PART B: REVIEW/SELECT POTENTIAL OPTIONS AND PRODUCTS

Introduction

This section of the Selection Guide provides the decision-maker with the means for evaluating detailed information for individual strategies and product categories for use when responding to spilled oil.

Purpose

Review all strategies and products in a detailed manner and allow easy comparison of individual products and strategies to evaluate their potential value to the individual response-specific conditions. Worksheet 2 will be used to facilitate review and comparison of the products.

The general subsections for which summary information is presented for each technology category include:

- Mechanism of action (how it works, what it does)
- When to use
- Authority required
- Availability
- General application requirements
- Health and safety issues
- Limiting factors/environmental constraints
- Monitoring requirements/suggestions
- Waste generation and disposal issues
- References
- Who to call for more information and additional resources

Within each strategy and product category, detailed, strategy/ product-specific information is presented in a table format in order to facilitate direct comparison of the various available products. This includes all the products on the NCP Product Schedule, plus others that are not required to be on the Schedule, such as sorbents. Products that are not currently listed on the NCP, but have been in the past are now located in Appendix K. The table organization for each technology category is similar, with some variation, to reflect the most relevant decision issues of interest or concern.

Note

To ensure that you are accessing the most current product pricing information, decision-makers should contact the supplier/vendor.

Continued on Next Page

PART B: REVIEW/SELECT (CONTINUED)

Step Action Table Follow the step action table below for Part B: Review/Select Potential Options and Products.

STEP	ACTION
1.	Obtain a blank copy of the Product Selection Worksheet (Worksheet 2) to record information for each product category. Worksheet 2 is on the next page. Another copy is in Appendix H for photocopying. ***Note***: If two product categories/strategies are being evaluated for an incident, fill out a separate Product Selection Worksheet for each category/strategy. ***Note***: If you are considering a category/ strategy that does not involve the use of NCP listed products, such as fast water booming or water intake monitoring, this worksheet is not needed.
2.	Record product category/strategy being evaluated on Line A of Worksheet 2. Review all information in the general category overview.
3.	Identify up to three products in this category to be reviewed. Record a product name in each column on Line B. *Use another copy of the worksheet if more than three products are being evaluated for a product category.*
4.	Complete questions C, D, E, and F for each product being considered. Record product-specific information in the space available for these questions.
5.	Record the toxicity ratings for Inland Silversides (96h) and Mysid Shrimp (48h) for each product in Line G, where applicable. ***Note***: For more information on the toxicity and toxicity ratings and what they mean refer to Appendix E of this volume.

Continued on Next Page

PART B: REVIEW/SELECT (CONTINUED)

Step Action Table Continued.

6.	Review product-specific information recorded and compare and contrast products. Rank the products in terms of value to the incident-specific response conditions. Identify those products that are not suitable at this time. Record this information in Line H.
7.	Record any additional comments or information that is pertinent to this decision in Line I.
8.	This worksheet is designed to assist in the decision-making process. In Line J, if a product(s) appears to add value to the response, the completed worksheets can be used to demonstrate consensus and can be FAXed to the incident-specific RRT for review and/or approval.
	NOTE: Identifying potential products for use in the response requires additional evaluation criteria in terms of actually testing the product on the oil and developing monitoring capabilities to determine the extent of effectiveness and when to cease using a product. Continue on to Part C to complete your evaluation

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WORKSHEET 2: PRODUCT SELECTION WORKSHEET

This worksheet is intended to be photocopied for each product category evaluated and used during drills and incidents and Faxed to the Incident Specific RRT for review. This worksheet may be used to evaluate 1, 2 or 3 separate products in an individual category.

Name(s):

Date:

Incident:

A:	**Product Category Being Reviewed:**			
	Products of Interest:	**Product 1**	**Product 2**	**Product 3**
B:	**Product Name:**			
C:	**RRT Approval Required? (Y/N)**			
D:	**Can Product Arrive in Time? (Y/N)**			
E:	**Can Product be Applied in Time? (Y/N)**			
F:	**Can Product be removed from the Environment? (Y/N)**			
G:	**Toxicity (Write in numbers and Toxicity Rating. See App E for more information on toxicity and Toxicity Rating)**	Inland silversides (96h): Mysid Shrimp (48h):	Inland silversides (96h): Mysid Shrimp (48h):	Inland silversides (96h): Mysid Shrimp (48h):
H:	**Mark as 1st, 2nd, or 3rd Choice or mark as Not Applicable for this incident**			

I: Additional Comments/Decisions/Recommendations:

J: Initials/Date of Incident-Specific RRT Review of Information:

Initial Box and Include Date Upon Review

USEPA: ☐ Date:

USCG: ☐ Date:

NOAA: ☐ Date:

USDOI: ☐ Date:

STATE: ☐ Date:_____

STATE: ☐ Date:_____

OTHER: ☐ Date:_____

OTHER: ☐ Date:_____

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FAST-WATER BOOMING STRATEGIES

Description

- For the purposes of the Selection Guide, the term "fast water" is applied to any water body with currents of one to six knots.
- Oil containment boom loses oil due to entrainment when the water current normal (perpendicular) to the boom exceeds 0.75 to 1 knot (depending on the oil's specific gravity, viscosity, and other factors). Above this "critical velocity", entrainment can be eliminated or reduced by deploying boom at an angle to the current to divert or deflect floating oil away from sensitive areas or toward areas of lower current velocity where the oil may be contained and recovered.
- With increasing current, the angle of the boom to the current must be reduced to control entrainment.
- Traditional containment booms can be positioned at sharp angles to the current (with great difficulty) to divert oil in up to two or three knots. With developing technologies, a current of six knots is considered the upper limit for controlling floating oil in the foreseeable future.

When to Use

- Fast-water booming strategies (Table 5) should be used whenever the current exceeds the critical velocity for the spilled oil, and entrains under the containment or deflection boom.

Understanding the Problem

- Sixty-nine percent of all oil transported on US waters (645 million tons annually) is transported on waterways in which currents routinely exceed one knot.
- Thousands of facilities with tanks containing millions of tons of oil are located in close proximity to high current waterways.
- During the past decade (1990s), 58% of all oil spills 100 gallons or larger have occurred in high-current waterways.
- Oil containment boom fails to contain oil due to entrainment at currents above 0.75 to 1.0 knots. With a 1.5 knot current, a deflection boom must be angled at approximately 35° to the current to prevent entrainment. At two-knots current velocity, the boom angle must be reduced to about 25° and to about 15° for a three-knot current. These sharp boom angles are very difficult to achieve and maintain, particularly with reversing tidal currents.

Authority Required

- **RRT approval is not required** for employing fast-water booming techniques, but operations personnel should coordinate with appropriate state and local authorities with respect to shoreline private property issues, environmentally

sensitive shorelines, and intertidal and subtidal areas when deploying mooring systems.

- Care should be enforced to ensure that coral reefs, seagrass beds, and other particularly sensitive resources are not damaged by boom-mooring systems, by boats, or by personnel operating in shallow water areas.

Availability

- Specialized fast-water booms and related equipment are not generally available in significant quantities at the time of this writing. There is, however, a growing awareness of the need for such resources in fast-water areas.
- Fast-water booming techniques, addressed below, can be implemented using traditional booming equipment.

General Application Requirements

- Fast-water booming strategies to protect sensitive areas must be:
  - well thought out;
  - practiced by well-trained, properly equipped, and experienced crews, under controlled conditions; and
  - refined, prior to implementation during an actual spill response.
- Improper implementation of fast-water booming strategies can seriously endanger boat crews in addition to jeopardizing the success of the operation. A towboat can easily be capsized and submerged when handling boom in a fast-water environment. For this reason alone, some of the newer booming techniques feature boom deployment and positioning using shore-tended lines should be considered where feasible.

Health and Safety Issues

The following health and safety issues should be addressed prior to engaging in fast-water booming operations:

- The Safety Officer must personally address fast-water safety issues or assign a knowledgeable assistant to do so. The Site Safety Plan should specifically address fast-water booming issues.
- As noted above, fast-water booming operations should be well planned and implemented by experienced work crews. Personnel must receive thorough safety briefings stressing operational objectives, procedures, chain of command, potential safety hazards, and required personnel protective equipment.
- Small boat operations, and particularly towing operations, under high-current conditions can be hazardous and should be undertaken only by highly trained and experienced boat crews familiar with the operating area.
- During operations, shoreside work crews may be exposed to the same range of hazards as boat crews, but will likely have had less training/experience.

Personnel wading in shallow, high current waters should be aware of the extreme hazard of foot entrapment and submersion by the current.

- Man-overboard procedures should be discussed and understood by all hands. Positioning a safety boat down current of the booming operations should be considered for potential man-overboard situations.
- Boom towlines and mooring lines can be subjected to high loads in high-current conditions. Boom and line-safe working loads should be considered and the potential for parting and snap-back anticipated. Booming techniques, such as cascading, should be considered as appropriate to reduce boom and line loading.

Monitoring Requirements/Suggestions

- Fast-water booming deployments must be continually monitored to ensure boom angles are appropriate to prevent entrainment, and to ensure that mooring system anchors have not dragged, lines parted, or other system components failed under load.
- Work crews must be prepared to make adjustments as required.

References

Coe, T., and B. Gurr. 1998. Control of oil spills in high speed currents: A technology assessment. US Coast Guard R&D Center, Groton, CT. Report No. CG-D-18-99.

Owens, E.H. 1995. Field guide for the protection and cleanup of oiled shorelines. Environment Canada, Atlantic Region, Environmental Emergencies Section, Dartmouth, Nova Scotia.

Michel, J., S. Christopherson, and F. Whipple. 1994. Mechanical protection guidelines. Hazardous Materials Response and Assessment Division. National Oceanic and Atmospheric Administration, Seattle, WA.

Exxon USA. 1992. Oil spill response field manual. Exxon Production Research Company, Houston, TX.

Who to Call for More Information and Additional Resources

- OHMSETT Testing Facility, PO Box 473, Atlantic Highland, NJ 07716
  Phone: (732) 866-7183; http://www.ohmsett.com

- Marine Spill Response Corporation HQ, 455 Spring Park Place, Suite 200, Herndon, VA 20170 Phone: (703) 326-5617

- USCG Response Plan Equipment Caps Review,
  http://www.uscg.mil/vrp/capsreview.htm

- USCG Research & Development Center, Groton, CT.

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Table 5. Fast-Water Booming Strategy Options.

	Angled Deflection	Site Selection	Boom Selection
Description	When the current exceeds the critical velocity and entrainment prevents effective oil containment, boom can be angled across the current to divert or deflect oil away from sensitive areas or toward lower current areas for recovery. Deflection may be effective in up to three knots of current, if a very sharp boom angle can be maintained across the current (about 15° from the direction of current flow, for a 3 knot current). Newer boom designs and refinements in technique may extend this capability.	Select a protective booming site where current is minimized (e.g. at the widest and/or deepest point of a river or channel, or at the channel entrance or exit, etc.). Select an area where oil can be diverted to a natural collection point or eddy where current allows recovery using skimmers or pumps. A shoreside recovery point accessible by land-based heavy equipment is preferred, but not essential. Floating platforms may be positioned to support oil recovery and temporary storage. Do not select a boom site where booming is impractical due to current, sea state, logistics, etc.	Boom characteristics important for fast-water booming include shallow skirt depth (draft of 6 inches or less) to minimize entrainment, bottom tension member to prevent boom planing, curtain versus fence design for vertical flexibility, high buoyancy to weight ratio to prevent submersion, and sufficient tensile strength to prevent structural failure. **Some manufacturers offer specially designed High Current Booms** incorporating the above features. Shallow draft deflection boom must transition to traditional deeper draft containment boom to hold diverted oil for recovery in the low-current oil collection area.
Equipment Availability	Any reasonably strong, relatively shallow draft, oil containment boom with a bottom tension member can be deployed in a deflection mode across a current. Adequate mooring systems are less readily available but can be assembled with adequate planning.	N/A	High current booms are not widely available at this writing. Any strong boom with a relatively shallow draft and a bottom tension member is a good candidate for fast-current booming
Logistical Needs	Launch site for tow boat(s) and boom near the area to be protected. One or more powerful towboats with adequate towing bitts and sufficient deck space for mooring system stowage and deployment.	**1) N/A**	See Logistical needs for "Angled Deflection" (to the left) on this page

Table 5. Continued.

