UPDATE SMART PROTOCOL FOR MONITORING EFFICACY OF OIL SPILL DISPERSANT OPERATIONS: Proceedings of the Stakeholder Workshop

Final Report

For

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Executive Summary

A two-day workshop was held to discuss updating the dispersant component of the SMART Protocol (U.S. Coast Guard et al., 2006). The meeting, involving 18 end-users of the protocol, was held on September 19-20, 2007 in Edison NJ. Objectives were to obtain input from end-users regarding experience with the protocol itself, the instruments used in the past and needs for upgrading the protocol. Participants included members of the USCG Strike Teams and NOAA who had served on SMART monitoring teams, as well as dispersant experts from industry and government. The workshop was part of a larger, SMART-focused project that also: a) analysed dispersant monitoring data collected during experiments at Ohmsett to verify the reliability of existing SMART methods (SL Ross 2008a); and b) reviewed commercially available off-the-shelf instruments that might be useful in monitoring efficacy of dispersant operations (SL Ross 2008b).

The meeting conclusions were as follows.

- In general, the three-tier approach used in SMART is still appropriate and should not be made more complicated. Some specification is required in documentation for all Tiers. The intent and methods for Tier 3 must be made explicit and the distinction between Tier 2 and 3 must be clarified.

- Regarding Tier 1, the operational aspect of the protocol lacks specificity, which is a problem when the Monitoring Team is inexperienced. The Protocol relies heavily on the NOAA "Dispersant Application Observer Job Aid (Job Aid)" to provide guidance, but the Job Aid[1] provides virtually no guidance at all in two critical areas, specifically: a) it lacks standards for characterizing effective and ineffective dispersions; and b) it lacks guidance regarding non-subjective, unambiguous signs that either effective and ineffective dispersion is taking place. Participants also concluded that: a) training standards should be established for the Monitoring Teams; and b) observers must be provided with experience in dispersant operations in both domestic and international spills and exercises. A core group of trained, experienced observers must be developed with job stability (e.g., USCG District Response Assist Teams (DRATs)).

[1] Note that an updated version of this NOAA Job Aid was published within days of the workshop and many of the deficiencies identified in the workshop were addressed. Unfortunately the new edition bears nothing to identify it as a new version (publication date, version number, edition number).

- Regarding Tier II, the intent of the original authors of SMART was that effectiveness could be assessed visually. However, in-situ measurements using instruments would be useful to: a) aid in decision making if two visual monitors disagreed on whether an application was effective; and b) gather information on the concentrations of dispersed oil in the upper water column under dispersant treated slicks for various purposes (Henry, pers. comm., 2007). Workshop participants agreed that the principles of Tier 2 were acceptable. However, the Turner 10AU (T-10AU) fluorometer instrument, around which the protocol was developed, poses several significant operational challenges that might be avoided if a newer, more modern instrument were used. Workshop discussions focused on: a) the many challenges associated with using the T-10AU instrument; b) merits of existing off-the-shelf fluorometers that might replace the T-10AU; c) merits of technologies other than fluorometry (e.g. oil-particle-size analysis) for making in-situ oil measurements; and d) the need for greater specificity in parts of the written Protocol, in particular the methods for capturing observational data and communicating it from the Monitoring Team to the Technical Specialist.
- Participants suggested that regardless of the instrument used, all USCG Strike Teams should have exactly the same version of the instrument, so that they would be completely interchangeable among geographic regions.
- The guideline suggested in SMART for identifying an effective dispersant application is that the level of oil measured in the water column below a treated slick must increase by at least a factor of five if the application is effective ("five-times" standard). Participants believed that the "five-times" standard appeared to be adequate based on experience to date, but believed that this standard might be T-10AU-specific and should be revisited if other instruments were used. [2]

[2] Editor's Note: It is important to recognize that participants did not have access to the SL Ross (2008a) report on verification of monitoring methods during dispersant tests at Ohmsett. That report suggested that there might be problems with the "five-times" guideline.

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1 Introduction

This report summarizes a two-day workshop convened to discuss updating the dispersant component of the Special Monitoring of Applied Response Technologies (SMART) Protocol (U.S. Coast Guard et al., 2006). SMART is a monitoring system for rapid collection and reporting of real-time, scientifically based information during oil spills at sea. It is deployed to assist the Unified Command with decision-making for in-situ burning or dispersant operations. The SMART document recommends monitoring methods, equipment, personnel training and command/control procedures. It strikes a balance between the Unified Command's need for feedback from the field and the operational demand for rapid response. The workshop, involving 18 end-users of the protocol, was held on September 19-20 in Edison NJ. Objectives were to obtain input from end-users of the SMART protocol regarding:

1. Past experience with the protocol and instrumentation; and
2. Opinions regarding needs for upgrading the effectiveness and operational utility of the protocol.

