SSC or other Technical Specialists would assist the SMART Monitoring Team in achieving such alternative monitoring goals.

Multiple Depths with One Instrument

This monitoring technique provides a cross section of relative concentrations of dispersed oil at different depths. To conduct this operation, the team stops the vessel while transecting the dispersant- treated slick at a location where the in-situ sensor monitoring at the one-meter depth indicated elevated readings. While holding steady at this location, the team lowers the sensor down to approximately ten meters (Figure 5). Monitoring is done for several minutes (2-3 minutes) for each water depth, and the readings recorded both automatically by the instrument's data logger and manually by the monitoring team, in the data logging form. This monitoring mode, like Tier II, requires one vessel and one sensor with a team to operate it.

<u>**Simultaneous Monitoring at Two Different Depths**</u>

If two sensors and monitoring setups are available, the transect outlined for Tier II may be expanded to provide sensor data for two different water depths (one and five meters are commonly used). Two sampling set-ups (outriggers, hoses, etc.) and two separate sensors (same model) are used, all on a single vessel, with enough monitoring personnel to operate both instruments. The team transects the dispersant-treated slick as outlined in Tier II, but simultaneously collect data for two water depths (Figure 5).

While the data logger in each instrument is automatically recording the data separately, the monitoring teams manually record the data from both instruments at the same time. Comparison of the readings at the two water depths may provide information on the dilution trend of the dispersed oil.

If requested by the Unified Command, water chemical and physical parameters may be collected along with the selected sensor to measure water temperature, conductivity, dissolved oxygen content, pH, and turbidity. These data can help explain the behavior of the dispersed oil.

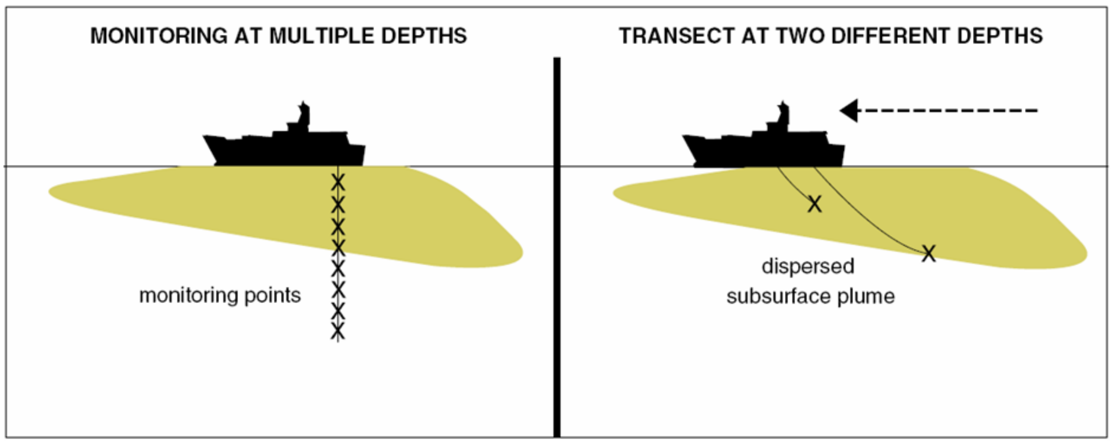

Figure 5 *Monitoring options for Tier III.*

3.6 Water Column Monitoring for Dispersants: Water Sampling

A SMART Sampling and Analysis Plan (SAP) is included in the NOAA SMART Data Processing and Evaluation Manual (NOAA, 2016), Appendix C.

APPENDIX A: REFERENCES CITED AND SMART RESOURCES

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