	Adequate Moorings	Cascade Booming	Shore-Tended Boom
Description	Stretching a length of boom in a relatively straight line across a high current requires application of considerable opposing forces on the two ends of the boom. Once in position, the forces must be maintained, traditionally with mooring systems featuring anchors, which are heavy and/or highly efficient (have high holding power). All components of the boom and mooring systems must have adequate safe working loads to prevent structural failure. In some cases, additional mooring systems must be secured at intermediate points along the boom to overcome lateral forces tending to create boom catenary leading to entrainment.	In some cases, a series of two or more overlapping, "cascade", deflection booms stretched across a high current waterway are more practical than a single long deflection boom spanning the same distance. The shorter, individual cascade boom sections will generate lesser loads in the current and will therefore require lighter rigging, smaller anchors, less powerful towboats, etc. On the other hand, cascade systems are more complex and system simplicity should be an objective to the extent possible. Multiple mooring systems in close proximity can result in fouling of anchors and related operational complications.	In relatively narrow rivers or channels, it may be feasible to rig single or cascade deflection boom sections using only shoreside anchor points. Shoreside anchor points may be trees, large rocks, or installed "deadmen". Boom mooring lines secured to shoreside points are accessible and readily adjustable. Envision a length of boom stretched in a fairly straight line, at a sharp angle across the current, from an upstream anchor point on one side of the river to a downstream anchor point on the opposite side of the river. In addition to the longitudinal mooring lines, other lines on the boom ends can be worked from the shore, at right angles to the boom, to control lateral positioning in the river.
Equipment Availability	Boom mooring systems with the high holding power necessary for deflection booming across a high current are not readily available from booming contractors. Suitable mooring system components can be assembled with adequate advance planning.	More mooring systems and rigging materials, and a little more boom will be required, but the moorings and rigging need not be as robust.	Shore-tended boom mooring systems can be readily assembled using appropriately sized line, shackles, snatch blocks, and other standard marine rigging materials. These systems work best with specially designed high-current booms (See Boom Selection above).
Logistical Needs	Adequate mooring systems for fast-water booming are not readily available. Deployment and especially recovery of heavy anchors requires specially equipped workboats and experienced crews. Pre-spill installation of permanent boom mooring buoys and anchor points ashore, to protect sensitive areas, is highly recommended.	Logistic support to install the more complex cascade system may be of longer duration, but less demanding in terms of the installation of smaller mooring systems and lighter rigging. Smaller, less powerful towboats may be adequate for deployment and recovery of the lighter weight cascade system moorings.	A small boat, heaving line, or other means of passing a messenger line across the river to haul mooring lines and booms across. Winches, "come-alongs", 4-wheel drive vehicles, or other means of hauling, as required. A trained and experienced work crew with a qualified rigger is required.

Table 5. Continued.

	Reduce Relative Velocity	New Innovations
Description	Fast-water booming in open-water areas may allow reducing water velocity relative to the boom by "going with the flow". Tow boats may sweep (U-configuration) oil collection boom through a slick at one knot relative to the slick, while being set back two knots "over the ground", by a three knot current. When filled with oil, the boom ends can be brought together in a "teardrop" configuration and allowed to drift with the current pending removal by skimming. Similarly, in open waters, a skimmer with V-configuration collection boom can recover an oil slick in a high current provided it proceeds at a slow speed through the slick while being set backward by the current.	A number of innovative new ideas have been proposed and tested with varying degrees of success to date. At the time of this writing it is not appropriate to include them in this Selection Guide. Operational systems are not yet available. The Coast Guard R&D Center in Groton, CT, and other sources may be contacted for further information on this subject.
Equipment Availability	Standard booms, skimmers, and towboats may be used, but specialized high-current booms and skimmers will enhance performance. "Open water" operation implies that equipment must be suitable for the sea state and other environmental conditions to be encountered.	
Logistical Needs	No unusual logistical needs would be anticipated beyond those required by offshore or open water operations.	

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NON-FLOATING OIL STRATEGIES

Understanding the Problem

- Non-floating oil spills can have complex behavioral patterns, depending on the API gravity of the oil, the density of the receiving water, and the physical setting of the spill site.
- Denser-than-water oil is expected to mix in the water column as oil drops rather than large, cohesive mats. Oil can accumulate on the bottom under low currents, so releases in harbors with dredged channels and berths in canals could readily sink and form pools of oil on the bottom.
- Releases in areas subject to tidal and riverine flow are likely to be kept in suspension in the water column by currents.
- Floating oil can sink after mixing with sand, either in the surf zone or after stranding onshore.
- Traditional methods for tracking, containment, and recovery are not effective for non-floating oil spills. Refer to the matrices to evaluate possible options for tracking, containing, and recovering oil suspended in the water column and on the bottom.

What to Do

Because non-floating oil can cause environmental and/or other problems, officials might require responders to assess the feasibility of taking action to deal with these oils. General options include:

- Mapping the extent of oil deposited on the bottom;
- Containing oil suspended in the water column; and
- Recovery of oil deposited on the bottom.

Authority Required

Key regulatory issues associated with response to non-floating oil spills can include:

- Getting approval from the Corps of Engineers and applicable state authorities for emergency dredging.
- Getting emergency decant authorization when handling large volumes of water during dredging.
- Disturbing bottom sediments that may be previously contaminated.
- Contamination of bottom sediments that may require additional testing and disposal restrictions during future maintenance dredging operations.

Availability

- Varies widely by equipment type. See Tables 6-8 for each option.

Limiting Factors/Environmental Constraints

- Human health and safety are of primary concern, particularly for dive operations in general and specifically contaminated-water diving.
- Existing methods for tracking oil suspended in the water column are ineffective; methods for mapping oil deposited on the bottom are slow and logistics-intensive.
- Strong currents limit the likelihood of any oil accumulating on the bottom and diver operations.
- Poor water visibility limits ability to locate oil deposits and effectiveness of divers in directing recovery devices.
- Debris on the bottom may make the recovery of sunken oil difficult and could tangle or damage nets and other recovery equipment.
- Not enough is known about the long-term effects of submerged, thick oil residues to determine cleanup endpoints appropriate for different benthic habitats.

Monitoring Requirements/Suggestions

- Since there is very poor documentation on the effectiveness and effects of containment and recovery of non-floating oils, monitoring is very important.

Waste Generation and Disposal Issues

- There are numerous and complex waste disposal issues associated with disposal of both the liquids and solids collected during recovery of non-floating oil spills.
- Large volumes of collected water will have to be decanted and discharged on-scene during recovery operations.

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National Research Council (NRC). 1999. Spills of non-floating oils: Risk and response. Prepared by the Committee on Marine Transportation of Heavy Oils, Marine Board. National Academy Press, Washington, DC. 75 p.

Weems, L.H., I. Byron, J. O'Brien, D.W. Oge, and R. Lanier. 1997. Recovery of LAPIO from the bottom of the lower Mississippi River. In: Proc. 1997 Intl. Oil Spill Conference, American Petroleum Institute, Washington, DC. pp. 773-776.

Who to Call for More Information and Additional Resources

NOAA HAZMAT/SSC, General contact number: 206-526-6317

O'Brien's Oil Pollution Services, Inc., 505 Weyer Street, Gretna, LA 70053
Phone: 504-368-9845; email: oops-usa@ix.netcom.com

Research Planning, Inc., 1121 Park Street, Columbia, SC 29201
Phone: 803-256-7322

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Table 6. Response Options for Mapping of Oil Deposited on the Bottom.

	Visual Observations	Bottom Sampling from the Surface	Underwater Surveys by Divers
Description	Trained observers in aircraft or on vessels look for visual evidence of oil on the bottom	A sampling device (corer, grab sampler, sorbents attached to weights) is deployed to collect samples from the bottom for visual inspection	Divers (trained in contaminated water diving) survey the sea floor either visually or with video cameras
Equipment Availability	Uses readily available equipment	Uses readily available equipment and supplies	Underwater video cameras are readily available, but divers and dive gear for contaminated water operations may not be available locally
Logistical Needs	Low; aircraft and vessels are readily available during spill response	Moderate; requires boat, sampling equipment, GPS for station location	Moderate, depending on the level of diver protection required
Coverage Rate	High for aircraft; low for vessels	Very low; collecting discrete bottom samples is very slow and devices sample only a very small area	Low, because of slow swimming rates, limited dive time, poor water quality
Data Turnaround	Quick	Quick since visual analysis is used	Quick
Probability of False Positives	High, due to poor water clarity, cloud shadows, seagrass beds, irregular bathymetry	Low, except in areas with high background oil contamination	Low, since divers can verify potential oil deposits
Operational Limitations	Good water clarity and light conditions (water depth < 60 ft); weather may restrict flights; only during daylight hours	Realistic only for water depths <100 ft; sea conditions may restrict vessel operations	Water depths of <100 ft (for divers); minimum visibility of 1-2 ft; low water currents
Pros	Can cover large areas quickly using standard resources available at spills	Can be effective in small areas to rapidly define a known patch of oil on the bottom; low tech; has been proven effective for certain spills	Accurate determination of oil on bottom; verbal and visual description of extent and thickness of oil and spatial variations
Cons	Only effective in areas with high water clarity; sediment cover will prevent detection over time; ground truthing is required	Samples a very small area which may not be representative; too slow to be effective over large area; does not indicate oil quantity on bottom	Slow; difficult to accurately locate deposits without GPS; decon of dive gear can be costly/time-consuming

Table 6. Continued.

	Bottom Trawls	Photobathymetry	Geophysical/Acoustic Techniques
Description	Fish nets or trawling gear are towed on the bottom for set distance then inspected for presence of oil	Aerial stereo photography mapping technique to identify and map underwater features. A realistic scale is 1:10,000	Sonar system which uses the differential density and sound speeds in oil and sediment to detect oil layers on the bottom. A fathometer records a single line under the sounder; side-scan sonar records a swath.
Equipment Availability	Readily available in commercial fishing areas	Available from most private aerial mapping companies, with specifications	Variable, and often not available locally; need trained personnel
Logistical Needs	Moderate; requires boat and operators to tow the nets; may need multiple vessels to cover large areas; may need many replacement nets as they become oiled	Aircraft specially equipped to obtain vertical aerial photography with GPS interface	Moderate; requires boat on which equipment can be mounted; need updated charts so that search area can be defined
Coverage Rate	Low; nets have a small sweep area and they have to be pulled up frequently for inspection	High	Moderate; data collected at speeds up to several knots
Data Turnaround	Quick	Slow; aerial photos can be produced in a few days in most places; data interpretation will take 1-2 + days	Medium; data processing takes hours, preliminary data usually available next day; potential sites need ground truthing
Probability of False Positives	Low; oil staining should be readily differentiated from other fouling materials	High; photograph identify potential sites, all of which will need ground truthing	High; identifies potential sites but all need ground truthing
Operational Limitations	Obstructions on the bottom can hang up nets; restricted to relatively shallow depths; sea conditions may restrict vessel operations; heavy debris in water can foul nets	Specifications call for low sun angles and calm sea state; water penetration is limited by water clarity; maximum penetration is 25 ft for very clear water; 2 ft for turbid water; best if baseline "before" photography is available for comparison	Sea conditions have to be relatively calm to minimize noise in the recording
Pros	Can provide data on relative concentrations on the bottom per unit trawl area/time; can survey in grids for more representative aerial coverage	Rapid assessment of large areas; high spatial resolution; good documentation and mapping	Can be used to identify potential accumulation areas; complete systems can generate high-quality data with track lines, good locational accuracy
Cons	Very slow; nets can fail from excess debris accumulation	Limited by water clarity, sun angle, and availability of pre-spill photography for comparisons	Data processing can be slow; requires extensive ground truthing; limited number of skilled operators

Table 7. Response Options for Containing Oil Suspended in the Water Column.

