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Standard Guide for Oil Spill Dispersant Application Equipment: Single-point Spray Systems[1]

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1. Scope

1.1 This guide covers performance criteria, requirements, material characteristics, and essential features for oil spill dispersant application systems. This guide is not intended to be restrictive to a specific configuration.

1.2 This guide covers vessel-based spray systems employing single-point spray nozzles, including designs that have been based on or evolved from "fire-monitor" systems, and is not fully applicable to other systems such as spray boom/nozzle or aircraft systems.

1.3 This guide is one of five related to dispersant application systems. The other four guides cover the design of boom and nozzle systems, spray system calibration, spray deposition measurements, and use of the systems. Familiarity with all five guides (listed in 2.1) is recommended.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F1737 Guide for Use of Oil Spill Dispersant Application Equipment During Spill Response: Boom and Nozzle Systems

F1738 Test Method for Determination of Deposition of Aerially Applied Oil Spill Dispersants

3. Equipment Description

3.1 *General*—"Single-point" oil spill dispersant spray systems include spray nozzles, some of which may be similar to those used in firefighting, that generate a spray pattern directed out from a location on the side of the vessel without the need for an outrigger boom or spray arm system to support the spray nozzle. The system includes a pumping or pressure system to deliver dispersants to the nozzle(s) or device used to spray the dispersant out onto the oil slick, and associated piping and control valves. All systems shall include flow meters and pressure gauges to monitor the dispersant discharge. All systems shall be equipped with provision for cleaning and drainage. System components shall be designed to give a uniform droplet spray and volumetric coverage as described in this guide.

NOTE 1—Nozzles used in firefighting applications are generally designed to direct a large quantity of water or firefighting foam, or both, to a small area or fire hot spot. As such, many standard firefighting nozzles are not suitable for effective application of dispersant. Some firefighting nozzles have variable spray pattern adjustment and flow control and these may be suitable for dispersant application. Some foam application nozzles have been designed to generate uniform, volumetric fallout along the length of their spray pattern and these have potential for dispersant application. Nozzles specifically designed for use in single-point dispersant application systems are also available.

3.2 *Modes of Operation*—Typical operational modes could include two nozzles, one mounted on the port deck rail and the other on the starboard deck rail, both located towards the bow of the vessel. The nozzles are supplied dispersant from either a common or separate pumps and are plumbed to permit independent operation and flow control. The nozzles spray dispersant out from the side of the vessel perpendicular to the direction of the vessel's movement and treat oil on each side of the vessel in the zone free of the influence of the vessel's bow wave as it moves through the slick. This type of operation is only effective in light winds.

3.2.1 In moderate to high wind conditions the vessel would travel in a cross-wind direction, and dispersant would be sprayed downwind, only from the nozzle mounted on the downwind side of the vessel. If nozzles were mounted on both sides of the vessels only the downwind of the two nozzles

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

would be used at any given time. Use of the two nozzles would alternate when the vessel reverses direction after completing a spray pass. Smaller single-point spray systems can utilize portable, "manned" nozzles to permit the operator to direct the spray from the side of the vessel onto oil slicks either while the vessel is moving or stationary. This allows the operator to target heavier patches of oil with dispersant as required.

3.3 *Neat versus Dilute Application*—Single-point spray systems may be used to apply dispersant neat or diluted, depending on the manufacturer's usage guidelines and on the slick conditions. Operators should be aware that some dispersant products are less effective when applied diluted with seawater. Manufacturer's recommended usage guidelines and independent research on dispersant effectiveness testing shall be consulted when considering dilute application.

3.4 *Operational Advantages:*

3.4.1 In operational terms, single-point spray systems may offer the following advantages over vessel-based application systems:

3.4.1.1 No specialized spray booms, spray boom attachments, or supports are required, which makes the system easy to install on vessels-of-opportunity.

