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Standard Guide for Use of Oil Spill Dispersant Application Equipment During Spill Response: Boom and Nozzle Systems[1]

This standard is issued under the fixed designation F1737/F1737M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers considerations for the maintenance, storage, and use of oil spill dispersant application systems.

1.2 This guide is applicable to spray systems employing booms and nozzles and not to other systems such as fire monitors or single-point spray systems.

1.3 This guide is applicable to systems employed on ships or boats and helicopters or airplanes.

1.4 This guide is applicable to temperate weather conditions and may not be applicable to freezing conditions.

1.5 This guide is one of five related to dispersant application systems. Guide F1413/F1413M covers design, Practice F1460/F1460M covers calibration, Test Method F1738 covers deposition, Guide F1737 covers the use of the systems, and Guide F2465/F2465M covers the design and specification for single-point spray systems. Familiarity with all five standards is recommended.

1.6 *Units*—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 nonconformance with the standard.

1.7 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F1413/F1413M Guide for Oil Spill Dispersant Application Equipment: Boom and Nozzle Systems

F1460/F1460M Practice for Calibrating Oil Spill Dispersant Application Equipment Boom and Nozzle Systems

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

F2465/F2465M Guide for Oil Spill Dispersant Application Equipment: Single-point Spray Systems

F2532 Guide for Determining Net Environmental Benefit of Dispersant Use

3. Significance and Use

3.1 This guide provides information, procedures, and requirements for management and operation of dispersant spray application equipment (boom and nozzle systems) in oil spill response.

3.2 This guide provides information on requirements for storage and maintenance of dispersant spray equipment and associated materials.

3.3 This guide will aid operators in ensuring that a dispersant spray operation is carried out in an effective manner.

4. Background to the Use of Dispersants and Spray Systems

4.1 *Primary Considerations:*

4.1.1 Use of dispersants, particularly in a specific area, may be subject to regulatory approval. Net Environmental Benefit Analysis is used for dispersant decision-making (Guide F2532). Dispersant response is for use in the early stages of a spill; so, it is strongly recommended that a pre-approval mechanism, or rapid approval, be part of response planning.

4.1.2 *Nature of Oil Slick(s) to Be Treated:*

4.1.2.1 The effectiveness of dispersants is dependent (assuming proper application) on two factors; the oil composition and the sea surface energy. The primary factor is the oil

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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.

composition. Heavier oils, those that contain large amounts of components such as asphaltenes, disperse poorly, and those which have only a small amount of these disperse more easily. As oil weathers on the sea surface, its composition changes and it generally becomes less dispersable. Some oils can also form highly viscous water-in-oil emulsions, known as "chocolate mousse," particularly in areas of high energy waves. Once mousse has formed, dispersants may not be effective.

4.1.2.2 Viscosity is an indicator of the oil composition, but affects dispersion by its influence on the amount of dispersant penetrating into and mixing with the oil. Dispersant can run off the surface of highly viscous oils or will mix only slowly with them. Traditionally, oils of a viscosity between 2000 and 10 000 mPa were thought to be un-dispersable. However, viscosity may not be as much a limitation as is composition as noted above, especially for dispersants which are not quickly lost to the water column. Viscosity may have its largest effect on the time required for mixing with the oil.

4.1.2.3 Natural weathering affects the composition and viscosity of the oil. Much of the oil evaporated will usually consist of the most dispersable fraction. Also, loss of the lighter fractions by evaporation increases the viscosity. This combined effect may rapidly reduce the dispersability of some spilled oils. Some oils may not be effectively dispersed after only 24 h on the surface.

4.1.2.4 Sea surface energy can be an important factor in dispersant effectiveness. Higher sea energy is needed to disperse oil of less favorable composition. Very low sea energies often result in poor dispersant performance. Very high seas can be detrimental since they can promote water-in-oil emulsion formation and can cause oil slicks to become discontinuous or submerged. Attempting to spray such slicks is likely to be ineffective resulting in significant dispersant loss.

4.1.3 *Environmental Conditions, Including Wind, Sea State, Visibility, and Temperature of Air and Water*—It is essential to minimize dispersant loss in aerial application due to wind drift and air turbulence. Large droplets assist in this, but, in addition, the aircraft should be flown as low as safety considerations allow. It is also best to fly into the wind while spraying, so as to limit wind drift.

5. Equipment Types For Vessels and Aircraft

5.1 A boom and nozzle spraying system consists of one or more pumps, flowmeters, storage tanks, spray booms, and nozzles that are mounted in various configurations depending on the platform.

