Designation: F2532 – 13

Standard Guide for Determining Net Environmental Benefit of Dispersant Use[1]

This standard is issued under the fixed designation F2532; 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 in assessing net environmental benefit of dispersant use on oil spills. The purpose of this guide is to minimize environmental and socioeconomic impacts of oil spills.

1.2 Net environmental benefit analysis (NEBA) of all response options should be conducted as part of oil spill contingency planning.

1.3 There are many methods to control or cleanup oil spills. All spill response options should be given equal consideration.

1.4 Only general guidance is provided here. It is assumed that the crude or fuel oil is dispersible. The dispersant is assumed to be relatively effective, applied correctly, and in compliance with relevant government regulations. Differences between commercial dispersants or between different oils are not considered in this guide.

1.5 This guide applies to marine and estuarine environments only.

1.6 When making dispersant use decisions, appropriate government authorities should be consulted as required by law.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F1788 Guide for In-Situ Burning of Oil Spills on Water: Environmental and Operational Considerations

F2205 Guide for Ecological Considerations for the Use of Chemical Dispersants in Oil Spill Response: Tropical Environments

3. Significance and Use

3.1 Net Environmental Benefit Analysis (NEBA) when applied to oil spill response, is the process of considering advantages and disadvantages of different spill response options (including a no response baseline) and comparing them to identify a spill response decision resulting in the lowest overall environmental and socioeconomic impacts from an oil spill and the response to that spill.

3.2 Spill response will likely involve some combination of response options. There are no response methods that are completely effective or risk-free. NEBA should be conducted with appropriate regulatory agencies and other organizations as part of spill response contingency planning. NEBA is important for pre-spill planning since some response options have a limited window of opportunity.

4. Net Environmental Benefit Analysis for Oil Spill Response

4.1 The objective of NEBA is to choose the oil spill response option that will result in the lowest overall negative impact on the environment. The NEBA should focus on local and regional areas of concern and should result in decisions based on what is best for a specific location. With NEBA comes the recognition that, regardless of the response option chosen, some impact will occur. Table 1 and Table 2 and Appendix X1 and Appendix X4 provide considerations for use in the NEBA process. Appendix X2 and Appendix X3 present an ecological risk assessment method for determining the net environmental benefit of dispersant use.

4.2 The NEBA process involves several tasks (**1, 2**).[3]

4.2.1 Gather information on habitats and species of concern, physical and chemical characteristics of the spilled oil, shoreline geomorphology, potential socioeconomic impacts, and spill response options. Resource trustees, area contingency plans, and environmental sensitivity maps are good sources of information.

4.2.2 Consider the relative importance of natural resources and their vulnerability and sensitivity to oiling in the region and time period of interest.

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[1] This guide is under the jurisdiction of ASTM Committee F20 on Hazardous Substances and Oil Spill Response and is the direct responsibility of Subcommittee F20.13 on Treatment.

Current edition approved Dec. 1, 2013. Published January 2014. Originally approved in 2006. Last previous edition approved in 2006 as F2532–06. DOI: 10.1520/F2532-13.

[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.

[3] The boldface numbers in parentheses refer to the list of references at the end of this standard.

TABLE 1 Pros and Cons of Spill Response Options

Response Method	Advantages	Disadvantages
No response (monitor only)	appropriate for spills that do not threaten shorelines used when other response options may cause more damage than natural removal used when environmental conditions do not allow use of other response methods	can be politically unacceptable potential wildlife exposure wind direction could shift resulting in oil stranding onshore
Mechanical on-water recovery	removes oil from environment allows recycling and proper disposal of recovered oil	wind, waves, and currents can limit containment and recovery debris and viscous oil problematic limited recovery of spilled oil due to encounter rates in large spills storage and disposal of recovered oil may be limited equipment and labor intensive
Dispersants	prevents or reduces oiling of wildlife prevents or reduces oil stranding onshore reduced or no storage and disposal of oil reduces or prevents formation of mousse rapid treatment of large areas See Guide F2205.	Oil is left in the environment time frame for effective use may be limited due to slick thickness, weathering, emulsification less effective on high viscosity oils or in highly emulsified oil oil concentrations in water column typically greater when dispersant used than when oil is naturally dispersed resulting in increased impacts on organisms in upper 10 m of water column exclusion zones may be created based on water depth, distance from shore, limited water circulation, presence of marine sanctuary or water intakes, etc. can be politically unacceptable Treated oil may resurface Treated oil is hard to recover with skimmers
In-situ Burning	reduced or no storage and disposal of oil may prevent or reduce oil stranding onshore prevents or reduces oiling of wildlife See Guide F1788	time frame for effective use may be limited due to slick thickness and emulsification wind, waves, and currents may make ignition difficult weathered oil difficult to ignite 2 to 3 mm minimum slick thickness for ignition air pollution issues (smoke) can have burn residues that sink can be politically unacceptable