3.4.1.2 Less possibility of damage to the spray equipment in rough sea conditions.

3.4.1.3 The spray swath can be considerably wider than conventional spray boom/multi-nozzle systems.

3.4.2 Single-point spray systems may offer the following advantages over conventional boom and nozzle application systems:

3.4.2.1 The single nozzles are easier to maintain than the multiple small orifices used in spray boom systems.

3.4.2.2 Higher application rates are possible which may allow one-pass spraying in thick oil conditions.

3.4.2.3 The single-point spray nozzle can be used in a "manned" operation and dispersant spray can be directed to thick oil patches in the vicinity of the vessel without the need to precisely position the spray vessel.

3.5 *Operational Disadvantages*—The single-point spray systems may have the following disadvantages as compared with conventional boom/multiple nozzle vessel and aircraft application systems.

3.5.1 The spray pattern from single-nozzle systems may be more susceptible to wind influences than conventional boom/multiple nozzle systems.

3.5.2 May be less able to apply a uniform dose rate of dispersant.

3.5.3 Application of low doses of dispersant for treatment of thin oil slicks is difficult unless the dispersant is diluted with seawater.

3.5.4 The vessel platform has slow transit and application speeds when compared with aircraft application systems (a problem common to all vessel-based application methods).

4. Minimum Equipment Performance Specifications

4.1 *Target Dosage*—Oil spill dispersant spray equipment shall provide a dispersant dosage of between 20 to 1000 L per hectare [2 to 100 U.S. gal per acre]. It is not a requirement that a single system cover the entire range. Section 7.2 of this standard lists the requirements for dosage and application data to be provided by the manufacturer.

4.2 *Dispersant Flow or Injection Rate Determination*—The dispersant flow from each single-point nozzle shall be monitored using appropriate pressure and flow meters. The dispersant flow rate (for diluted application, the dispersant flow rate is equal to the dispersant injection rate) must be sufficient to produce the required dosage on the thickness of oil being encountered

4.2.1 Dispersant flow rate (DFR) shall be verified using the following equations:

$$DFR = S \times W \times D \times 1.67 \times 10^{-3} \quad (1)$$

where:

DFR = dispersant flow rate, L/min,
S = speed of the delivery vehicle, km/h,
W = swath width, m, and
D = dosage, L/ha.

Or equivalently in U.S. units:

$$DFR = S \times W \times D \times 2.33 \times 10^{-3} \quad (2)$$

where:

DFR = dispersant flow rate, U.S. gal/min (USGPM),
S = speed of the delivery vehicle, knots,
W = swath width, ft, and
D = dosage, U.S. gal per acre (USGPA).

4.3 *Droplet Size Distribution*—The droplet size distribution of the dispersant reaching the target shall have a Volume Median Diameter (VMD) of between 300 to 800 μm. The volume median diameter is a means of expressing droplet size in terms of the volume of liquid sprayed. The median volume diameter droplet size, when measured in terms of volume, is a value where 50 % of the total volume of liquid sprayed is made up of droplets with diameters larger than the median value and 50 % smaller than the median value. Droplets having diameters lesser than approximately 300 μm have a lower probability of hitting the target because of excessive wind drift. Particles with diameters greater than 800 μm have a higher probability of penetrating through thin and non-viscous oil slicks to the water surface where their effectiveness is lost.

4.3.1 *Discussion*—There is a trade-off in effectiveness versus drop size. Larger drop sizes may be desirable from an application point-of-view as they have more momentum and can be more easily broadcast, with control, over a wide area. From an effectiveness point-of-view, larger drops may be less desirable as they can lead to herding of the slick, ineffective dispersant application, and wasted dispersant. Larger drops may also be inefficient on thin slicks, but this is not likely to be a problem for drops smaller (in diameter) than the slick thickness. There are no universally agreed limits for dispersant drop size; the range stated here is based on the current state of knowledge and should be revised when experience or experimentation permits.

4.3.2 Test Method F1738 provides guidelines for the measurement of dispersant drop sizes from aerially applied oil spill dispersants and these guidelines can be used to measure drop sizes from single-point, vessel-based spray systems. However,

it is adequate to visually assess the characteristics of the dispersant spray droplets as outlined in Guide F1737.