The workshop included invited presentations on the history of SMART and experience with dispersant monitoring instruments, but the workshop's main focus was the breakout sessions that identified the strengths and weaknesses of the existing protocol and areas in which it should be updated. The list of attendees and agenda are in Appendices 1 and 2, respectively. The workshop is part of a larger SMART-focused project that was also intended to:

1. Analyze monitoring data (visual and instrumental monitoring) collected during Ohmsett dispersant experiments completed between 2003 through 2007 for the purposes of verifying the reliability of existing SMART effectiveness monitoring protocols and recommending changes to improve monitoring methods; and
2. Review the commercially available off-the-shelf instruments that might fit the needs of the USCG Strike Teams for monitoring the effectiveness of oil spill dispersant operations.

1.1 Rationale

Effectiveness monitoring is a critical component of dispersant application. To address the need for monitoring, agencies developed an effectiveness monitoring protocol, (SMART) (USCG et al. 2006), its forerunner, "Special Response Operations Monitoring Program (SROMP) (NOAA and USCG 1994)[3] and support documents such as NOAA's "Dispersant Application Observer Job Aid (Job Aid) (NOAA no date)". In recent dispersant experiments in the large, outdoor wave-tank at Ohmsett, researchers have routinely deployed one or more monitoring methods during large-scale dispersant effectiveness tests in order verify the usefulness of SMART methods and identify any limitations. This work showed that existing SMART protocols are generally useful, but may be misleading and result in incorrect conclusions under some conditions. In their recent review of dispersant technology, the National Research Council (2005, page 284) strongly recommended that agencies involved in SMART update the monitoring protocols and data quality objectives. The present workshop sought to assemble the experience of SMART practitioners and stakeholders for purposes of upgrading the protocol.

[3] In 1993, CAPT James Calhoun (District Chief, USCG 8th District) tasked NOAA (NOAA Scientific Support Coordinator, Mike Barnhill) and the USCG Gulf Strike Team to develop a non-industry-based dispersant monitoring protocol. Barnhill, working with Charlie Henry (Louisiana State University) and members of the Gulf and Atlantic Strike Teams developed a two-tiered monitoring system based on visual observation and continuous in-situ water monitoring, called "Special Response Operations Monitoring Program" or SROMP (NOAA and USCG 1994).

2 Summary of Workshop Breakout Sessions

As mentioned above, the September 2007 workshop involved structured breakout sessions designed to solicit input from users of SMART, identifying areas where the protocol works well and areas where improvements might be required. For these discussions, the eighteen workshop participants were divided into two groups. In the first session, one group of operational personnel assessed SMART from an operational perspective. A second group of technical experts and government regulators examined SMART from the perspective of Technical Specialists who interpret the monitoring data and advise the Incident Command Team. Organizers then summarized the questions and issues raised in the breakout sessions and asked participants to elaborate on them and set priorities. The main points from these sessions are summarized below on a tier-by-tier basis.

2.1 General

Participants agreed that the three-tier approach to dispersant monitoring was still appropriate, but made the following comments.

1. For dispersant use in pre-approved zones, terms of Tier I and II are sufficient and relatively clear. For non-pre-approved zones, where significant sub-surface resources may be at risk, the expectation is that Tier III will be needed.
2. The three-tier format should not be made more complicated than it is, but some clarification is required. Specifically, practical experience has shown that the line between Tier I and II is explicit and straightforward, but that between Tier II and III seems to confuse some. Clarification is needed.

2.2 Tier I

Tier I monitoring involves using trained airborne observers or visual monitors (VM) to examine dispersant-treated oil slicks for signs of effectiveness. In general VMs: a) observe the slick itself for evidence of changes in slick condition resulting from dispersant application; and b) assess the water-column under the treated slick to determine whether or not a cloud of chemically dispersed oil has appeared. This information is then summarized and communicated back to the Technical Specialist (TS) for interpretation.

2.2.1 Operations

Participants agreed that the operational aspect of the protocol lacks specificity and therefore allows for subjectivity, which is a problem when VMs are inexperienced. At present the Protocol relies heavily on the NOAA "Dispersant Application Observer Job Aid (Job Aid)" to provide guidance to VMs on: a) diagnostic cues of effectiveness in visual appearance of effective and ineffective dispersion; and b) terms to be used in describing what is observed and communicating information concerning this behavior to the TS. Unhappily, the Job Aid provides virtually no guidance at all in these areas[4].

Participants concluded that VMs must be provided with clear guidance concerning:

1. Standards for characterizing effective and ineffective dispersion; and
2. Non-subjective, unambiguous signs that allow them to distinguish between of effective and ineffective dispersant applications.

Participants placed a high priority on providing VMs with pictorial examples of effective and ineffective dispersion. One group suggested that a "paint chips" approach be developed for providing a visual scale of effectiveness[5]. This would simplify the observers' job of classifying and communicating effectiveness. In short, a high priority was placed on providing more pictures of effective and ineffective dispersant applications.