	Air Curtains/Barriers	Net Booms	Silt Curtains
Description	Piping with holes is placed on the bottom and compressed air is pumped through it, creating an air bubble barrier	Floating booms with weighted skirts (3-6 ft) composed of mesh designed to allow water to pass while containing suspended oil	Silt curtains, as used during dredging operations, are deployed as a physical barrier to the spread of suspended oil; weighted ballast chains keep the curtain in place
Equipment Availability	Uses readily available equipment, though in unique configuration	There are commercially available net booms, developed and tested for containing spills of Orimulsion. Little availability in the US	Not readily available; limited expertise in deployment and maintenance
Logistical Needs	Moderate: need system to deploy and maintain bubbler; piping has tendency to clog; high installation costs	Moderate; similar to deployment of standard booms, but with added difficulty because of longer skirt; can become heavy and unmanageable	Moderate; to properly deploy and maintain the silt curtains
Operational Limitations	Only effective in low currents (<0.5 knots), small waves, and water depths < 5 ft	In field tests, the booms failed in currents <0.75 knots. They will work under very few conditions	Only effective in very low currents (<0.5 knots); practical limits on curtain depth are 5-10 ft, which normally doesn't extend to the bottom
Optimal Conditions	To contain oil spilled in dead-end canals and piers; to protect water intakes	Will contain oil only in very low-flow areas, such as dead-end canals and piers	Still water bodies such as lakes; dead-end canals
Pros	Does not interfere with vessel traffic	Can be deployed similar to traditional booms	Can be deployed throughout the entire water column
Cons	Only effective under very limited conditions; takes time to fabricate and deploy, thus only effective where pre-deployed; little data to assess performance	Only contains oil suspended in the upper water column, to the depth of the mesh skirt; if sufficient oil is suspended in the upper water column to warrant the use of nets, then it is likely that the nets will become clogged and will need to be monitored and/or replaced	Only effective under very limited conditions, not likely to coincide with those where suspended oil needs containment; oil droplets are larger than silt and could clog curtain

Table 8. Response Options for Recovering Oil Deposited on the Bottom.

	Manual Removal by Divers	Nets/Trawls	Pump and Vacuum Systems (Diver-directed)
Description	Divers pick up solid and semi-solid oil by hand or with nets on the bottom, placing it in bags or other containers	Fish nets and trawls are dragged on the bottom to collect solidified oil	Divers direct a suction hose connected to a pump and vacuum system, connected to oil-water separator, and solids containers. Viscous oils require special pumps and suction heads. Even in low water visibility, divers can identify oil by feel or get feedback from top-side monitors of changes in oil recovery rates in effluents
Equipment Availability	Contaminated-water dive gear may not be locally available	Nets and vessels readily available in areas with commercial fishing industry	Readily available equipment but needs modification to spill conditions, particularly pumping systems, and capacity for handling large volumes of materials during oil-water-solids separation
Logistical Needs	Moderate; diving in contaminated-water requires special gear and decon procedures; handling of oily wastes on water can be difficult	Low; uses standard equipment, though nets will have to be replaced often because of fouling	High, especially if recovery operations are not very close to shore. On-water systems will be very complicated and subject to weather, vessel traffic, and other safety issues
Operational Limitations	Water depths < 100 ft for routine dive operations; water visibility of 1-2 ft so divers can see the oil; bad weather can shut down operations	Water depths normally reached by bottom trawlers; obstructions on the bottom which will hang up nets; rough sea conditions; too shallow for boat operations	Water depths < 100 ft for routine dive operations; water visibility of 1-2 ft so divers can see the oil; bad weather can shut down operations; solid oil which is not pumpable
Optimal Conditions	Shallow, protected areas where dive operations can be conducted safely; small amount of oil; scattered oil deposits	Areas where bottom trawlers normally work; solidified oil	Sites adjacent to shore, requiring minimal on-water systems; liquid or semi-solid oil; thick oil deposits, good visibility; low currents
Pros	Divers can be very selective, removing only oil, minimizing the volume of recovered materials; most effective method for widely scattered oil deposits	Uses available resources; low tech	Most experience is with this type of recovery; diver can be selective in recovering only oil and effective with scattered deposits
Cons	Large manpower and logistics requirements; problems with contaminated-water diving and equipment decon; slow recovery rates; weather dependent operations	Not effective for liquid or semi-solid oil; nets can quickly become clogged and fail; can become heavy and unmanageable if loaded with oil; could require many nets which are expensive	Very large manpower and logistics requirements, including large volumes of water-oil-solids handling, separation, storage, and disposal; problems with contaminated-water diving and equipment decon; slow recovery rates; weather dependent operations

Table 8. Continued.

	Dredging
Description	Special purpose dredges, usually small and mobile, with ability for accurate vertical control. Uses land- or barge-based systems for storage and separation of the large volumes of oil-water-solids
Equipment Availability	Varies; readily available in active port areas; takes days/week to mobilize complete systems
Logistical Needs	High, especially if recovery operations are not very close to shore, because of large volumes of materials handled. On-water systems will be very complicated and subject to weather, vessel traffic, and other safety issues
Operational Limitations	Min/max water depths are a function of dredge type, usually 2 to 100 ft; not in rocky substrates; bad weather can shut down operations
Optimal Conditions	Large volume of thick oil on the bottom; need for rapid removal before conditions change and oil is remobilized, buried by clean sediment, or will have larger environmental effects
Pros	Rapid removal rates; can recover non-pumpable oil
Cons	Generates large volumes of water/solids for handling, treatment, disposal; large logistics requirements; could re-suspend oil/turbidity and affect other resources

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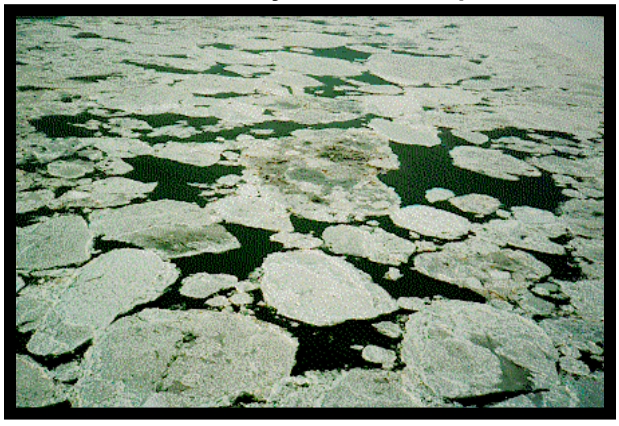
OIL-AND-ICE RESPONSE STRATEGIES

Description

- Response techniques must vary or be modified when an oil spill interacts with ice.
- Ice habitat presents unique safety issues in terms of cold, ice stability, and wildlife interactions.
- Ice forming on the water surface can persist for a matter of days to several months, depending upon location. Most ice is floating, but occasionally, the ice is frozen to the bottom. Responses to oil spills in ice are divided into two categories (defined by API Marine Manual, [2001]):

Picture courtesy of A. Allen, Spiltec

Accessible ice – can safely support the personnel and equipment suitable for response to a particular oil spill on, in, under, or adjacent to solid ice; and



Picture courtesy of C. Rivet, Canada

Inaccessible ice – cannot safely support response personnel and response equipment (e.g., river systems). Oil spills on, in, under, or adjacent to brash ice, small or fast moving floes, or other ice types which are "inaccessible" must be treated from the air or from vessels working in or alongside, the ice.

- Water/shoreline habitats which experience ice formation in winter months are, in general, considered to have low sensitivity to oil spills. In most instances, the ice along the shoreline or in the adjacent nearshore water acts as a natural barrier, often reducing the amount of oil that might otherwise make contact with the shoreline.
- During the ice growth phase (or following an extended snowfall), the oil can become encapsulated within the ice.

- During the next or subsequent thaw periods, encapsulated oil could be released but is unlikely to adhere to the melting ice, therefore remaining on the water surface or in leads among the ice. The oil in or below the ice surface will often migrate through brine channels (in sea ice) to the surface. The same is true in freshwater environments.
- Booms, other barriers, skimmers, absorbents, and the ice itself often work effectively in containment and recovery of oil for areas with accessible ice. Boom, skimmers, manual oil recovery, and other conventional countermeasures are not effective or are hazardous to use in areas with inaccessible ice, especially when ice is present in river systems with fast-moving currents and under tidal influence.

When to Use

- When oil is spilled in areas where ice is present.
- Natural recovery may be the only response option available, and is the preferred method for spills of light oils (e.g., gasoline) in accessible and inaccessible ice, particularly when oil quantities are small.
- Traditional countermeasures (booming, skimming, barriers/berms, manual and mechanical removal, sorbents, and vacuums) are typically the response options of choice for spills in accessible ice and in riverine systems. In rivers, the currents would normally carry the oil with loose ice toward open water where conventional clean up methods would be used. Ice build up out from shorelines would tend to assist in keeping the oil in the opened channel.
- Additionally, low-pressure ambient and hot water flushing, steam cleaning, dispersants, and in situ (ISB) burning are also recommended options for dealing with oil spilled in accessible ice.
- Many of the conventional countermeasures have reduced effectiveness and serious health and safety issues associated with their use in inaccessible ice conditions. Dispersants and in situ burning are widely accepted methods for responding to oil spills in inaccessible ice conditions in the open ocean. Dispersants are not applicable in lake and riverine environments.
- For spills where the oil is frozen into the ice, collecting and removing the ice and oil is a sensible strategy. A stable platform is needed.

Understanding the Problem

- The presence of ice greatly reduces the rate of natural weathering for petroleum hydrocarbons.
- Oil may become trapped or frozen into the ice, reducing the natural weathering processes.
- Equipment must be able to handle rugged terrain, extreme cold, blowing snow, and the risks associated with operating with heavy loads on accessible and inaccessible ice.

- Equipment in extreme environments must be designed for self-sufficiency in often remote and inhospitable areas where the ability to call for backup or evacuation may not be possible.
- In the Great Lakes, there is often shorefast, accessible ice cover ranging from 40 percent to 100 percent on Lake Erie. The St. Mary's River typically experiences up to 5 months of shorefast ice.
- In Alaska, particularly in the Beaufort Sea and North Slope areas, the ability to respond to oil spills depends largely on the season. The North Slope region is characterized by a band of shorefast ice (much of it bottom-fast as well) in the shallow coastal waters. At the edge of the accessible ice is deeper water, a transition is made to pack ice through a shearing zone characterized by massive pressure ridges, grounded rubble combined with heavy old ice (Tornga, 2000).
    - Tugs and barges can operate when light ice or open water conditions are present, typically early August to September.
    - Deep draft icebreaking vessels can substantially extend the marine operating season offshore, but in the shallow coastal waters of the North Slope area, the shallow draft icebreaking barges extend the season into October.
    - In Alaska, heavy trucks and loaders can operate safely through much of the landfast ice during winter after barges are forced back to the dock, until April when the ice starts soften.
    - Helicopters and hovercraft represent the only vehicles that can achieve continuous access to an offshore site throughout the year. Helicopters require a minimum ice thickness to land and experience downtimes in conditions of fog and icing. Hovercraft are relatively unaffected by thickness or state of the ice, but can experience problems in rough ice and strong winds.
- In the lower 48, the typical incident is confined to spills of oil in navigable waterways, ruptures of pipelines (underwater and on land), and other discharges on land.
    - The thickness and duration of ice presence varies from state to state and from year to year.
    - Oil discharged in lakes/ponds and on land would expect very little current and transportation of the oil. Once detected, responders would need to determine the extent of spread and determine how to contain the oil.
    - Tugs and barges can operate when light ice or open water conditions are present.
    - Conventional response equipment may not function properly in the presence of ice.
    - Containment of oil under ice is primarily done by cutting a slot in ice around oil and placing boom to contain the further spread of the oil. Responders can cut holes in ice to remove oil or wait for the ice to melt and recover oil with normal means. Environmental considerations would determine the urgency for removal.

- ISB is often one of the few practical options for removing oil spilled in ice-covered waters. Often ISB is the only option with the exception of no response or natural attenuation. ISB depends of the characteristics of the spilled oil and how it behaves in the ice environment.

Authority Required

- **RRT approval is not required** for employing conventional countermeasure strategies for recovery /remediation of oil spilled in either accessible or inaccessible ice. However, if dispersants or in situ burning are considered a viable response option, **concurrence of the incident-specific RRT would be required**. Review the summary sheets on dispersants and in situ burning later in this section for additional authorization requirement instructions.
- A detailed health and safety plan should be developed when using any technology in accessible or inaccessible ice environments. This safety plan should deal with hypothermia problems as well as "falls through the ice" issues.