TABLE 2 Risk Considerations for Dispersant Use

Oil Location	Risk Drivers	Priorities
Water surface	oil type persistence size of oil slick advection time/distance before oil comes ashore	birds, marine mammals, sea turtles, endangered/protected species
Water column	oil type oil concentrations advection depth dilution potential rate of water exchange exposure duration food web contamination proximity to water intakes season life stages of species of concern biological recovery time	commercial or subsistence fisheries coral reefs seagrass beds endangered/protected species tourist/recreational areas
Shoreline	oil type persistence season extent of oiled shoreline oil thickness natural cleansing (wave and tidal action) shoreline accessibility biological recovery time	intertidal communities marshes mangroves bird concentration areas endangered/protected species tourist/recreational areas subsistence harvesting mariculture fish spawning areas archeological/historical sites

4.2.3 Review oil spill case histories and experimental data relevant to the spill location and response options being assessed.

4.2.4 Compare advantages and disadvantages of response options including no response (see Table 1). Computer models. can be used to evaluate tradeoffs of dispersant use. The models can estimate the volume of water adversely affected by physically or chemically dispersed oil and the surface area impacted by floating oil. Adverse effects are based on toxicity to aquatic organisms and density of wildlife species present in the spill area. Different model scenarios can be run in order to evaluate tradeoffs of dispersant use or non-use.

4.2.5 Predict potential environmental impacts for chosen response option.

4.2.6 Weigh advantages and disadvantages of response options in relation to ecological value and human use of impacted area.

4.2.7 Choose the optimum response method.

4.3 Conflicts during the NEBA process are inevitable (**1, 2**). Conflicts may arise regarding protection of one species or ecological habitat over another. Conflicts may occur between environmental and socioeconomic interests. It is desirable that agreements are reached before a spill occurs. Some examples of potential conflicts are presented here.

4.3.1 Dispersing oil can decrease the potential for birds becoming oiled from surface slicks. Dispersant use can increase the exposure of aquatic organisms to oil in the water column.

4.3.2 Dispersing oil can decrease the potential for adverse effects to marshes threatened by stranding oil. Dispersants can increase the potential for adverse effects to seagrass beds exposed to chemically dispersed oil.

4.3.3 Dispersing oil can decrease the potential for adverse effects to mangroves threatened by stranding oil. Oil chemically dispersed in the water column can cause adverse effects to coral reef organisms.

5. Keywords

5.1 benefit analysis; dispersant; ecological risk assessment; NEBA

APPENDIXES

(Nonmandatory Information)

X1. FACTORS TO CONSIDER WITH DISPERSANT USE

Accessibility to the oil spill
Amount of oil spilled
Aquatic toxicity of chemically dispersed oil
Areas of socioeconomic importance
Commercial fisheries or subsistence fishing in spill area
Critical ecological habitats (feeding, migratory, nesting, spawning etc.) in spill area
Designated exclusion zones for certain response methods
Effectiveness of other response methods
Equipment and trained personnel readily available
Expected environmental recovery time for each response option
Expected time of oil stranding onshore or entering an environmentally sensitive area
How quickly can equipment be deployed?
Meteorological conditions (wind speed and direction, inclement weather)
Oceanographic conditions (salinity, wave height, current velocity/direction, tides, water depth)
Oil type, viscosity, weathered state
Presence of sensitive archaeological or historical sites
Regulatory approvals in place
Safety issues
Shoreline type and vulnerability
Shoreline accessibility
Slick thickness
Threatened/endangered species
Vulnerability of valued habitat or species to oiling
Window of opportunity for each response method

NOTE X1.1—The above factors are not weighted equally and will vary depending on regional priorities.

X2. ECOLOGICAL RISK ASSESSMENT METHOD FOR DISPERSANT USE PLANNING (3, 4, 2, 5, 6, 7)

X2.1 Phase 1 Problem Formulation (Refer to Appendix X1)

X2.1.1 Identify stakeholders.

X2.1.2 Identify ecological resources of concern.

X2.1.3 Create spill scenarios

X2.1.4 Identify endpoints for ecosystem protection and recovery.

X2.1.5 Identify response options and scenarios to be evaluated.

X2.1.6 Identify potential effects of response options alone, response options in combination with oil, and oil alone.

X2.1.7 Develop conceptual model of the ecosystem affected.