Participants recognized that under some circumstances visual observations would be complicated by oceanographic conditions, such as background turbidity (e.g., Gulf of Mexico near the Mississippi Delta) and recommended that guidance must be provided for those circumstances, as well.

2.2.2 Instrumentation for Tier I

Discussion about instrumental methods for Tier I addressed two subjects: a) instruments that could potentially be useful in observing properties and behavior of slicks; and b) instrumental systems that produce information that might be useful in managing dispersant response or the spill response in general. Participants believed that, overall, this subject was of a lesser priority than the above, but recommended that new instruments and their potential applications to SMART be revisited annually or at regular intervals. This was also true for new oceanographic monitoring systems.

[4] An updated version of this NOAA Job Aid was published within days of the workshop and many of the deficiencies identified in the workshop were addressed. Unfortunately the new edition bears nothing to identify it as a new version (publication date, version number, edition number).

[5] MMS-sponsored work at Ohmsett is providing experience with a scale for ranking dispersant performance based on visual observations as well as the photo imagery to support it.

The workshop suggested that new and alternative technologies be investigated to enhance visual observations of slicks. New methods include new applications of IR, UV, and laser. Participants concluded that, while the cost of putting the technology into the field may be an issue for small spills, advances in technology are making available at low cost technologies that have been prohibitively expensive in the past. The National Science Foundation (NSF) was mentioned as potential source of technology development in support of Tier 1 oil spill response.

Participants pointed out that instrumental systems are available that yield information useful in managing dispersant response or the spill response in general. Some effort may be required to identify how these might be used to support the response effort. These include:

1. Integrated Ocean Observation System (IOOS)[6]; and

2. Coastal Ocean Observation Lab (COOL)[7].

2.2.3 Training

Training of observers is important. The SMART (2006) document directs the VM repeatedly to the Job Aid. One group member expected to see good photos in the Job Aid showing the characteristic "café au lait-colored" cloud in the water column under dispersing slicks, as well as those of white clouds of dispersants in the water in cases where dispersants are completely ineffective and simply roll off the oil making a white cloud in the water under the slick. It would be useful to have standard pictures of dispersants working effectively, as well as when they have been ineffective[8]. Participants concluded that:

1. Training standards should be established for VMs. Participants emphasized that their recommendation was for establishment of "training standards", but not "standardized training".
2. Training materials must include standards for describing effective dispersion, including photographs of effective and ineffective dispersant applications in order to reduce the level of subjectivity currently involved in visual assessments.

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[6] The Integrated Ocean Observing System (IOOS) is a system that provides information on states of the oceans and Great Lakes at both global and local scales. It is a multidisciplinary system designed to provide data in forms required by decision makers. (see: http://oceanservice.noaa.gov/topics/coasts/monitoring/ioos/ioos.html)

[7] Coastal Ocean Observation Lab (COOL) at Rutgers University - research focuses on the bio-physical processes of the coastal ocean. Projects involve operational observatories collecting real-time data for adaptive sampling studying coastal waters off New Jersey and around the World.

[8] See footnote 2 above.

3. Observers may be provided with experience in spill and dispersant operations by exposing them not only to domestic spills, but also to international spills and dispersant exercises (e.g., SINTEF research effort).
4. There is a need to develop a core group/pool of trained, experienced observers with job stability: USCG District Response Assist Teams (DRATs) may be key as they have a stable civilian workforce. It's difficult to gain experience for observers. There are few large spills in the US and even fewer in which dispersant is used.

2.3 Tier II

Tier II monitoring involves using both visual methods and in-situ measurements of oil concentrations under treated oil slicks to assess efficacy of dispersion. The intent of the original authors of SMART was that effectiveness could be assessed reliably by visual means under many, if not most circumstances, but the ability to make in-situ measurements would be useful for two purposes (Henry, pers. comm., 2007):

1. To aid in decision making if two visual monitors disagreed on whether an application was effective; and
2. To gather information on the actual concentrations of dispersed oil generated in the upper water column under dispersant treated slicks.

The original version of SMART called for using the Turner 10-AU Fluorometer (T-10AU) in flow-through configuration to measure in-water oil concentrations under treated slicks. Coast Guard Strike Teams still use the T-10AU for this purpose, although the most recent revision of the Protocol allows discretion in selecting the type of instrument used. The procedure involves deploying the instrument system at sea by boat. The monitoring team pumps water continuously to the instrument for analysis from under untreated slicks and dispersant-treated slick samples. Samples are taken at a depth of 1 to 2 m along transects through sections of the slick before and after dispersant spraying. Dispersant applications are judged to be effective if oil concentrations under treated slicks are at least 5 times greater than under untreated slicks (i.e., under the slick prior to treatment). Digital output is recorded continuously with readings being recorded manually at intervals as backup. The monitor summarizes the output and communicates them to the Technical Specialist after each sortie. Grab samples are taken from the water stream at intervals for purposes of post-event calibration of the T-10AU.