4.3.3 Guide F1737 states that acceptable dispersant droplets shall be "visually larger than a fog or mist and smaller than heavy rain" and this description accurately describes a suitable spray in the case of the single-point spray systems. Fogs and mists are made up of drops 100 µm and less in diameter. Heavy rain is made up of drops greater than about 1000 µm (1 mm).

4.4 *Maximum Delivery Variation Over Spray Swath*—The equipment shall be capable of delivering dispersant to the water surface with a maximum delivery variance of 25 % over the length of the spray pattern. The swath width is defined as the length between the points at which the delivery drops below 90 % of the design fallout. Deposition characteristics of single-point nozzle systems can be determined using the methods outlined in Test Method F1738. If this method is used the spray system would be moved parallel along the up-wind side of the spray collection zone, with the spray nozzle oriented perpendicular to the direction of travel and pointed down-wind, so the spray falls out over the collection area similar to the spray from an aerial application. Tests shall be completed in calm or light down-wind conditions.

NOTE 2—It may be more practical and economical to determine the dispersant delivery variation along the swath width in a stationary test. Presently, the applicable test method (F1738) does not specifically allow for this, but it may be possible to modify the procedure in Test Method F1738 to produce an acceptable test. If this is contemplated, several test issues must be resolved, including: start and end conditions, establishment of steady-state conditions, and measurement of swath width.

5. Safety

5.1 *General*—Safety issues concerning the storage and handling of oil spill dispersants, Material Safety Data Sheets (MSDS) information, and personnel safety on vessels while using dispersants and dispersant application equipment are discussed in Guide F1737.

6. Material Characteristics

6.1 *Corrosion Resistance*—Materials used in the spray system shall be corrosion-resistant to salt water. All materials that come into contact with dispersants shall be compatible with that dispersant. Special attention shall be given to pump components. Consultation with the dispersant manufacturer is recommended.

6.2 *Extreme Temperature Properties*—Systems to be used or stored at extreme temperatures shall be constructed of materials that are not adversely affected by those temperatures. Temperature range specifications shall be clearly indicated on the spray equipment.

7. Information to be Provided to User

7.1 Performance data shall be provided to the user by the manufacturer, and shall include:

7.1.1 Estimated or measured droplet size information (VMD in µm),

7.1.2 Volumetric output distribution over the swath width (%),

7.1.3 A table of pump rates and dispersant injection rates ranging from the recommended minimum to the recommended maximum,

7.1.4 Nozzle design height,

7.1.5 The nozzle discharge angle from horizontal for optimum spray swath at selected pump rate,

7.1.6 Swath width,

7.1.7 Recommended operating pressures at the inlet to the nozzle, and

7.1.8 Dose variation versus ship roll.

7.2 *Dilute versus Neat Application*—The manufacturer shall specify whether the system is intended for neat or dilute application, or both, and shall specify the operating parameters for neat and dilute application if both are applicable to the system.

7.3 *Dosage Chart*—The manufacturer shall supply the user with a chart of dosages achievable with different vessel speeds and different dispersant flow or injection rates (if dilute application is considered), and dosages in a 90-degree (horizontal) arc if operating in a stationary position.

7.4 *Accuracy of Data*—The data referenced in 7.1 and 7.3 shall be accurate to two significant digits.

7.5 *Materials of Construction*—The supplier shall provide the user with a list of materials of construction.

7.6 *Nozzles and Pumps:*

7.6.1 The supplier shall provide full data on the manufacturer, model numbers, and dimensions of nozzles supplied with the spray equipment.

7.6.2 The supplier shall provide full data on the manufacturer, model number, and basic maintenance and operational data on all major components of the spray equipment including pumps, eductors, flow meters, and engines.

7.7 *Operator's Manual*—The supplier shall provide a comprehensive operator's manual including diagrams of the equipment layout.

8. Keywords

8.1 dispersant application; dispersants; dispersant spray equipment; fire monitor; oil spill chemicals; oil spill dispersants; oil spill treating agents; single-point spray nozzles