X2.2 Phase 2 Analysis (Refer to X3.1)

X2.2.1 Characterize ecological effects (toxicity, physical effects) and environmental data for various response options alone, response options in combination with oil, and oil alone.

X2.2.2 Estimate exposures for various response options alone, response options in combination with oil, and oil alone.

X2.3 Phase 3 Risk Characterization (Refer to X3.2)

X2.3.1 Estimate potential ecological effects of response options alone, response options in combination with oil, and oil alone.

X2.3.2 Optimize response based on endpoints for ecosystem protection.

X2.3.3 Integrate ecological risk results into contingency plans.

X2.3.4 Periodic revision and review.

X2.3.5 Data collection on endpoints during response.

X3. ECOLOGICAL RISK MATRIX AND CHARACTERIZATION

X3.1 Ecological Risk Matrix (Modified from Ref (5))

X3.1.1 The risk matrix below can be used for the Phase 2 analysis of the ecological risk assessment. In Phase 2 analysis, ecological effects are characterized. Letters A through E describe impact and numbers 1 through 4 describe recovery of the resource. This is an example only. What is considered high, moderate, low, slow, or rapid will vary with location and are not fixed values. Consult with stakeholders.

Impact = % of total resources affected	1 = Slow Recovery (>7 years)	2 = Moderate/Slow Recovery (≥3 to 7 years)	3 = Moderate/Rapid Recovery (≥1 to 2 years)	4 = Rapid Recovery <1 year
A = High Impact (>60%)	A1	A2	A3	A4
B = Moderate/ High Impact (≥40 to 60%)	B1	B2	B3	B4
C = Moderate Impact (≥20 to 39%)	C1	C2	C3	C4
D = Moderate/ Low Impact (5 to 19 %)	D1	D2	D3	D4
E = Low Impact (<5 %)	E1	E2	E3	E4

X3.2 Ecological Risk Characterization (Example Only)

X3.2.1 Below is an example of a possible matrix that could be used for Phase 3 (risk characterization) of the ecological risk assessment method. The potential ecological effects of the response options are characterized. The example is for an oil spill occurring in a salt marsh.

X3.2.2 Risk values in this example matrix are hypothetical. Potential effects will depend on water depth and circulation, oil type and volume, weather, season, and other factors.

Resource	Mud Flats	Oyster Beds	Water Column Plankton	Marsh Plants	Waterfowl (Non-endangered)	Recreational Fisheries
Response:						
No Response	C4	D4	D3	B2	A3	A3
Mechanical Recovery	C3	C3	B4	B2	B3	B4
Dispersant	E4	D3	A3	E4	E4	C4
In-situ Burning	E4	E4	E4	A3	E4	E4

A3: High impact and moderate to rapid recovery
B2: Moderate to high impact and moderate to slow recovery
B3: Moderate to high impact and moderate to rapid recovery
B4: Moderate to high impact and rapid recovery
C3: Moderate impact and moderate to rapid recovery
C4: Moderate impact and rapid recovery
D3: Moderate to low impact and moderate to rapid recovery
D4: Moderate to low impact and rapid recovery
E4: Low impact and rapid recovery

X4. CONSIDERATIONS FOR AN ECOLOGICAL RISK ASSESSMENT

NOTE X4.1—The example below is not an ecological risk assessment but provides considerations.

X4.1 Phase 1 Problem Formulation: Marsh Threatened by Oil Spill

X4.1.1 *Potential Stakeholders*—Government agencies, landowners, community, fishermen.

X4.1.2 *Ecological Resources of Concern*—Marsh vegetation, wildlife, juvenile fish, oyster beds.

X4.1.3 *Endpoints for Ecosystem Protection and Recovery*—Plant survival, propagation, and growth; oyster survival, propagation, and growth; tainting of fish and oysters.

X4.1.4 *Response Options*—Dispersants, in-situ burning, no response (natural recovery), mechanical recovery.

X4.1.5 *Potential Effects from Oil and Response Options*—Oyster mortality, marsh plant mortality, erosion, oiled wildlife.

X4.2 Phase 2 Analysis

X4.2.1 *Potential Ecological Effects from Oil and Response Options*—Early life stage (fish, invertebrate) mortality, oiled birds, reduced growth in oysters, marsh plant mortality.

X4.2.2 *Exposures*—Water column organisms, sediment, marsh plants, wildlife.

X4.3 Phase 3 Risk Characterization

X4.3.1 *Optimize Response Based on Endpoints for Ecosystem Protection*—Disperse oil offshore to prevent oil from entering marsh, protective booming.

X4.3.2 *Discuss Ecological Risk Results with Stakeholders and Incorporate into Contingency Plans.*

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