Workshop participants appeared to accept the principles of Tier II monitoring, (e.g., comparing oil concentrations under untreated and treated slicks). On the other hand, discussion of the challenges of using the T-10AU and the possible need for change focused largely on: a) the advantages and drawbacks of the T-10AU instrument itself; b) potential merits of other more modern fluorometer instruments; c) merits of recently developed technologies other than fluorimetry for making in-situ oil measurements (e.g. oil-particle-size analysis); and d) details of the method and the need for greater specificity in parts of the written Protocol [9].

2.3.1 Turner 10AU Flow-through Fluorometer

The consensus was that despite its limitations, fluorometry is still an accepted way of measuring in-water concentrations of oil and dispersed oil for purposes of SMART[10]. Fluorescence measurements cannot be related unambiguously to oil concentrations, but they approximate oil concentrations sufficiently well for purposes of the SMART efficacy decisions. Grab samples can be taken of the flow through the instrument and analysed for oil content by gas chromatography (post-event) to create a rough calibration curve of fluorescence signal and actual oil concentration. Participants recognized that other technologies (e.g., in-situ laser particle-size analysis) have become available in recent years. These instruments provide simultaneous estimates of oil concentration and oil droplet size distribution. According to operators, "We like fluorometry (users and technical evaluators of the data are familiar with it) – there is probably a strong preference to continue this, but other technologies should be explored (e.g., particle size determination using the Sequoia LISST – 100X)." Operators agreed that the T-10AU (Figure 1) "has been fine, but it is not ideal for deployment". Indeed "many of the steps in the T-10AU procedure are challenging, but they are do-able". In short, the T-10AU has numerous operating challenges (summarized below) that could be overcome by converting to newer instruments or technologies.

2.3.1.1 Set-Up and Standardization of the Turner 10AU

Operators had several criticisms concerning the operation of the T-10AU that might be overcome if other instruments were used.

[9] In the discussion that follows the Turner is occasionally compared to other newer instruments in order to illustrate the changes that have taken place in instrumentation over the past decade. References to the newer instruments should not be considered to be an endorsement of their use.
[10] Editor's Note: Participants did not have access to the SL Ross 2008 report on verification of monitoring methods during dispersant tests at Ohmsett. That report suggested that there might be problems with the "five-times" guideline.

1. The T-10AU requires a multi-step set-up and calibration procedure each time it is deployed in spills, exercises or training. The set up itself is complex and must be re-learned by operators, using the manual, at each deployment (In some regions teams may train with the instrument each month.) By contrast, set up for some newer instruments, e.g., " BUBA Buster [11] " or "BUBA II", can be as simple as turning the instrument on and setting up the data management software on the system laptop.
2. The current standardization procedure for the T-10AU requires a standard fluoroscein dye solution that operators regard as problematic (there are challenges in preparing a standard solution of fluorescein dye), but they recognized it to be reliable and practicable. A large volume of fluorescein calibration standard is required, prompting operators to request that if use of the T-10AU is to continue, a better standardization/calibration method be developed. This appears to be particularly problematic when standardizing the instrument in the field. Operators mentioned a number of possible alternatives including using small amounts of gasoline or diesel fuel in water or crude oil dissolved in methylene chloride, methanol or hexane. Some of these suggested alternatives for standardization have their own challenges.
3. This set-up and standardization challenge is exacerbated by the need to recalibrate frequently. Operators regard at least some versions of the T-10AU to be unstable. "Operators have found some issues about some spurious calibration quirks (e.g., [The T-10AU] may work fine one day, not the next, but OK on the third day)". Some operators point out the need to recalibrate when the instrument is transported to a spill or drill. Participants noted that newer, solid-state versions of the T-10AU might be less prone to instability.
4. Losses in precision arise due to the lag between the time that the sample enters the sampling tube at depth and the time that it reaches the fluorometer. This is a feature of the T-10AU that could be avoided in instruments where the sensor itself is in-situ. This question was raised in the workshop, but participants agreed that this consideration was not significant in considering new instrumentation.

By comparison newer instruments like the "BUBA Buster", an in-situ fluorometer, may be much simpler to operate than the T-10AU. The "BUBA Buster" was developed to address the complexity problem. Setting it up requires only turning it on and initiating the data management software on the system laptop. Any instrument used in SMART monitoring would require standardization prior to use to confirm for the TS that it is functioning properly. This process might be simpler with newer instruments and require less material than with the T-10AU. Also because newer instruments would have solid-state electronics, they should not suffer from instability.

[11] BUBA Buster is an integrated monitoring system that includes the WETStar fluorometer a Global Positioning System laptop, networking, data management and imaging software.