Availability

- Specific equipment designed for oil spills in ice conditions is currently available in several areas of the US, including Alaska and the Great Lakes, and Canada.
- Steel pontoon booms designed for oil recovery in ice infested waters are currently being constructed, tested, and stockpiled at various sites in Canada and the US (Abdelnour, 2000).
    - Stockpile amounts will change over time.

Limiting Factors/Environmental Constraints

- Human health and safety are of primary concern, particularly for operations situated in inaccessible ice or near the edges of the accessible ice.
- Existing methods for tracking oil spilled under the ice are being modified to rapidly detect and trace the oil.

Health and Safety Concerns

The following health and safety issues should be addressed prior to engaging in oil in ice recovery operations:

- The Safety Officer must personally address health and safety issues associated with cold weather response operations, or assign a knowledgeable assistant to do so. The Site Safety Plan should specifically address working conditions associated with cold weather, ice, and hypothermia issues.

Waste Generation and Disposal Issues

- There are numerous and complex waste disposal issues associated with the disposal of liquids and solids recovered during recovery operations when oil is spilled in, or on ice.
- Recovered oil frozen in ice needs to be transported to approved disposal sites.

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Who to Call for More Information and Additional Resources

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Eugene Johnson, Delaware Bay & River Cooperative Inc., Lewes, DE.
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Ian Buist and Sy Ross, SL Ross Environmental Research, Ottawa, Ontario, Canada
Phone: (613) 232-1564.

Equipment Deployment:

USCG National Strike Force Coordination Center, Elizabeth City, NC
Phone: 252-331-6000
and Regional Strike Teams

Emergencies Science Division, Environment Canada, Ottawa, Canada (613) 988-9622

ISB in Ice Environments

Al Allen, Spiltec, Inc., Woodinville, WA (206) 869-0988

Ian Buist and Sy Ross, SL Ross Environmental Research, Ottawa, Ontario, Canada
Phone: (613) 232-1564.

Table 9. Response Options for Detecting Oil Under Ice.

	Underwater Surveys by Divers	Aerial Thermography	Scanning Fluorescence Laser
Description	Divers (trained in contaminated water diving) survey areas under the ice either visually or with video cameras	Using an infrared camera or IR/UV system allows detection of oil under a variety of conditions, discriminate oil from some background.	A laser and fiber optic scanner perform a fast line scan from a height of 50 meters onboard a small helicopter; covers the ground with laser pulses 10 cm apart.
Equipment Availability	Underwater video cameras are readily available, but divers and dive gear for cold, contaminated water operations may not be available locally		Testing phase; required to be attached to small helicopter; uses GPS positioning to mark identified oil on a map for post-processing.
Logistical Needs	Moderate, depending on the level of diver protection required		Extensive; equipment needs are also extensive
Coverage Rate	Low, because of slow swimming rates, limited dive time, poor water quality		
Data Turnaround	Quick		Delayed; must import information and display on three-dimensional GIS system using Virtual Reality technology
Probability of False Positives	Low, since divers can verify potential oil deposits		
Operational Limitations	Water depths of <100 ft (for divers); minimum visibility of 1-2 ft; escape issues		Helicopter and equipment limitations; spill must be accessible by the limits of round-trip travel using helicopters
Pros	Accurate determination of oil under ice; verbal and visual description of extent and thickness of oil and spatial variations	Low cost	Allows responders to travel into the virtual landscape in order to view the environment from different perspectives, allowing a quick response to a number questions.
Cons	Slow; difficult to accurately locate deposits without GPS; decon of dive gear can be costly/time-consuming; health and safety issues of supreme importance.	Inability to discriminate oil from debris on ice and when oil is mixed with slush ice. Sometimes oil-in-water emulsions are not detected.	New technology; not readily available; experienced personnel not readily available; large size, weight, and high cost.

Table 9. Continued.

	Radar	Acoustic Detection	Auger and Underwater Lights
Description		Using ___, oil is detected in ice because the oil behaves as a solid and transmits a sheer wave that can be detected.	Using an auger, drill hole in ice to find oil. Can also use underwater lights to assist in looking for oil under the ice through the auger hole
Equipment Availability		Prototype	
Logistical Needs			
Coverage Rate			
Data Turnaround			
Probability of False Positives	High; up to 95% false targeting.		
Operational Limitations			
Pros	Allows only potential for large area searches and foul weather remote sensing		
Cons	Costly, requires a dedicated aircraft, and is prone to many interferences.	New technology; not readily available.	

Table 10. Response Options Specific for Containing and Recovering Oil Spilled in Ice.

	Fast Water Booming	Sorbents	Bioremediation Agents	Dispersant	Elasticity Modifier	Emulsion Treating Agents
Inland Waters (see page 10 for definition)						
Oil on Ice	?	●	?	✕	✕	●
Oil Mixed in Broken Ice	?	?	●	●	●	●
Oil Frozen in Ice	✕	✕	?	✕	✕	✕
Oil Trapped Under Ice	?	✕	✕	✕	?	✕
Coastal Waters (see page 10 for definition)						
Oil on Ice	?	●	?	✕	✕	●
Oil Mixed in Broken Ice	?	?	●	●	●	●
Oil Frozen in Ice	✕	✕	?	✕	✕	✕
Oil Trapped Under Ice	?	✕	✕	✕	?	✕
Adjacent Lands (see page 10 for definition)						
Oil on Ice	N/A	●	●	N/A	N/A	●
Oil Mixed in Broken Ice	N/A	●	●	N/A	N/A	?
Oil Frozen in Ice	N/A	?	?	N/A	N/A	✕
Oil Trapped Under Ice	N/A	?	?	N/A	N/A	✕

KEY

● Considered to provide value as a response option for this situation.

? May provide value as a response option in this situation.

✕ Not considered a viable response option in this situation.

I Insufficient information- impact or effectiveness of the method could not be evaluated

N/A Response option not applicable for this situation

Table 10. (Continued).

	Fire-fighting Foams	In situ Burning On Land	In Situ Burning On Water	Manual Recovery	Natural Attenuation	Pre-Treatment Agents
Inland Waters (see page 10 for definition)						
Oil on Ice	I	N/A	●	?	I	●
Oil Mixed in Broken Ice	I	N/A	●	?	I	●
Oil Frozen in Ice	I	N/A	✕	●	I	●
Oil Trapped Under Ice	I	N/A	✕	?	I	●
Coastal Waters (see page 10 for definition)						
Oil on Ice	I	N/A	●	?	I	?
Oil Mixed in Broken Ice	I	N/A	●	?	I	?
Oil Frozen in Ice	I	N/A	✕	●	I	?
Oil Trapped Under Ice	I	N/A	✕	?	I	?
Adjacent Lands (see page 10 for definition)						
Oil on Ice	I	●	N/A	●	I	●
Oil Mixed in Broken Ice	I	?	N/A	?	I	●
Oil Frozen in Ice	I	✕	N/A	●	I	●
Oil Trapped Under Ice	I	✕	N/A	?	I	●

KEY

● Considered to provide value as a response option for this situation.

? May provide value as a response option in this situation.

✕ Not considered a viable response option in this situation.

I Insufficient information- impact or effectiveness of the method could not be evaluated

N/A Response option not applicable for this situation

Table 10. (Continued)

	Solidifier	Surface Collecting Agent	Surface Washing Agent
Inland Waters (see page 10 for definition)			
Oil on Ice	●	?	N/A
Oil Mixed in Broken Ice	●	●	N/A
Oil Frozen in Ice	✕	✕	N/A
Oil Trapped Under Ice	?	●	N/A
Coastal Waters (see page 10 for definition)			
Oil on Ice	●	?	N/A
Oil Mixed in Broken Ice	●	●	N/A
Oil Frozen in Ice	✕	✕	N/A
Oil Trapped Under Ice	?	?	N/A
Adjacent Lands (see page 10 for definition)			
Oil on Ice	●	?	●
Oil Mixed in Broken Ice	●	?	●
Oil Frozen in Ice	✕	✕	?
Oil Trapped Under Ice	●	✕	●

KEY

● Considered to provide value as a response option for this situation.

? May provide value as a response option in this situation.

✕ Not considered a viable response option in this situation.

I Insufficient information- impact or effectiveness of the method could not be evaluated

N/A Response option not applicable for this situation

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Response Strategies for Tire Fires
(to reduce production of pyrolytic oil residue)

Description

- An estimated 270 million vehicle tires are disposed of each year in the United States. The management of scrap tires has become a major economic and environmental issue. Although responsible means for disposal, such as recycling, reuse and energy recovery have become more common, the tire dumps of the last forty to fifty years continue to present environmental and safety hazards that will last into the foreseeable future.
- Waste tires are made using approximately 2.5 to 7 gallons of crude oil, mixed with vulcanized or cross-lined polymers, carbon black, dispersing oils, sulfur, synthetic fibers, pigments, processing chemicals, and steel or fiberglass. These components make tires readily combustible, and a potential hazard that must be addressed and planned for.

Table 11. Typical Tire Composition: Passenger Tire Recipe. (Taken from CA IWMB's LEA Advisory # 46, 1997).

Materials	Percentage
Styrene butadiene	46.78%
Carbon black	45.49%
Aromatic oil	1.74%
Zinc oxide	1.40%
Antioxidant 6C	1.40%
Sulfur	1.17%
Stearic acid	0.94%
Accelerator CZ	0.75%
Wax	0.23%

Understanding the Problem

- There are many tire dumps, legal and illegal, that exist throughout the United States. There are decreasing landfill options for used tires and the risk of fire is great.
- Most tire fires are started by arson and generate large amounts of heat, and smoke which makes them extremely difficult to extinguish. Some tire fires burn for months (e.g., the Rhinehart tire fire in Winchester VA burned for nearly 9 months).
- The intense heat also leads to the generation of pyrolytic oil (and other incomplete combustion by-product); a standard passenger car tire can generate about two gallons of pyrolytic oil as it burns and liquefies. The oil mixes with the extinguishing material, and can lead to contaminated soils, surface and ground waters in the surrounding area.

- Traditional fire department tactics have included smothering or cooling the fire with water or foam to extinguish it. The resulting efforts often generate incomplete combustion products, pyrolytic oils, smoke, and other toxic waste products.
- The environmental consequences of major tire fires are significant. A tire fire in Rhinehart, Virginia issued a plume of smoke 3,000 feet high and 50 miles long with fallout reported in three states. This fire also threatened the drinking water in the District of Columbia with lead and arsenic contamination.
- During periods of inverse atmospheric conditions, the contaminants will be kept close to the earth and will cause further problems to the community of population. This could result in Shelter in Place or other public protective actions for citizens with respiratory problems.

What to Do

- In recent times, there have been several fire incidents where the decision was made to allow the tire piles to burn to reduce the amount of polluted water runoff and hazardous smoke generation.
    - the Sinclaireville Fire Department in New York (in charge of the Chautauqua County Tire fire in April 1995),
    - the Manitoba Conservation along with local fire departments (in charge of the April 2001 tire fire west of Winnipeg, Manitoba, Canada), and
    - the Roanoke County Fire and Rescue Department (in charge of the March, 2002 Roanoke, VA Buck Mountain tire fire),
- These agencies had pre-determined that their response efforts would be best served by only addressing any resultant brush fires, rather than trying to douse the tire fires. Roanoke County Fire and Rescue Chief Richard Burch was quoted stating that "The hotter [the pile] burns, the faster it consumes the tires, and the less smoke and runoff we will have" (Roanoke Times, March 25, 2002).

Authority Required

- **RRT approval is not required** for the use of conventional response techniques, but operations personnel should coordinate with appropriate state and local authorities with respect to the use of fire fighting foams.
- **Incident-specific RRT approval is required** to use an applied technology in the open environment **unless used to prevent**
- Examples of agencies with trustee and functional responsibilities during a tire fire would be:

    (a) State and local Police

    (b) Public Works agencies

    (c) State Department of Emergency Management

(d) Regional offices of the Federal Emergency Management Agency (FEMA)

(e) Regional, State or Federal Environmental Protection Agency (EPA)

(f) State Division/Department of Natural Resources or State Forestry Agency

(g) State Fire Marshal's office

(h) Finance, Purchasing and Budget agencies

Availability

- Response strategies for fighting tire fires and dealing with incomplete combustion products (smoke and pyrolytic oils) must be:
  - Well thought out;
  - Practiced b well-trained, properly equipped, and experienced crews under controlled conditions; and
  - Refined prior to implementation during an actual spill response.
- Each product or technology is evaluated for potential functionality for dealing with tire fires, both in assisting with fire suppression and runoff recovery. See Table 14 for a review of each product/technology, its applicability for addressing suppression of the tire fire, and addressing the need to collect/contain any pyrolytic oil produced as a result of incomplete combustion from the use of these products and technologies for the long-term cleanup needs.