5.2 Single-point spray systems are not covered by this standard. See Guide F2465/F2465M.

5.3 Dispersant application systems on ships or boats may be portable or permanently installed. Vessels may have built-in dispersant storage tanks and on-board pumps for use with the spraying system.

5.4 Dispersant application systems on helicopters are most commonly slung beneath the aircraft, with remote controls available to the pilot. Some specially configured helicopters have integral tanks and pumps. Helicopter spraying systems are available with dispersant capacity of about 400 to 3000 L [100 to 800 U.S. gal].

5.5 Dispersant application systems on single-engine airplanes have a built-in tank and pump, with the booms attached to the wings. Dispersant capacity varies with the airplane design but is about 400 to 4000 L [100 to 1000 U.S. gal].

5.6 Dispersant application systems can also be installed on large multi-engine airplanes. These must be designed for each type of aircraft, and will include one or more pumps, flowmeters, dispersant storage tanks, and spray booms with nozzles. The airplane type and payload capability will determine the available dispersant capacity from about 2000 to 20 000 L [500 to 5000 U.S. gal].

6. Equipment Configuration for Vessels and Aircraft

6.1 *Vessels*—Dispersant spray systems for boats have been designed for many types of craft. Most systems use water-compatible dispersants diluted with seawater during application. These dispersants are mixed with seawater by use of an eductor or metering pump to allow for the dispersant to be used at the desired concentration (generally 10 %). Some systems spray dispersants neat (without dilution with water) and thus eliminate the need for seawater.

6.1.1 Mounting the spray booms as far forward as possible is optimal, so that the spray is applied in front of the bow wave, because this wave can push oil out of reach of the spray at typical boat speeds. Nozzles and extensions should be downward-pointing and stable relative to the boom. Spray booms with multiple nozzles should be arranged to produce flat, fan-shaped spray patterns, striking the water (oil) surface in a line perpendicular to the direction of travel of the vessel. Nozzles producing a hollow-cone shaped spray pattern should not be used. Spray pressure should not be excessive so that the droplets do not break the oil surface. The dispersant-water mixture should be delivered to the oil surface in the desired pattern, with a minimum amount of energy. The spray should strike the oil in small droplets of 300 to 500-µm volume median diameter (VMD). The droplets should be visually larger than a fog or mist and smaller than heavy rain drops. The fan-shaped sprays from adjacent nozzles should overlap just above the oil surface. The height of the nozzles should ideally not exceed 1 metre from the water surface.

6.1.2 Relatively small spills may be treated by vessels, but vessels are limited on large offshore spills by their spray swath and speed. For example, a boat operating at 10 km/h [5 knots or 6 mph], and spraying a 12-m [40-ft] swath, can only treat about 1.3 km^2 [0.5 $miles^2$] of an oil spill surface in about 12 h.

6.2 *Helicopters*—Spraying systems on helicopters are either integral (attached to the airframe) or external units that have a combined tank, pump, and spray boom assembly suspended below the aircraft from a cargo hook, as specified by the manufacturer of the bucket. Sufficient room must be allowed between the helicopter and the spray unit to allow for safe connection and release. Spraying is controlled from the cockpit with an electrical remote-control unit, attached by cable to the spray system. Nozzles should be oriented parallel to the direction of travel and pointed aft on the spray boom. Only dispersants applied without dilution are suitable for aerial spraying. The spray-boom altitude, when spraying, should typically be 10 m [30 ft].

6.2.1 Helicopters are limited in the volume of dispersant they can carry, typically under 2000 L [500 U.S. gal]. They have greater speed than vessels, however, and if working near the source of dispersant supply, helicopters provide very efficient dispersant application on small areas. Helicopters are best close to shore and should not work further than 20 km [15 miles] from shore, unless there are available offshore platforms on which to land, refuel, and load dispersants. Certain specialty helicopters may have a greater range.

6.3 *Small Airplanes*—Small single-engine airplanes will have a pump that draws dispersant from a tank to feed the spray booms, that are usually fitted close to the trailing edge of the wing. The dispersant is discharged through nozzles (spaced at intervals along the boom) that are designed to generate droplets within the required size range. The dispersant pump should be capable of spraying at a rate that is required for a surface coverage of 20 to 100 L/hectare [2 to 10 U.S. gal/acre]. The pump rate should be variable in flight, and regulated and monitored with a pre-calibrated flowmeter or pressure gage. Air shear, which affects droplet size, may be a problem for lower viscosity dispersants of less than 60 mPas [cP], at aircraft velocities exceeding about 200 km/h [100 knots or 120 mph]. The spray-boom altitude during application should not be over 10 to 30 m [30 to 100 ft].