2.3.1.2 Standardization of Equipment

Participants suggested that regardless of the instrument used, all USCG Strike Teams should have exactly the same version of the instrument, so that they would be completely interchangeable. This would have a number of advantages, including cost advantages, "At present the challenge is that the USCG will only buy 6 of these. If EPA jumps on this number may go as high as 100, but still not enough for business sector to jump aboard". The discussion led towards the Federal government drafting an RFP for the needs of the equipment with possibly separate contracts (equipment & support). "Maybe this is something Commandant (CG-3RPP) can jump into with a one time purchase."

2.3.1.3 Logistics of the Turner 10AU

The very large package of T-10AU equipment poses logistics challenges in transporting and deploying the gear on an emergency basis. The suite of equipment includes the T-10AU itself, pumps, cables and hoses, the downrigger assembly, computer, batteries or a generator, as well as the fluorescein standardization kit (Figure 1). The current NSF equipment suite includes 100 lbs of gear in two large cases (AST[12] and GST) or seven smaller cases for air transportation (PST). Logistics are particularly challenging for the PST because they use commercial aircraft to travel to spill scenes in remote areas like the Aleutian Islands and Oceania. The situation in the AST and GST is less problematic because operators usually drive their gear to the scene. However, after being bounced down rough roads, operating stability and calibration of the T-10AU are concerns.

The T-10AU is large and bulky, but logistics challenges are complicated by the need for pumps hoses, a computer and power sources for all of these. The laptop computer is an indispensable part of any system such as this order to download, store, manage and view data so cannot be avoided. Pumps and hoses are needed in the T-10AU system to move a continuous stream of water from the sea to the instrument, which may be on the deck of a large ship 10 or more feet above the waterline. Some newer devices such as the "BUBA Buster" allow the sensor to be placed in-situ connecting it to the computer by a cable, thus avoiding the need for pumps and hoses. However, without the pumping system there is no way to take grab samples for back-calibrating the fluorometer.

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[12] AST = Atlantic Strike Team, GST = Gulf Strike Team, PST = Pacific Strike Team

Figure 1. Photographs of Atlantic Strike Team SMART Protocol Equipment Suite

Batteries or a generator are needed to power the pump, T-10AU and laptop computer for the full duration of each monitoring sortie. The challenge of providing power may be complicated because the pump may require 12V, while the computer requires 110V. Some teams have simplified the challenge using a generator and inverter, while others use only 110V-powered equipment that can be run off ship power [13].

By contrast a newer instrument like the "BUBA Buster" may be transported in a single small Pelican case.

2.3.1.4 Repairs and Refurbishment

If the T-10AU breaks down, backup or repairs can be very expensive (e.g. $1.8k for rehabilitation, $15k repair) and pose a significant problem in isolated areas. Leasing this equipment may be a better option since Turner Designs Hydrocarbon Instruments, Inc. services the equipment within the continental U.S.

2.3.1.5 Summary

The advantages of the T-10AU are that it uses fluorometry, can sample continuously, allows grab samples of water of known fluorescence to be taken easily and reliably for post-event calibration, plus its operating characteristics are well known. On the other hand, some T-10AU units are chronically unstable requiring frequent re-calibration and set-up; are somewhat complex to set-up and standardize; requires a standardization procedure that operators consider problematic; poses demanding logistics problems in transporting it to spill sites; and can be costly to repair.

2.3.2 Procedure/Method

The following are comments on the operational elements of the protocol.

2.3.2.1 General Comment

Operators must recognize that the distribution of dispersed oil clouds may be patchy because, within the area sprayed with dispersants, both the oil slicks and the breaking waves that mix them may be patchy. If the dispersed oil clouds are patchy, fluorometer readings will be patchy as well. That being the case, it may not be useful to manually record fluorometry output at

[13] Lessons learned by Clean Islands Council (Hawaii): i) Converted over to 120 V pumping system – resolves issue of carrying power inverter; ii) Used non-translucent tubing- switched to dark colored tubing; iii) Honda 2000 generator – increased weight & bulk but they don't have far to go (see letter dtd 9/10/2007 from CIC to USCG R&D Center).

regular intervals, (say every one- or two minutes) as the resulting data may not adequately represent the oil concentrations in the clouds of dispersed oil and thus may lead to the wrong conclusion with respect to dispersant effectiveness. Rather it will be necessary to capture and analyze the digital data stream being output from the T-10AU during continuous sampling. The digital electronic data stream from the instrument must be recorded, registered in time and space and related to information on the spatial distribution of oil patches and dispersant spray in order to be meaningful.

2.3.2.2 The "Five-Times" Guideline

The guideline set by SMART for determining dispersant effectiveness is that the level of oil measured in the water column below an oil slick should increase by at least a factor of five after dispersant is applied. This "five-times" standard for assessing effectiveness appears to be adequate based on experience to date and need not be changed[14]. Participants believed that this standard was T-10AU-specific and should be revisited if other instruments were used in the protocol. Comments received in post-workshop correspondence raised the following points.