NOTE:
Many of these suggestions found in Table 14 are untried, and are only considered potential response options. Small-scale field-testing of these products and technologies is highly recommended to ensure effectiveness and efficacy.

Health and Safety Issues

- Human health and safety are of primary concern, particularly for response operations in general and specifically threats from air contaminates.
- Tire fires can pose a significant health problem for humans, animals, and the environment. Smoke and a wide variety of incomplete combustion products are generated during scrap tire fires, including:
  - ash (carbon, zinc oxide, titanium dioxide, silicon dioxides, etc.),
  - sulfur compounds (carbon disulfide, sulfur dioxide, hydrogen sulfide),
  - polynuclear aromatic hydrocarbons, which are usually detected in oil runoff (such as benzo(a)pyrene, chrysene, benzo(a)anthracene, etc),
  - aromatic, naphthenic, and paraffinic oils,
  - oxides of carbon and nitrogen,

  - particulates,
  - pyrolytic oils, and
  - various aromatic hydrocarbons including toluene, xylene, benzene, etc.
- These incomplete combustion products are extensive and vary depending on factors such as tire type, burn rate, pile size, ambient temperature and humidity, among others.
- A safety officer should be established immediately to address the need for exclusion zones, personal protection equipment (PPE) for all response personnel, and to ensure that these requirements are being followed.
- All personnel should be equipped with appropriate personal protective gear and be fully instructed in its use. Personal protective clothing (turn-out gear) and self-contained breathing apparatus (SCBA) meeting NFPA standards should also be worn by all personnel working in, or exposed to, the products of combustion.
  - The ash produced in tire fires has been shown to contain high concentrations of heavy metals, including lead, cadmium, and zinc. The CA IWMB reports that the Total Threshold Limit Concentration (TTLC) for zinc should not exceed 5,000 mg/kg.
  - Dermal or skin contact with contaminated materials should be avoided at all times. The metals act as primary irritants by removing the surface film, disturbing the water-holding quality of cells, and injuring the membrane structure of the epidermal cells (CA IWMB LEA Advisory 46).
- The smoke plume may contain hazardous substances that should not be inhaled or allowed to contact the skin. The two substances that are of greatest concern relative to excessive exposure are PAHs and carbon monoxide.
- Increased incidence of respiratory problems, especially in high risk or sensitive populations that include people with chronic lung or heart disease, such as asthma, emphysema, chronic bronchitis, angina, or congestive heart failure.

Pre-incident Planning Needs:

To address tire fires, the following should be considered (much of this list was taken from the IAFC and Scrap Tire Management Council, 2000, publication):

- Pre-incident plans should be developed to identify the special considerations and hazards of a particular site or property so that responding units will know what to expect and how to proceed during initial operations. Pre-incident plans must accommodate the agency's standard operating procedures and specify exactly how those procedures are to be applied should a fire break out at a given location.
- There will be great public concern over the polluting of the air primarily due to the highly visible, thick, black smoke plume from the fire. This is a short-term problem. Air Quality monitoring should be addressed immediately. The incident commander may require the evacuation of population facilities that are directly affected by the smoke plumes.

- A safety officer should be established immediately to address the need for exclusion zones, personal protection equipment (PPE) for all response personnel, and to ensure that these requirements are being followed.
- A detailed health and safety plan must be developed. Exclusion zones, contamination reduction zones, and decontamination zones are all recommended as part of the response to a tire fire.
- The potentially hazardous effects of rubber fire emissions, the physical exertion required to fight such fires, the intense heat, and the often unsanitary conditions of dumps all present unique dangers to fire fighters that need to be recognized as priority health and safety concerns.
- The potential for run-off into, and pollution of, natural resources is a significant concern and should be addressed during size-up. If necessary, immediate efforts should be made to contain pollution from the fire and master-stream runoff.

Limiting Factors/Environmental Constraints

- Scrap tire piles are breeding grounds for millions of mosquitoes, rodents, and snakes. Personnel may need special protection from fleeing rodents, reptiles, and from insects. All food preparation facilities should be enclosed.
- Contaminated run-off water due to the fire fighting and rain needs to be contained and treated. Water sampling of surface waters and ground waters near the tire fire site should be conducted throughout the incident to determine if they are being contaminated by the pyrolytic oil and other compounds resulting from the tire fire.
- Because burning tires can yield oil, officials might require responders to assess the feasibility of taking action to deal with these oils. General response options include:
  - Restrict access to the site
  - Construct dams, ditches, ponds for the collection of drainage waters;
  - Extensive excavation may be required
  - Institute soil erosion controls
  - Collect and treat surface water runoff with gravity settling
  - Collect shallow ground water oily seeps
  - Conduct oil-water separation and transportation to waste water treatment facilities.
  - Skim off hydrocarbons (oil) from runoff and the residual water can be recycled for use on the incident.

Monitoring Requirements/Suggestions

- Monitoring is very important during the actual burn.
- Air sampling and analysis to determine the particulate loads in the plume should be monitored throughout the incident to ensure worker and public safety.

- The plume should be monitored in terms of the particulate matter (PM) that is smaller than 10 microns in diameter. These small particles are easily respired and drawn deeply into the lungs where they can lodge in the lungs and cause damage. Table 12 provides a summary of the USEPA National Ambient Air Quality Standards for particulate matter.
- Table 13 provides a summary of the Air Quality Standards that were specified for response workers during the Filbin Tire Fire in Stanislaus County, California.
- The migrating oil and fire fighting residue needs to be collected/recovered and the site should be evaluated for soil, surface and groundwater contamination. This waste must be considered hazardous material and treated accordingly.
- Monitoring of surface and ground waters should be conducted as soon as possible.

Table 12. National Ambient Air Quality Standards for criteria pollutants of concern during tire fires. Based on the 1997 EPA Revised Particulate Matter Standards.

Criteria Pollutant	Primary Standard	Secondary Standard
Carbon Monoxide		
8 hour average	9 ppm or (10 mg/m^3)	9 ppm or (10 mg/m^3)
1 hour average	35 ppm or (40 mg/m^3)	35 ppm or (40 mg/m^3)
Sulfur Dioxide		
Annual Average	0.03 ppm or (80 µg/m^3)	—
24 hour average	0.14 ppm or (365 µg/m^3)	—
3 hour average	—	0.50 ppm or (1,300 µg/m^3)
Inhalable Particulates (PM 10)		
Annual Average	~0.02 ppm or (50 µg/m^3)	~0.02 ppm or (50 µg/m^3)
24 hour Average	~0.07 ppm or (150 µg/m^3)	~0.07 ppm or (150 µg/m^3)

Table 13. Example of Air Quality Categories for the Filbin Tire Fire. (Taken from the California Office of Environmental Health Hazard Assessment, Integrated Waste Management Board for the Filbin Tire Fire in Stanislaus County, California (1999)).

Air Quality Index Category	PM 10 Reading	Potential Health Effects	Health Protective Action
Good	0-49	None	None
Moderate	50-149	Beginning of respiratory symptoms in very sensitive people	Very Sensitive* persons should begin to limit outdoor exertion
Unhealthy for Sensitive* Groups	150-249	Increased respiratory symptoms and aggravation in sensitive people; possible respiratory effects in general populations	Sensitive* persons should limit outdoor exertion
Unhealthy	250-349	Significant increased respiratory symptoms and aggravation in sensitive people; increased likelihood of respiratory effects in general population	Sensitive* persons, the elderly, and children should avoid outdoor exertion; everyone else should limit prolonged outdoor exertion
Very Unhealthy	350-424	Serious risk of respiratory symptoms and aggravation in sensitive people; respiratory effects likely in general population.	Sensitive* persons, the elderly, and children should avoid any outdoor activity; everyone else should limit prolonged outdoor exertion
Hazardous	425+	Serious risk of respiratory symptoms and aggravation in sensitive people; respiratory effects likely in the general population	Everyone should avoid outdoor exertion; sensitive* persons should remain indoors or evacuate

*Sensitive Groups: people with chronic lung or heart disease, such as asthma, emphysema, chronic bronchitis, angina, or congestive heart failure.

Waste Generation and Disposal Issues

- Many states have regulations regarding the disposal of tire fire debris. In some states, the solid tire fire debris is classified as solid waste and must be disposed of in approved landfill facilities.
- The debris remaining following the cessation of the tire fire burn includes large quantities of pyrolytic oils and oily waters (containing polyaromatic hydrocarbons (PAH) and other metals such as cadmium, chromium, nickel and zinc) and ash that also contains high concentrations of heavy metals (zinc, lead, or arsenic).

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California Integrated Waste Management Board (CA IWMB). 1996. Evaluation of Employee Health Risk From Open Tire Burning. LEA Advisory # 46 – November 6, 1997. Publication No. 232-97-019. Available from the web at: www.ciwmb.ca.gov/LEAAdvisory/46/default.htm.

USEPA Office of Air Quality Planning and Standards. 1997. National Ambient Air Quality Standards (NAAQS).

Who to Call for More Information and Additional Resources

Building and Fire Research Laboratory, NIST. Gaithersburg, MD. Phone: 301-975-5900

NOAA HAZMAT/SSC, General contact number: 206-526-6317

USEPA

International Association of Fire Chiefs. Fairfax, VA. Phone: 703-273-0911

National Fire Prevention Association. Quincy, MA. Phone: 617 770-3000

Local Fire Departments

State Fire Marshall

Local Emergency Planning Commissions

Table 14. Tire fires and the potential uses of products and strategies listed in the Selection Guide.

	Use on the fire (to put out or increase effectiveness of the burn)	Use to stop flow of pyrolytic oils (produced by fire)	Long Term Cleanup
Water	●	✕	?
Sorbents	● (s)	●	●
Bioremediation Agents	**N/A**	**N/A**	●
Dispersants	✕ (d)	**N/A**	**N/A**
Elasticity Modifiers	✕	?	**N/A**
Emulsion Treating Agents	? (e)	**N/A**	**N/A**
Fire-Fighting Foams	●	●	**N/A**
In Situ Burning	● (b1)	? (b2)	?
Solidifiers	?	●	?
Surface Collecting Agents	**N/A**	?	?
Surface Washing Agents	**N/A**	● (sw)	?
Shoreline Pre-Treatment Agents	**N/A**	?	?
Oil Tracking	**N/A**	● (ot)	●

(s) Wet sorbents have been used to prevent the advance of forest fires

(d) Dispersants may function as vapor suppressants (?); when mixed with water they might act like the wetting agents in Class A fire fighting foams?

(e) Emulsion Treating Agents may function as to assist the burn of pyrolytic oils if ISB is considered as an option for removal (?)

(b1) In Situ Burning can be used to create fire breaks and igniters may assist in a more complete combustion of the tire piles (?)

(b2) In Situ Burning may be able to be used on pyrolytic oils (?)

(sw) Surface Washing Agents can be used for spot cleanup on paved areas

(ot) Various Oil Tracking methods should be used when pyrolytic oils enter surface or ground waters

KEY

●	Considered to provide value as a response option for this situation.	**I**	Insufficient information- impact or effectiveness of the method could not be evaluated
?	May provide value as a response option in this situation.	**N/A**	Response option not applicable for this situation
✕	Not considered a viable response option in this situation.		

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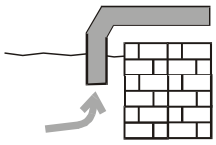


WATER INTAKE MONITORING STRATEGIES

Description

- Monitoring of water intakes at risk of contamination during an oil spill is needed to protect both human health and the water treatment facility. The objective is to detect and track the presence of petroleum hydrocarbons in the water body, as a warning system for downstream users, and at the intake point to protect water supplies.

