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Standard Guide for Ecological Considerations for the Use of Chemical Dispersants in Oil Spill Response—Salt Marshes[1]

This standard is issued under the fixed designation F 1008; 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.

ϵ^1 NOTE—Section 7 was added editorially in December 1992.

1. Scope

1.1 This guide covers recommendations for the use of chemical dispersants to assist in the control of oil spills. This guide is written with the goal of minimizing the environmental impacts of oil spills; this goal is the basis upon which recommendations are made. Aesthetic and socioeconomic factors are not considered, although these and other factors are often important in spill response.

1.2 Each on-scene coordinator has available several means of control or cleanup of spilled oil. In this guide, use of chemical dispersants is not considered as a last resort after other methods have failed. Chemical dispersants are to be given equal consideration with other spill countermeasures.

1.3 This is a general guide only assuming the oil to be dispersible and the dispersant to be effective, available, applied correctly and in compliance with relevant government regulations. Oil, as used in this guide, includes crude oils and fuel oils (No. 1 through No. 6). Differences between individual dispersants or between different oils or products are not considered.

1.4 This guide covers one type of habitat, salt marshes. Other guides, similar to this one, cover habitats such as rocky shores. The use of dispersants is considered primarily to protect such habitats from impact (or minimize impacts) and also to clean them after the spill takes place.

1.5 This guide applies to marine and estuarine environments, but not to freshwater environments.

1.6 In 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 problems, 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. Significance and Use

2.1 This guide is meant to aid local and regional spill response teams during spill response planning and spill events.

3. General Considerations for Making Dispersant-Use Decisions

3.1 The decision of whether or not to use dispersants in a given spill situation is always one involving trade-offs. Dispersing a slick at one site temporarily introduces more oil into the water column at that site than would be there if a surface slick floated over it. Therefore, adverse effects on water column organisms may be increased at the site so that adverse effects can be decreased or eliminated at other sites.

3.2 Dispersant use is primarily a spill control method, not a cleanup method. Such use can give spill response personnel some control over where the impacts of a spill will occur and what types of impacts they may be. Since some environments are known to be more vulnerable to the longer lasting impacts of spilled oil, an acceptable trade-off may be to protect those environments by dispersing an oil slick in a less sensitive or less productive environment. In general, the trade-off that must be evaluated is between the impact of the relatively long residence time of spilled oil that strands on shorelines versus the short-term impact of dispersed oil in the water column.

3.3 In this guide, environments that are most vulnerable to the longer-term impacts of oil contamination are identified. Protection of these habitats is recommended as a high priority by means of dispersants and other methods.

4. Environments Covered—Coastal Salt Marsh

4.1 Coastal salt marshes (distinct from inland salt marshes) are intertidal wetlands, transitional zones between terrestrial and aquatic ecosystems. Salt marshes form when plants invade shallow, protected tidal flats on low coasts (for example, behind barrier islands or in estuaries where protection from strong wave action is provided) **(1).**[2] Their primary formation requires soil emersion for approximately half the tidal period, water calm enough to prevent uprooting of the newly settled seedlings, and a sufficient amount of sediment to enable the upward growth of the marsh **(2, 3).**

4.2 Coastal salt marshes are usually found in temperate regions but can and do occur in the tropics, especially in arid or monsoonal zones. Salt marshes occur where abundant silt is

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

deposited by major river systems or where geological nature of the coast results in considerable erosion and significant silt resuspension **(4).** Major geographic groupings according to Chapman **(5)**are as follows:

4.2.1 Arctic Group,

4.2.2 Northern European Group (Scandinavian, North Sea, Baltic, English Channel, and Southwest Ireland subgroups),

4.2.3 Mediterranean Group (western Mediterranean, eastern Mediterranean, and Caspian subgroups),

4.2.4 Western Atlantic Group (Bay of Fundy, New England, and Coastal Plain subgroups),

4.2.5 Pacific American Group,

4.2.6 Sino-Japanese Group,

4.2.7 Australasian Group (Australian and New Zealand subgroups),

4.2.8 South American Group, and

4.2.9 Tropical Group.

4.3 The fundamental physiographic units of the marsh are **(6)** the drainage basin or creek system **(7)** and the salt pan. Creeks form by accretion on the surrounding marsh, supplemented by lateral and bed erosion. In sandy marshes, where puccinellia grass is dominant, the creek systems are simple and drainage channels are few. In other muddier marshes the creek systems branch in long, dendritic patterns, and cord grass (*Spartina*) marshes form intricate winding systems of creeks and drainage channels. A salt pan is a bare spot or depression, usually circular in shape, that is surrounded by marsh vegetation and has lost an outlet for water. As a result of flooding by spring tides and evaporation in the summer, this area becomes hypersaline and adverse to plant growth **(6).**

4.4 Along coastlines where marshes are found, there exists a gradual progression from submerged sand flats through a range of different plant communities and brackish water vegetation to fresh water swamps and finally upland vegetation.