1. If measurements are taken at a depth of 3 m rather 1-2 m, is the "five-times" guideline still good? [15]
2. Is the "five-times" guideline fluorisensor specific?[16]

2.3.2.3 Level of Accuracy

Operators asked several times, "What levels of accuracy and precision are needed?" Within the Protocols, the levels of precision required for parameters such as instrument positioning, sampling depth, and instrument detection limit should be stated in specific terms and explained. Some participants did not understand that all that is required is a yes/no assessment with respect to effectiveness.

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[14] See Footnote 10.

[15] **If the measurements are taken at a depth of 3 m rather 1-2 m, is the "five-times" guideline still good?** Editors' Comment: I assume that the 1-2 m depth standard was put in place to ensure that measurements would be taken in the upper mixing zone in the water column, where oil concentrations would be highest in both in effective and ineffective dispersions and where processes determining oil behaviour would be the simplest. Depending on the average wave height, 3 m may be at the bottom of the mixing zone or below the mixing zone where processes determining oil behavior would be more complex. Therefore the "five-times" guideline may not apply.

[16] **Is it fluorisensor specific?** Editors' Comment: It is not clear why participants believed that the "five-times" guideline was Turner-specific. In the absence of information to the contrary, it would appear that the standard should apply to all sensors. The justification that comes to mind for making a standard sensor specific would be if the relationship between fluorescence signal and oil concentration was non-linear in the operating range.

2.3.2.4 Sampling Depth(s)

Participants agreed that sampling at a single depth in the 1-2 m range is adequate, but sampling at two depths would be better. Basing decisions on sampling at only one depth may be adequate for some oils, but may be prone to problems when light, non-viscous oils are involved. Basing decisions on samples taken at two depths, generally at 1-2 m and 3-5 m, is less prone to errors because oil concentrations at 3-5 m (i.e., below the upper mixing depth) become elevated only during effective dispersions. However, despite the obvious advantages of sampling at two depths, the logistics challenges of sampling at two depths with two T-10AUs is prohibitive. In short, “From a practical standpoint, getting two T-10AUs to work could be problematic” and “[The] logistics of using two instruments outside of the Gulf of Mexico could be horrendous.” Obviously, this issue could be simplified somewhat if a simpler, more reliable analytical system were to be used. Participants recommended that: a) this be flagged as an issue, but not one of high priority; and b) the “default approach” should be to sample at one depth and have the TS decide sampling at a second depth is needed.

The discussion surrounding depth of samplers addressed use of a planing device vs. a heavy downrigger weight to maintain the depth of the sampler or hose intake. Participants also questioned proper vessel speed (e.g., DIW or 2 knots, what is better and what are the limitations?). There was also some discussion about using a depth transducer to improve depth accuracy, but operational personnel indicated that this is not required. As a point of information, “BUBA II” – sensors have capability to measure different depths and capture 3D information over a fairly large area (at speeds at up to 7kts).

2.3.2.5 Discrete Sampling and Back Calibration

A detailed protocol is needed for grab sampling or discrete sampling. The description must state the purpose, specific procedure regarding how to take samples if the T-10AU is not used, the numbers and locations of samples to be taken, and what to do with them once taken (i.e., where to send them and what lab tests are to be performed). If the purpose of the sampling protocol is to back-calibrate the sensor, how can this be done if the sensor is in-situ as it is with the “BUBA Buster” or Sequoia LISST? In short, an acceptable sampling protocol must be developed and specified in SMART because operators’ interpretations may not be consistent.

Participants suggested developing a "job aid" describing the relationship between oil concentration and raw fluorescence signal, taking into each oil's account the PAH content.

2.3.2.6 Operational Checklist

Some participants suggested developing an operational checklist. However, operators pointed out that teams have already developed their own. Operators pointed out that if the National Strike Force were to develop a checklist, an important entry would be to remind users that boats may encounter significant pounding and spray en route to the spill site so instruments should be properly secured for transit, then set up and checked on-scene prior to use.

2.3.3 Data Management and Communication

This refers to the types and amount of data gathered, how it is recorded, processed, displayed and communicated. Participants reiterated that information from the observer team is communicated to the TS only, and not to the UC. The UC requires only the interpretation of the field data, not the data itself. The field data need not be communicated to the TS in real-time; a verbal report on trends observed during transects through the area sprayed within an hour of the end of each sortie is sufficient. The digital data is useful for the debriefing, but is not needed in real-time.

The following data issues were raised.