When to Use

- In a body of water, such as a river or lake, to track the spread and downstream transport of oil in the water column. This information can be used to initialize and calibrate trajectories for the prediction the movement of the leading edge of the plume, the zone of maximum contaminant concentration, and the behavior of the trailing edge.
- At a water intake, either just outside of the intake piping (at the intake depth) or from the raw water feed, to decide when to shut down or re-start water flow.
- In addition to public water supply intakes, consideration should also be made for industrial and agricultural water intakes.

Methodology

There are four basic approaches for detecting petroleum hydrocarbons in water:

1) Visible Sheen – A visible sheen near water intakes is a simple way of detecting oil presence. This is not quantitative or oil-specific.

2) Taste and odor - a standard analysis of raw and finished water quality conducted by drinking water treatment facilities, but this is not quantitative or oil-specific.

3) Collection of individual samples for chemical analysis. Analyses can include:

MTBE – **M**ethyl **t**ertiary **b**utyl **e**ther; a gasoline additive.

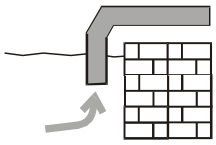
BTEX – volatile aromatic compounds of **b**enzene, **t**oluene, **e**thyl benzene, and the **x**ylenes using EPA Method SW-846.

TPH (total hydrocarbons) – the actual compounds measured vary widely by method.

PAHs (polynuclear aromatic hydrocarbons) – using a modified EPA Method 8290 to include alkyl homologues of the prominent PAHs in oil; also can be used to fingerprint the oil

Pros: Individual compounds can be measured by gas chromatography/mass spectrometry (GC/MS). Most laboratories can measure BTEX, which are of greatest concern. Detailed chemical analyses are very appropriate for supporting decisions to close/re-open intakes.

Cons: Even with a nearby laboratory and rapid-turnaround, it often takes 1-2 days for results to be available. Thus, there is no real-time feedback on where the



plume is and how to optimize sample collection to delineate the plume. Costs can be very high plus a rapid-turnaround premium for GC/MS analyses.

4) Field fluorometry. Fluorometers measure the natural tendency of some compounds to fluoresce after adsorbing ultraviolet (UV) light. In its simplest form, a fluorometer is a black-box containing a light-transparent cell to contain the sample, a UV lamp (excitation source), a series of optical filters that increase selectivity, a photomultiplier, and a recorder. Configured as a flow-through system, the instrument can be connected to the raw water feed at a water treatment plant, or deployed on a boat with a pump and hose that can be lowered into the water column. In this manner, continuous readings are made. The Ohio River Valley Water Sanitation Commission (ORSANCO) developed a system consisting of a field fluorometer and a flow-through system that is mounted on a boat and able to function at speeds up to 30 miles per hour. This system was devised during the Ashland oil spill in 1988 and was successfully used during two releases to the river of ethylene dibromide and methyl carbamate in 1994.

Pros: Provides rapid, real-time detection and tracking of oil in the water column. The intake can be towed to track the length of the plume, or lowered through the water column to produce a profile of oil concentrations with depth.

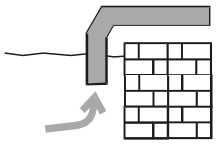
Cons: Fluorometer detector response values vary with oil composition and weathering. To convert detector response to a concentration value, a calibration curve must be derived using the spilled oil. Furthermore, oil in the water column is likely to be a mixture of dispersed and dissolved oil; fluorometers work best on analytes in solution. The minimum detection limit of dispersed oil is directly related to the ability of the instrument to differentiate oil fluorescence from that of background (which is from suspended sediments, algae, and tiny animals that may contribute to background fluorescence or adsorb fluorescence).

Health and Safety Issues

- Consider boating safety issues when using field fluorometers on boats.
- Evaluate potential for inhalation hazards to survey teams during spills of volatile oils.

Limiting Factors/Environmental Constraints

- When using fluorometry, it is important to also collect water samples for detailed chemical analysis. The quantitative values obtained from field water samples can be used to establish a response curve to convert raw field response values into "true" concentrations, especially as the oil weathers.
- There are no Federal water quality guidelines for when to shut down water intakes, or when it is safe to re-open them. Each state has its own guidelines. Federal drinking water quality standards for individual organic compounds in finished water that may apply to oil spills are listed below (Table 15). Health advisories may be more appropriate for spill events since they address short-term exposure to contaminants.



- Most of the standard water-quality analyses conducted by water treatment facilities, such as oil and grease, total organic carbon, and taste and odor, are not appropriate for oil spills because they have high detection levels and are not specific to oil. Taste and odor may be useful, in conjunction with chemical analyses, to determine when water quality has returned to normal.
- The standard "priority pollutant" PAH organic compound analysis (EPA Method 8270) is also not appropriate for oil spills since it does not measure the dominant petroleum compounds in oil.
- The application of a dispersant would increase the potential for water intake contamination.

Table 15. Federal Drinking Water Standards for Individual Organic Compounds. One-day and 10-day health advisories listed are based on a 10-kg child.

		Health Advisory	
Compound	**Water Quality Standard (mg/l)**	**1 day (mg/l)**	**10 day (mg/l)**
Benzene	0.005	0.2	0.2
Benzo (a) pyrene	0.0002	-	-
Ethylbenzene	0.7	30.0	3.0
Toluene	1.0	20.0	2.0
Xylenes	10.0	40.0	40.0
MTBE	0.013		

References

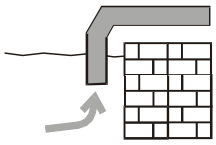
Cremeans, W.L., R.M. Meyer, and G.P. Kincaid. 1998. High-speed system for synoptic assessment of riverine near surface water-quality conditions and spill response. U.S. Army Corps of Engineers, Water Quality Section, Huntington District, 7 pp.

Henry, C.B., Jr., P.O. Roberts, E.O. Overton. 1999. A primer on *in situ* fluorometry to monitor dispersed oil. In: Proceedings of the 1999 International Oil Spill Conference, American Petroleum Institute, Washington, DC. Pp. 225-228.

Who to Call for More Information and Additional Resources

USEPA Oil Program Center, Washington, DC 703-603-9918

California DHS Drinking Water Program, Berkeley, CA 94704
Phone: 510-540-2177;
http://www.dhs.ca.gov/ps/ddwem/publications/regulations/regulations/index



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BIOREMEDIATION AGENTS
(A Category on the NCP Product Schedule)

Mechanism of Action

The objective of bioremediation is to accelerate the rate of hydrocarbon degradation due to natural microbial processes by:

Nutrient Enrichment - addition of nutrients (generally nitrogen and phosphorous) to stimulate microbial growth. Assumes nutrient availability is a limiting factor. Also called biostimulation.

Natural Microbe Seeding - addition of high numbers of oil-degrading microorganisms. Assumes indigenous hydrocarbon degraders are low in number or not effective at degrading the oil. Will require addition of nutrients if not included in the microbe product. Also called bioaugmentation.

- The ultimate end products are carbon dioxide and water.
- Some products contain surfactants to break up the oil into droplets, increasing the surface area of the hydrocarbons and thus the rate of microbial degradation.

When to Use

- After other techniques have been used to remove free product and gross contamination.
- When further oil removal is likely to be destructive, ineffective, or cost-prohibitive.
- Nutrient Enrichment: when nutrients are limiting rates of natural biodegradation.
- Natural Microbe Seeding: when indigenous hydrocarbon microbes capable of degrading hydrocarbons are present in low numbers (<106/gram sediment)

On Water:

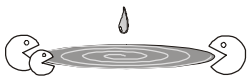
- CONSIDER for sheens and sediment contamination in small, static water bodies such as natural ponds and man-made lagoons; aeration may be needed to maintain oxygen levels
- NOT for use on oil slicks on flowing water, such as rivers, streams, and large lakes
- NOT for gasoline spills (since it will quickly be removed by evaporation without treatment)

On Land:

- YES for many conditions, esp. where the substrate can be tilled, irrigated, etc.
- CONSIDER for thick or highly weathered oils on shorelines or land surfaces

Authority Required

- **Incident–specific RRT approval is required**; Products **must** be on the NCP Product Schedule in order to be considered for use.
- **NOTE**: As of December, 2002, there were 14 bioremediation agents on the NCP Product Schedule.



- Verify need for applicable state requirements.
- Prior to listing, products must submit efficacy test results to be listed on the Product Schedule. The evaluation criteria were established by a scientific panel under the USEPA Bioremediation Action Committee and are noted as minimal standards for acceptance.
  - The test uses Alaska North Slope crude oil with water-oil control, oil-nutrients, and oil-agent.
  - Samples are taken at day 0, 7, and 28 for GC/MS analysis of alkanes and aromatics, and gravimetric change in weight after 28 days.
  - The standard for listing is: The products need to perform statistically significantly better than the control.
  - The conditions of the efficacy test are ideal: closed, well-mixed flasks where neither nutrients nor microbes are lost from the system, competition from indigenous microbes is minimal, and aeration is good.
  - Performance in the field will most certainly differ.

Availability

- Seldom an issue since they are not used in the emergency phase of a spill. See Table 16 for product-specific availability.

General Application Requirements

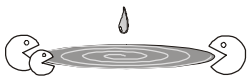
- Liquid products are diluted in water and applied with spray system. Dry products are applied by hand or powder spray systems.
- Frequent re-application is required for nutrients dissolved in water and sprayed as a dilute solution, depending on the rate of wash out (fast for intertidal areas, slower for rainfall infiltration);
- Granular or encapsulated nutrients dissolve more slowly.
- For oiled soils, products need to be mixed into the material (adding nutrients, if required), by tilling or disking.
- Regular tilling or other means of aeration is needed to maintain minimum oxygen levels.
- Irrigation may be needed to maintain minimum moisture levels.

Health and Safety Issues

- All products have to be tested to show that they do not contain pathogens.

Limiting Factors/Environmental Constraints

- Microbial degradation of hydrocarbons requires: microbes, nutrients, oxygen, moisture, and TIME. Any of these factors can be limiting.



- Degradation proceeds faster at warm temperatures (>60°F), neutral pH (optimum is 7-8.5), and high surface area of the contaminant.
- Expect degradation to take months to years, especially where control of moisture, temperature, mixing rate, etc. is limited.
- Avoid using ammonia-based fertilizers adjacent to waterbodies because un-ionized ammonia is toxic to aquatic life at very low levels. Nitrate is just as good a nitrogen source, minus the toxicity.
- Check fertilizers for their metal content since some common fertilizers contain relatively high levels of metals.

NOTE:
The NCP Subpart J does not explicitly require toxicity testing of bioremediation products. At EPA's discretion, bioremediation agents that contain ingredients such as surfactants and other chemicals, or any other component the EPA designates may cause harm to the environment, may be required to perform the (LC50) toxicity test currently required for all other NCP Product Schedule product categories. Manufacturers of products may have performed their own toxicity tests. For questions relating to toxicity of bioremediation products, please refer to the Oil Program Product Schedule Manager, Mr. William (Nick) Nichols at the USEPA Oil Program Center, Washington, DC. Phone: 703-603-9918.

Monitoring Requirements/Suggestions

- Monitoring is required to ensure that target moisture, nutrient (2-5 mg nitrogen/liter), and oxygen (2 mg/L) are being maintained, and determine re-application rates.
- Take samples before and at set intervals after treatment to determine that degradation is occurring and at sufficient rates. Specialized chemical analyses are needed to prove degradation (GC/MS of alkanes and aromatics). Sampling plan should cover the expected duration of degradation (months after treatment).

Waste Generation and Disposal Issues

- Effective use of bioremediation agents should significantly reduce the amount of oily wastes generated.

References

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Venosa, A.D., J.R. Haines, W. Nisamaneepong, R. Govind, S. Pradhan, and B. Siddique. 1992. Efficacy of commercial products in enhancing oil biodegradation in closed laboratory reactors. J. Ind. Microbiol. 10:13-23.

Wrenn, B.A., J.R. Haines, A.D. Venosa, M. Kadkhodayan, and M.T. Suidan. 1994. Effects of nitrogen source on crude oil biodegradation. J. Ind. Microbiol. 13:279-286.

Wrenn, B.A., M.T. Suidan, K.L. Strohmeier, B.L. Eberhart, G.J. Wilson, and A.D. Venosa. 1996. Nutrient transport during bioremediation of contaminated beaches: Evaluation with lithium as a conservative tracer. Wat. Res. 31:515-524.