6.3.1 Small airplanes generally have limited load capacity, about 400 to 3000 L [100 to 800 U.S. gal]. This size of aircraft may provide rapid response to small spills, and has longer range and greater speeds than a helicopter system.

6.4 *Large Airplanes*—Large multi-engine airplanes offer increased payload, range, and speed for the treatment of large spills. Some large cargo airplanes have a rear cargo or personnel door that can be opened in flight, can accommodate portable tank systems, and have extendable booms that can be deployed in flight. Such a system can be permanently fitted to a dedicated airplane, or installed as needed in an airplane of opportunity. These systems may require specific certification by aviation authorities for use on a particular type of aircraft.

6.4.1 These larger aircraft will generally fly at altitudes of 15 to 30 m [50 to 100 ft] when applying dispersant to the oil.

6.4.2 The largest dispersant liquid capacity for such aircraft is 20 000 L [5000 U.S. gal]. Aircraft range and payload characteristics can limit the dispersant volume. Application rates from 10 to 100 L/hectare [1 to 10 U.S. gal/acre] can be achieved. Typical coverage for these systems is 20 hectares/min [50 acres/min] at 130 to 150 knots.

7. Control of Spraying Operations

7.1 Whichever method is employed to apply dispersants, an objective assessment is required to ensure that a vessel or aircraft spraying operation is conducted properly and effectively. Direction of the operation and observation of its effectiveness can best be conducted from another controller (spotter) aircraft overhead. This can be a light airplane or helicopter, but it must have a high endurance and good communications with the spray aircraft or vessel. An airborne observer cannot function adequately in the spraying aircraft, unless the aircraft is equipped with GPS flight assist and recording instrumentation. To ensure safety in such a case, all the aircraft must have planned for, and maintained, continuous communications.

7.2 Personnel in the controller (spotter) aircraft can identify the heavier concentrations of oil (or those slicks posing the greatest threat), direct spray aircraft or boats to the target, request spraying to be started and stopped, and assess the accuracy of the application. This guidance is important for spraying operations since observation from a vessel or a spray plane is limited. Air support is essential when large multi-engine aircraft are used for spraying. Even when using helicopters and small airplanes for spraying, it is not reasonable to rely on pilot observation, since all of the sprayed area is behind the aircraft. It is recommended that a separate spotter aircraft be utilized. Consequently, the area of coverage and the effect of the dispersant is better seen by a qualified observer in a control plane at a higher altitude, who also can better direct the spray plane on the next pass, in the same or a different treatment area.

7.3 With the advent and use of GPS flight assist and recording instrumentation, it is possible for aircraft to map, spray, observe, and document the oil slick, the dispersant application, and the visual dispersant effectiveness.

8. Storage, Handling, and Maintenance of Dispersant and Dispersant Application Systems

8.1 Dispersants are to be handled and stored in accordance with information provided by the manufacturer's (Material) Safety Data Sheets (MSDS or SDS), labels, and user-specified policies. (See Section 10.)

8.2 Dispersant application systems will normally be loaded by means of pumps, with dispersants from drums, storage tanks, or tank trailers. Pumps of adequate capacity must be available to load dispersant rapidly in order to reduce aircraft downtime between sorties.

8.3 Conduct routine maintenance on dispersant application systems and subcomponents in accordance with the manufacturer's recommendations, to ensure system readiness and availability for immediate use.

8.3.1 Nozzles on dispersant application systems must be inspected after each day's operation and cleaned before storage of the system. Pumps and systems using seawater (as from vessels) must be flushed well with fresh water.

8.3.2 The system calibration should be checked at least once a year (see Practice F1460/F1460M). Spray systems should be cleaned, and the calibration checked, after each exercise or spill incident in which the equipment was used, and after making any changes in the system configuration. Also, systems must be completely drained and freeze-protected, as necessary, after each use.

8.3.3 Any remote control devices used in operation of a dispersant system should be checked immediately prior to any use of the system.

8.3.4 Operating crews should be given comprehensive training in dispersant application systems installation and methods of use. Practical exercises with dispersant surrogates should be held on an annual basis. Fixed-wing aircraft systems should be exercised annually.