1. Recording data – This is currently done by hand (a round of data taken every 2-5 minutes), which may miss highs and lows in the dispersed oil concentration. A more continuous data flow that is automatically logged is needed, with a manual log being kept as backup.
2. Fluorometry data can be stored in the T-10AU and downloaded later, but it's not geospatially referenced. Spatial referencing is needed.
3. The NSF T-10AUs still run MS DOS. The DOS operating system must be replaced with MS Windows.
4. Ultimately, an MS Windows-based system or something like it is needed with a GPS-integrated navigation overlay for plotting and visualization of transects. (The integrated system needs to be run on a ruggedized laptop.)
5. Interactive digital mapping programs (e.g., OziExplorer, which allows observers to work on their own computer screen with digital maps) relieve SMART observer and technical teams from the data logging workload and provide better situational awareness.

2.3.4 Alternative Sensors and Selection of a New System

Two types of alternate sensors figured in workshop discussions, including newer generation fluorometry-based systems (e.g., WET Labs CDOM in-situ fluorometer, the sensor used in the

"BUBA Buster" and "BUBA II") and systems using particle-analysis technology to measure oil in water (e.g., Sequoia LISST-100X system). The newer fluorometry-based systems (fluorometry systems) have the same analytical capabilities and limitations as the T-10AU, but have numerous advantages for operating (simpler set-up) and logistics (smaller, compact instrument, no pumps needed). In addition, they may be available at a lower unit cost.

The particle-analysis systems (particle systems) provide estimates of oil concentrations in the water column based on measurements of oil particles and as such can provide more information than can fluorometry. In addition to providing oil concentration data, particle analyzers also provide information concerning the sizes of the oil particles present. This removes uncertainty from decision-making because average oil droplet diameters > 100 µm of are indicative of physically dispersed oil, while elevated oil concentrations in the water combined with average diameters < 70 µm is a clear indication of effective chemical dispersion. Existing particle systems like the Sequoia LISST-100X (Figure 2), tested at Ohmsett, have the operating advantage of being simpler to set-up and calibrate/standardize than the T-10AU. This system has a number of deficiencies as well, as mentioned in one of the workshop presentations. However, newer additions to the Sequoia product line have addressed some of these deficiencies, as also discussed in a workshop presentation.

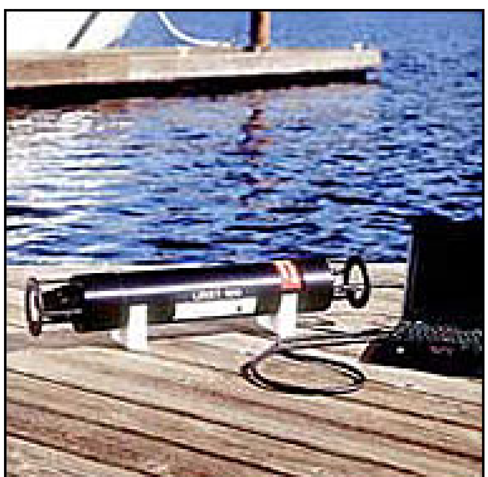

Figure 2. Sequoia LISST-100X

2.3.4.1 Considerations in Choosing a New Analytical Instrument

If a new system is considered to replace the T-10AU, regardless of type, operators recommend that it must include the following.

1. In-situ versus ex-situ – In-situ sensors should be the priority.
2. Analytical characteristics – Must meet the following operating sensitivity characteristics - required detection limits and ranges (0.1 – 1 ppm for lower detection limit; upper would be ~100 ppm). Operators might be willing to sacrifice a little if the equipment were more easily deployable, but minimum performance standards must be set by TS.
3. Operational simplicity – Instrument should be simpler to use than T-10AU, that is, be easier to transport, set up and standardize.
4. Reliability – T-10AU setup may vary from day to day and instrument is sensitive to rough handling. New instrument must be robust.
5. Easier Logistics – New system must have fewer components, be lighter and require less logistics (e.g., do not want to bring two 75-100 lb boxes).
6. Maintenance – Lower maintenance requirements (cost and frequency) – off the shelf components, for example.
7. Features – Must be capable of being integrated with GPS Software and Windows-compatible.
8. Selection process – Multiple unit exercise at-sea needed to compare instruments with – T-10AU as the baseline. At-sea testing should be considered a priority.

2.3.4.2 Transition from Turner 10AU to New System

If there is a change, the transition phase should be structured so that any correlation between the T-10AU-based process and new system are well understood before a point of no return is reached. Although there could be concern about needing to maintain two systems during the transition – the group (USCG in particular) did not think this would be a large problem.

2.3.4.3 Fluorometry vs. particle size or "Do we need fluorometry as well as particle size?"

As discussed above, fluorometry offers an index of oil concentration while particle-size analysis (particle system) produces information on both oil concentration and the size-distribution of oil droplets. One group asked the question, "Should the question be choosing between sampling (the grab samples) vs. particle size?" The short answer is "No". The grab samples are not useful for assessing effectiveness in real-time. Rather they are taken to back-calibrate the fluorometer for purposes of post-event analysis. On the other hand the particle size analyzer would be useful for real-time decision-making, may greatly improve the reliability of decision-making. The particle analyser would also require the taking of grab samples for post event analysis.