Who to Call for More Information and Additional Resources

USEPA-ORD, 26 West Martin Luther King Dr., Cincinnati, OH 45268
Phone: 513-569-7668

NOAA-HAZMAT, Seattle, WA 98115 Phone: 206-526-6317

USEPA Oil Program Center, Washington, DC. Phone: 703-603-9918

Table 16. Characteristics of Bioremediation Agents Listed on the NCP Product Schedule (as of December, 2002).

	BET BIOPETRO	BioGee HC	INIPOL EAP 22	Land and Sea 001	Micro-Blaze
General Description	Powder	Liquid	Oleophilic liquid	Tan dried and ground plant material	Concentrated, white liquid; perfumed; when mixing, add product to water or solution will foam.
Active Ingredients	NP	Microbes	Nutrients	Microbes, Nutrients	Nutrients, Microbes, and Surfactants
Nutrient Composition	NP	NP	Microemulsion	NP	NP
How does it change the oil behavior?	NP	No immediate change	Softens the oil; can cause oil to lift off substrates	Immediate protection to flora and fauna; Changes oil from a liquid to a non-sticking solid	Surfactant cleaves oil droplets into molecules small enough for microbes to effectively digest.
Availability (amount per location)	NP	NP	NP	10 tons - San Antonio, TX	10,000 gal, Houston, TX
Application Rate	Varies. Contact BET for specific technical advice	1 gal/yd^3 soil; 0.25 gal/1,000 ft^2 water surface	1:10 product to oil	1:3 product to oil	Spills-1:10, product to oil, as 3-6% solution; Soil- 1 gal per 10 yd^3 at 3-6% solution
Application Method	Contact BET for specific technical advice.	Spray	Spray product neat onto oiled surfaces	On water, spread over contaminated area at 1 to 3 ratio. On soil, blend to depth equivalent to contamination level.	Mix in hand-held sprayers; educt into spray systems; pour concentrate directly on oil**;** in all cases, use broom or pressurized water stream to agitate the solution; then rinse clean with water and vacuum up liquids; **do not** discharge untreated solution to waterbodies.
Temperature Limitations	45°-100°F	34-140°F; optimal is 83°F	>52°F	32 to 135°F; optimal is 77-86°F for microbe activity	>32°F
EPA Efficacy Test (Reports % reduction of components over a 28 day period)	Alkanes: 99% Aromatics: 67% Gravimetric weight decrease: 30%	Alkanes: NP Aromatics: NP Gravimetric weight decrease: 13%	Alkanes: 94% Aromatics: 23% Gravimetric weight decrease: 50%	Alkanes: 43% Aromatics: 32% Gravimetric weight decrease: 25%	Alkanes: 94% Aromatics: 48% Gravimetric weight decrease: 12%
Use in Fresh Water?	Yes	Yes	Yes	Yes	Yes

	BET BIOPETRO	BioGee HC	INIPOL EAP 22	Land and Sea 001	Micro-Blaze
Use in Salt Water?	Yes	Yes, salinity may have slight effects	Yes	Yes	Yes, but effectiveness is reduced above 10% salinity
Inland Silversides 96h	NP	NP	135	NP	NP on NCP; 1390 value provided by vendor
Mysid Shrimp 48h	NP	NP	23	NP	NP on NCP 1230 value provided by vendor
Solubility in water	NP	Assume 100% soluble	Dispersible	Not Applicable	99% soluble
Other Information	Product works at pH 5.5-8.5 and dissolved oxygen level of 3 to 5 mg/l.	Product works at pH 4.5-9.5, optimally at pH 7.0	Does not contain trace metals	Optimum pH of 6 – 8	Use as a grease digester in wastewater systems; storage tank cleaning of benzene and other organics; long term bioremediation projects in soil.
Application Assistance Information*	BioEnviroTech 281-351-5594 800-758-3253	RMC Bioremediation 318-219-3929 Fax: 318-219-3920 www.rmcbio.com	Elf Aquitaine 202-659-1810	Land and Sea Restoration LLC 210-650-5556	Verde Environmental, Inc. 713-691-6468 800-626-6598 Garner Environmental Services- 409-935-0308 www.micro-blaze.com
Unit Cost **	NP	NP	NP	$60 per bag	$25.00 $40.00 per gal.
Photograph of Product (photos are added as they become available)					

NP = Information Not Provided

* For additional technical assistance on product application, contact the supplier listed on the NCP Product Schedule Notebook.

** Unit costs are based on 2002 information supplied by the vendors, where provided. For a more up-to-date cost estimate, contact the supplier listed in the NCP Product Schedule. Generally, product prices decrease as purchase volume increase, and may also vary between distributors. Product application rates often vary greatly depending on use.

Table 16. Continued.

	Oil Spill Eater II	Oppenheimer Formula	Pristine Sea II	PRP	S-200
General Description	Amber liquid, ferment smell	Powder	Biological Additive Powder or liquid bacterial mixture	Granular, yellow powder (0.25 to 500 micrometers) with a wax coating that makes it float, oleophilic, and hydrophobic	Light amber liquid
Active Ingredients	Nutrients, Enzymes, and Surfactants	Microbes; oil absorbing clay mixed with hydrophobic Archaeobacteria	NP	Enzymes	Nutrients
Nutrient Composition	Nutrient enhancement product with nitrogen, phosphorus, and readily available carbon and vitamins	NP	NP	Enzyme names: oxidoreductases, transferases, hydrolases, lyases, isomerases, and lipases	NP
How does it change the oil behavior?	Emulsifies oil (breaks the oil into droplets) in 3-10 minutes; complete bioremediation occurs in 2-30 days	Will absorb sheens and rainbows	NP	Immediate change – binds the oil. Does not allow the oil to sink or emulsify. Reduces stickiness	Bioremediation accelerator
Availability (amount per location)	1,000-2,000 gal, Dallas, TX	10 tons in Austin, TX	1,500 lbs in Montpelier, ID	10,000lbs.- Houston, TX 10,000lbs.- Houma, LA 60,000lbs- Pittsburgh, PA	NP
Application Rate	1 gal product/50 gal crude oil, as a 2% solution; 1 gal product /100 gal light oil at 1% solution	10 lbs per acre surface on open water; 100 lbs per 1,000 square feet on soil or rocks.	Varies. Contact vendor for assistance.	1:2 product to oil; 50 lb/1,000 ft^2 of contaminated surface, 1 ton of PRP covers 40,000 ft^2 to a depth of ¼ inch	1:10 product to oil; 1 lb/sq. yard of surface area
Application Method	Mix 1-2% solution using ambient water; spray on oiled surface. Reapply if oil persists on water and shorelines. On soils, use same application rate, keep soils moist, till area 1x/week, add more product as needed. Can be applied by any eductor spray system.	Spray dry powder directly or as a water mix with nutrients	"Soak at a rate of 1kg to 4L influent waste and 4L tap-water, or add directly to your system."	Apply dry powder to small spills; for large spills and in open waters, mix or educt with water and spray affected area.	Applied with pressurized sprayers or back pack sprayers
Temperature Limitations	28°F to 120°F; bioremediation slows below 40°F	32-150°F; optimal is 82°F	40°F to 120°F; bioremediation slows below 50ºF	Wax is sensitive to heat at 85°F, melts at 120°F	50-120°F; optimal is 86°F
EPA Efficacy Test (Reports % reduction of components over a 28 day period)	n-paraffins NA Aromatics NA Gravimetric weight decrease: Under Review (contact EPA)	Alkanes: 89% Aromatics: 38% Gravimetric weight decrease: 10%	Alkanes: 96% *(These are 20 d tests)* Aromatics: 90% *(These are 20 d tests)* Gravimetric weight decrease: NP	Alkanes: 12% Aromatics: 3% Gravimetric weight decrease: 1%	Alkanes: 32% Aromatics: 0.05% Gravimetric weight decrease: 28%

	Oil Spill Eater II	Oppenheimer Formula	Pristine Sea II	PRP	S-200
Use in Fresh Water?	Yes	Yes	Yes	Yes	Yes
Use in Salt Water?	Yes	Yes, to 20% salt, optimal is 0.5-3.5%	Yes	Yes	Yes
Toxicity (LC-50, ppm); Note: a low value = high toxicity					
Inland Silversides 96h	NP on NCP; 58 value provided by vendor	NP	NP	NP on NCP: 354,000 (48h) reported by vendor	40
Mysid Shrimp 48h	NP on NCP; 152 value provided by vendor	NP	NP	NP on NCP 68,000 reported by vendor	21
Solubility in water	100% soluble	NP	Non Soluble	Insoluble	
Other Information	Does not contain trace metals. Eliminates adhesion, and reduces fire hazard and toxicity in 3-10 minutes. Light end sheen disappears immediately upon application.	www.obio.com	Improves settling and minimizes foam formation and/or production. No trace metals		
Application Assistance Information*	Oil Spill Eater International 972-669-3390	Oppenheimer Biotechnology, Inc. 512-474-1016	Marine Systems 225-755-7711 702-871-1884	Petro Rem, Inc. 412-279-9745	International Environmental Products, LLC 610-644-4588 or email at info@oilgone.net
Unit Cost**	$.81 per spilled gal light oil $1.62 per spilled gal heavy oil	$30 per lb volume discounts available	$16.50 per lb or $2.48 per spilled gal oil	$12-$20 per lb depending on quantity and purchase location	
Photograph of Product (photos are added as they become available)					

NP = Information Not Provided

* For additional technical assistance on product application, contact the supplier listed on the NCP Product Schedule Notebook.

** Unit costs are based on 2002 information supplied by the vendors, where provided. For a more up-to-date cost estimate, contact the supplier listed in the NCP Product Schedule. Generally, product prices decrease as purchase volume increase, and may also vary between distributors. Product application rates often vary greatly depending on use.

Table 16. Continued.

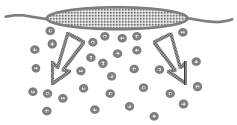
	Step One	System E.T. 20	VB591 Water	Vita-Bugg	WMI-2000
General Description	Liquid	Brown powder	Yellow powder	Powder	Tan powder, with yeast odor
Active Ingredients	Microbes, Nutrients	Microbes	Oleophilic compounds	Nutrients	Microbes
Nutrient Composition	Phosphoric acid	NP	NP	Oleophilic	None; product requires nutrient supplements
How does it change the oil behavior?	Starts digesting oil particles immediately	No immediate change	No immediate change	No immediate change	No immediate change
Availability (amount per location)	Unlimited Amount-Embarrass, MN	Sufficient to treat 2 million yd^3, Houston, TX	15,000 lbs.- Houston, TX	15,000 lbs.- Houston, TX	500-1,000 lb, Houston, TX
Application Rate	Provided by vendor at time of purchase	Varies	5-15 lbs. of product to 1 barrel of spilled oil	5-15 lb/bbl oil; 6 lb/1,000ft^2	1.4 lb/1,000ft^2, inoculation concentration of 5-9 billion spores per gram
Application Method	Provided by vendor at time of purchase	Spray reconstituted organisms, broadcast nutrients, mix into affected soils	Apply with hand held pressurized dust blowers or boat mounted dust blowers. Follow up application recommended after 48 hours.	Use conventional powder spraying equipment to apply product; additional applications at 48-72 h as needed	Activate culture in water for 2 h, then spray or inject, mix in nutrients, and till/aerate
Temperature Limitations	50-135°F; optimal is 70-90°F	41-95°F ; optimal is 39-95°F	None	None	35-100°F, optimal at 45-90°F
EPA Efficacy Test (Reports % reduction of components over a 28 day period)	Alkanes: 44% Aromatics: 55% Gravimetric weight decrease: 51%	Alkanes: 99% Aromatics: 77% Gravimetric weight decrease: 18%	Alkanes: 97% Aromatics: 73% Gravimetric weight decrease: 18%	Alkanes: 97% Aromatics: 73% Gravimetric weight decrease: 18%	Alkanes: 60% Aromatics: 33% Gravimetric weight decrease: 44%
Use in Fresh Water?	Yes	Yes	Yes	Yes	Yes
Use in Salt Water?	Yes	Yes, but salt water adapted bacteria must be specified	Yes	Yes	Yes
Inland Silversides 96h	NP	NP	NP	NP	NP
Mysid Shrimp 48h	NP	NP	NP	NP	85% survival at 2,500 ppm (24h)
Solubility in water	100% soluble	NP	Soluble	Soluble	Soluble

	Step One	System E.T. 20	VB591 Water	Vita-Bugg	WMI-2000
Other Information			.9gm/cc water soluble 2.5gm/100cc oil soluble	www.bionutratech.com 0.9gm/cc- water soluble 2.5gm/100cc oil soluble	Optimal pH 7.0-8.0
Application Assistance Information*	B&S Research Inc 218-984-3757	Quantum Environmental Technologies, Inc. 619-535-0664	BioNutraTech, Inc. 281-894-7471 www.bionutratech.com	BioNutraTech, Inc. 281-894-7371	Waste Microbes, Inc. 713-956-4001 800-460-4507
Unit Cost**	$1.20/yd^2 - $20/yd^2 for water $1.50/yd^3 - $12/yd^3 for soil	NP	$8-$12 per lb.	NP	Unit cost = $25 per lb.
Photograph of Product (photos are added as they become available)					

NP = Information Not Provided

* For additional technical assistance on product application, contact the supplier listed on the NCP Product Schedule Notebook.