4.5 Perennial marsh grasses and rushes on the higher intertidal levels **(8, 9)** dominate the flora of the marsh. Some annuals may also be present.

4.6 In wave protected submerged shallows (or the seaward sand flat), sea grasses and algae take root and trap sediment. When the bottom has risen to form a tidal flat, it becomes suitable for colonization by lateral marsh grass pioneers. These plants maintain the process of sediment gathering, and the high marsh is generally dominated by the short cord grass or by species of salt grass, pickleweed, or sea blite. The transition continues from salt marsh to reed swamp or to a cattail swamp dominated by the rushes or sedges.

4.7 Within the salt marsh proper, there are about ten rather distinctive subhabitats **(10).** Each of these subhabitats provides distinctive growing conditions for the communities that occupy them. While these subhabitats can occupy a large area within the marsh, their distinctive community structures and functions have not been studied in detail.

4.8 Primary production in coastal marshes is carried out mainly by the grasses and by algae living on the surface of the sediments. Total net primary production of a healthy cord grass (*Spartina alterniflora*) marsh system has been estimated to be as high as 200 g/m^2/year of biomass **(11).** This biomass supports a complex food web, as well as stabilizing the substrate or sediments by a network of rhizomes (submerged roots). Bacterial breakdown of dead plant matter supports populations of detritus feeders (for example, fiddler crabs, mussels, and snails), which in turn are eaten by higher organisms (for example, mud crabs, birds, and raccoons). Tidal exchange between the salt marsh proper and adjacent waters provides food (detritus) for aquatic animals (for example, shrimp and commercially important fish).

4.9 Salt marshes function as vital breeding and nursery grounds for many commercially important fish and shellfish, may support overwintering water fowl, provide a temporary or permanent home to birds, and provide food and shelter for terrestrial animals.

5. Background

5.1 Oil slicks impact the salt marsh ecosystem directly by coating the leaves, shoots, and aerial roots of the marsh grasses **(12, 13).** The degree of coating may be dependent upon recoating of the grass during subsequent tidal cycles. Entrapped oil also may be toxic to burrowing and surface organisms **(14).** Toxicity to *Spartina* spp. (cord grass), the predominant perennial in salt marshes **(8),** is due to absorption of oil through stomata **(12)** that apparently decreases the diffusion of oxygen to the root systems **(15).** Brown **(12)** found that nonbiogenic hydrocarbon in oiled *Spartina* were concentrated in the lower shoots and roots, even after one year of weathering. Concentrated petroleum hydrocarbons can result in death of the underground rhizome system of a *Spartina* marsh and inhibit natural regrowth **(16).** Annual marsh grasses may be even more susceptible to damage from oil than perennials **(12, 14).**

5.2 Although devastation of a marsh from a single oiling and subsequent cleanup has been reported **(17)**, observations in later growing seasons of good recoveries of vegetation and associated infauna following single and even multiple spill events are common **(12, 18, 19, 20, 21).** For example, in West Falmouth, MA, following a spill of about 700 000 L of No. 2 fuel oil, an oil high in toxic aromatic compounds, Blumer, Sass, et al **(22, 23)** reported large scale mortalities of the salt marsh grasses (*Spartina* and others) that came into contact with the oil and heavy mortalities in fiddler crabs and mollusc populations **(24).** In a limited area, oil penetrating the sediments as deep as 70 cm initially prevented resettlement by the original fauna. However, after eight months, a reduction of the oil by biochemical and physical processes led to the subsequent repopulation of that area **(24).**

5.3 In some cases, spilled oil can persist for years within or on the surface of the sediments, where it remains biologically available to benthic organisms **(25, 26, 27),** and may cause re-oiling of the marsh during tidal flushing **(14)** or if the sediments are disturbed **(27).** Vandermeulen and Ross **(27)** found that toxic aromatic hydrocarbons were persistent in marsh sediments whereas aliphatic compounds degraded over time.

5.4 In general, damage to vegetation increases with the number of exposures. Brown **(12)** found that while even a single exposure to crude oil "caused some plant mortality as well as 40 to 50 % reduction of growth the following year,"