2.3.5 Training

Training on this equipment is an issue – only a few NSF members are trained at each Team and they may be deployed elsewhere such as the members of the PST currently deployed to D14. NSF members aren't trained in-depth on the process, so they only know the specific equipment they work with and have very limited capability when conditions change or adaptations are required.

2.4 Tier III

The objective of Tier III is to gathered data to verify that dispersed oil is spreading, diluting and moving as expected by the planning team. It involves gathering data concerning both oil concentrations in the water column and physical oceanographic measurements (e.g., water temperature, density and salinity). Current practices call for sampling at multiple depths at one location and making transects at 2 depths. Participants clarified that Tier III monitoring was envisioned for use for spills in shallow nearshore areas. It is intended to help regulators verify assumptions made about dilution behavior of the dispersed oil in those areas, the basis for the approval for dispersant use. The regulators who give approvals for dispersant use in these areas want verification that oil movement and dilution proceeded as predicted. The results of this monitoring in a spill incident may influence decisions made in future spills or in future sorties in the current spill.

Perhaps the most important point in these discussions was as follows. The USCG Strike Team pointed out that they are equipped to perform Tier III activities such as: a) deployment of fluorometers at the location(s) and depth(s) needed; b) collecting samples as directed by the TS; and c) getting the samples to someone for shipping to labs for testing. However, with respect to other tasks such as taking measurements of salinity, temperature (water column profiles), the USCG is not necessarily in a position to do all that might be asked. Note that not all Strike Teams are equipped with "Hydrolab" equipment. Although the "Hydrolab" is easier to use than the T-10AU, Strike Team personnel do not currently practice with it. Expertise may reside with State teams that may arrive on site after the Strike Teams. Participants emphasized that there may be a need to have further discussion about Tier III expectations and where the responsibilities reside.

Additional points raised are as follows.

1. Who pays? The question of financial responsibility for Tier III is clearly an issue and disagreement was expressed with respect to financial responsibility for Tier III activities. A group member provided one historical example. During an actual spill, an RP chose not to mobilize Tier III in shallow water near a sandy beach apparently because of potential liabilities. In some cases, additional information might be useful from an oil transport perspective and regulators might benefit from having it gathered without being initially concerned with who pays. The group felt that government could take action and then try to recover costs from the RP. Is this counter to definition (see above) of what Tier III really is? The way in which Tier III is defined and required needs to be clarified. Additional information is certainly useful from an oil transport perspective. However, it would be valuable to gather that information without being initially concerned with who pays.

2. For Tier III purposes, fluorescence is acceptable, but availability of new sensors might be considered on a regular basis (e.g., polycyclic aromatic hydrocarbon sensors).

3. Participants recognized that technology continues to advance, becoming more effective and less costly. A desire was expressed to stay tuned in to all relevant new technologies, not only those developed for use in oil spill response, but also those used in other applications. In this connection please note the National Science Foundation Sensor and Sensor Networks program.

3 References

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Appendix 1 – List of Participants

Table A.1 List of Participants

Albert Venosa	U.S. EPA (Cincinnati, OH)	Venosa.albert@epa.gov	513-569-7668
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Appendix 2 – Workshop Agenda

Workshop to Update the SMART Protocol for Monitoring Efficacy of Oil Spill Dispersant Operations

EPA Region II, Edison Laboratories
2890 Woodbridge Ave, Building 205,
Edison, NJ 08837-3679
September 19-20, 2007

WORKSHOP AGENDA

September 19, 2007

0800	Arrival / Welcome	Joseph Mullin / Mark VanHaverbeke
0810	Welcome to EPA Region II	Harry Allen
0815	Workshop Objectives and Program	Mark VanHaverbeke
0830	Overview of SMART	Mark VanHaverbeke
0915	Introduction to User Wants/Needs Analysis	Mark VanHaverbeke
0930	Break	
1015	Breakout Session I	
1200	Lunch (On Own)	
1300	Reports from Breakout Sessions	Mark VanHaverbeke / Ken Trudel
1400	Introduction to New Instruments	Ken Trudel
1430	Introduction to Recent Ohmsett Testing	Ken Trudel
1530	Break	
1545	Summary	Mark VanHaverbeke
1630	Adjourn	

September 20, 2007

0830	Introduction to Day Two	Mark VanHaverbeke
0845	Breakout Session II	
1000	Break	
1100	Reports from Breakout Sessions	Mark VanHaverbeke / Ken Trudel
1145	Round-Table Summary	
1200	Closing Remarks	Joseph Mullin/Mark VanHaverbeke
1210	Adjourn	