** Unit costs are based on 2002 information supplied by the vendors, where provided. For a more up-to-date cost estimate, contact the supplier listed in the NCP Product Schedule. Generally, product prices decrease as purchase volume increase, and may also vary between distributors. Product application rates often vary greatly depending on use.



DISPERSANTS
(A Category on the NCP Product Schedule)

Mechanism of Action

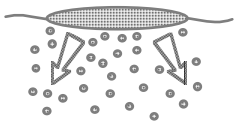
- Mixtures of surfactants and solvents.
  - Surfactants reduce the interfacial tension between oil and water and promote effective delivery of the surfactant to the oil.
  - Solvents dissolve any solid surfactant, reduce the viscosity of the product so it can be sprayed effectively, and promote rapid solubility of the dispersant into the oil.
- Prevents small droplets from recoalescing and forming bigger, more buoyant droplets that float to the surface, re-creating sheens.

When to Use

- When dispersing the oil will cause less environmental impact than surface slicks that will strand on shore or impact sensitive water-surface resources (e.g., birds).
- Dispersants should be considered when other techniques would be inappropriate to use, such as mechanical recovery in rough seas.
- For large spills, consider application to the leading edge or parts of the slick that threatens sensitive shoreline habitats or bird concentration areas. Typical offshore dispersant applications are targeted at the thicker portions of the slick so that more oil can be treated.
- Based on real-time use, 100 % effectiveness is not presently possible. Oil that does not disperse will still need to be addressed by the response.

Authority Required

- **It is the policy of the US EPA to not allow dispersants use in freshwater. Possible exceptions to this policy will be region specific.**
- **Incident-specific RRT approval is required** to use dispersants. **NOTE**: As of December, 2002, there were ten dispersants on the NCP Product Schedule: Corexit 9500, Corexit 9527, Dispersit SPC 1000™, Mare Clean 200, Neos AB 3000, Nokomis 3F-4, PetroBioDispers, and SeaBrat #4 (Table 17).
- Products must achieve an effectiveness of at least 45% dispersion of the oil in laboratory testing to be listed on the Product Schedule.
- For dispersant use/consideration, RRT III requires the following:
  - <u>For waters within established pre-approval zones</u> – at FOSC discretion (Incident-specific RRT notification required) following the guidance of the DRAFT Region III Dispersant Operation Plan provided in Volume II, Dispersants Operations Implementation Plan of this Selection Guide.



- For all other areas – FOSC required to seek incident-specific RRT approval and follow the dispersants use guidance outlined in the Region III Regional Contingency Plan's Memorandum of Understanding (MOU) for Dispersants, in Volume II, Appendices.

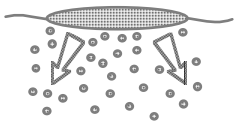
Availability

Dispersant products manufactured in the US are readily available, with stockpiles at selected coastal sites.

- See specific-product tables (Table 17) for amounts and locations.
- Stockpile amounts will change over time.

General Application Requirements

- There are two primary dispersant delivery systems being used today: aerial and vessel-based systems. Backpack type spray systems have been manufactured and used for applying dispersants but their use is not addressed in detail here.
- Aerial spraying systems include spray buckets (payload of 7-21 bbls) deployed from helicopters; specially equipped DC-3 aircraft (payload of 30 bbls); and cargo aircraft fitted with an ADDS (Airborne Dispersant Delivery System) pack (payload of up to 150 bbls).
- There are two primary types of vessel-based delivery systems; spray booms and water monitors or cannons. Depending on boom height, nozzle pattern, and the desired dispersant to oil application ratio, dispersant can be applied from spray booms at full concentration. However, in both spray booms and water monitors, dispersant is usually diluted with seawater. Proportioning of the dispersant is usually accomplished by use of an eductor or a positive displacement metering pump.
- Dispersants are applied using spraying systems at a target treatment rate of 5 gal per acre of oil, to achieve a dispersant to oil ratio of 1:20; application rates will vary with spill and oil conditions.
- Multiple applications may be needed over a period of days.
- Use vessels when weather grounds aircraft or for smaller spills close to shore or near pre-staged equipment.
    - A boat operating at 5 knots while spraying a 40 foot swath can only treat about one half square mile in 12 hours. A slick thickness of 0.1mm in this case equates to treatment of approximately 830 barrels per day assuming the vessel has the necessary dispersant storage and fuel capacity to operate all day. (National Research Council, 1989; API Task Force, 1986; Belore,1985: Chau *et al.*,1986; McAuliffe, 1986).
    - An additional factor in deciding when to consider vessel based systems are the availability of vessels with sufficient stability to keep the extended spray arms at the desired height and the availability of spotter aircraft to direct the vessel(s) to the thickest portions of the slick.
    - Water monitors are gaining popularity on small spills due to the widespread availability of vessel with fire monitors installed. The most critical factors in using this method are selecting a water compatible dispersant, providing a means of proportioning the dispersant in desired concentration, and producing a spray that maximizes contact of the dispersing agent on the top of the slick with only slight penetrating impetus. Exxon recommends the installation of a metal screen on the monitor nozzle to achieve droplet sizes in the 400-600µm.



- Good spraying operations include skilled personnel in all positions, spotter aircraft to direct the spray applications, and excellent communications among the group.
- The availability of vessels over dispersant aerial spray assets makes this method attractive in some areas. Spray booms should be rigged as far forward a practicable to avoid interference from the bow wake. On spray booms, fan shaped nozzle patterns permit a more even application than cones that tend to deliver more product at edges of their pattern while the vessel advances.
- Sources of vessel mounted spray equipment are identified in the World Catalog of Oil Spill Response Products and the International Oil Spill Control Directory, and other publications.

Health and Safety Concerns

- Ensure that dispersants are not applied in areas where on-scene personnel could be sprayed or affected by overspray.
- Deploy monitoring crews in vessels only under safe sea conditions.

Limiting Factors/Environmental Constraints

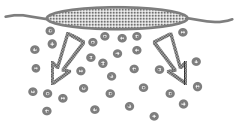
- Effectiveness decreases with heavy, weathered, and emulsified oils.
- Effectiveness of current formulations decreases significantly with decreasing salinity; essentially, there is no effective freshwater dispersant.
- Most become ineffective when the viscosity reaches 20,000 cP. Corexit 9500 may be effective on oils with a viscosity up to 40,000 cP, extending the "window of opportunity" for dispersant application.
- Most pre-approvals specify a minimum water depth (usually 30 feet), distance from shore, or a specific, sensitive resource such as coral reefs, and maximum time after release. Other constraints include separation distance from rafting birds and avoidance of spraying over marine mammals and sea turtles.
- Not likely to be 100% effective; often requires mechanical recovery and/or shoreline cleanup.

Monitoring Requirements/Suggestions

- Follow the Special Monitoring of Applied Response Technologies (SMART), which consists of a hierarchy of activities:
  - visual aerial observations by trained observers;
  - fluorometry sampling of the dispersed plume, tracked by drifters; and
  - water sampling to validate the quantitative fluorescence values and characterize the composition of the dispersed oil.
- Monitoring should not be a prerequisite for dispersant approval in any specific incident.

Waste Generation and Disposal Issues

- Effective use of dispersants should significantly reduce the amount of oily wastes generated.



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American Petroleum Institute. 1999. A Decision Maker's Guide to Dispersants; A Review of the Theory and Operational Requirements. American Petroleum Institute, Washington, DC. API Publication #4692. 38 pp.

Belore, 1995.

Chau, E., A. Chau, W.Y. shiu, and D. Mackay. 1986. Multi-hit dispersion of oil spills. Report EE-72. Ottawa: Environment Canada. 45 pp.

Exxon USA. 1999. Dispersant Course Manual. Mr. Dick Lessard, Exxon Oil Spill Technology Coordinator, Houston, TX.

National Research Council. 1989. Using Oil Spill Dispersants at Sea, National Academy Press, Washington, DC.

Scholz, D.K., J.H. Kucklick, R. Pond, A.H. Walker, A. Bostrom, and P. Fischbeck. 1999. A Decision-maker's Guide to Dispersants: A Review of the Theory and Operational Requirements. American Petroleum Institute, Health and Environmental Sciences Department, Washington, DC. API Publication Number 4692. 38 p.

USCG, NOAA, USEPA, and CDC. 1999. Special Monitoring of Applied Response Technologies (SMART). A Joint Project.

Who to Call for More Information and Additional Resources

- USEPA Oil Program Center, Washington, DC Phone: 703-603-9918
- USEPA ERT, Edison, NJ, 08837 Phone: 732-321-6740
- NOAA-HAZMAT, Seattle, WA 98115 Phone: 206-526-6317
- USCG National Strike Force Coordination Center, Elizabeth City, NC Phone: 252-331-6000
- OHMSETT Testing Facility, PO Box 473, Atlantic Highland, NJ 07716
  Phone: (732) 866-7183; http://www.ohmsett.com

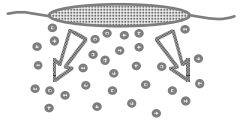


Table 17. Characteristics of Dispersants Listed on the NCP Product Schedule (as of December, 2002).

	Corexit 9500	Corexit 9527	Dispersit SPC	JD-109	JD-2000
Dispersant Type	Glycol Ether Concentrate; solvent is paraffinic	Glycol Ether based Concentrate; solvent is ethylene glycol monobutyl ether	Concentrate; surfactants are water based	NP	NP
Availability	ABASCO 281-470-0440	ABASCO 281-470-0440	Maritime Solutions, Inc. 212-747-9044	GlobeMark Resources Ltd. 937-643-1796	GlobeMark Resources Ltd. 937-643-1796
Application Rate	Apply undiluted at 2-10 gal per acre, or a dispersant:oil ratio of 1:50 to 1:10	Apply undiluted at 2-10 gal per acre, or a dispersant:oil ratio of 1:50 to 1:10	Apply at 2-10 gal per acre; or dispersant:oil ratio of 1:50 to 1:10	Apply at 2-10 gal per acre; or dispersant to oil ratio of 1:50 to 1:10	Apply at 2-10 gal per acre; or dispersant:oil ratio of 1:50 to 1:10 at a 5-10% dilution rate
Application Method	Spray neat as droplets	Spray neat as droplets	Spray neat as droplets	Spray neat as droplets	Spray as droplets
Temperature Limitations	Above -30°F	Above -30°F	Above - 25ºF	32º-120ºF	Above 30ºF
EPA Dispersant Effectiveness Test (%)	Prudhoe Bay crude: 49 S. Louisiana crude: 45 Average of above: 47	Prudhoe Bay crude: 51 S. Louisiana crude: 31 Average of above: 41	Prudhoe Bay crude: 52 S. Louisiana crude: 50 Average of above: 51	Prudhoe Bay crude: 30 S. Louisiana crude: 53 Average of above: 41	Prudhoe Bay crude: 39 S. Louisiana crude: 84 Average of above: 61
Vendor Lab Report on Effectiveness (%)	Prudhoe Bay crude: 45 S. Louisiana crude: 55 Average of above: 50	Prudhoe Bay crude: 37 S. Louisiana crude: 63 Average of above: 50	Prudhoe Bay crude: 40 S. Louisiana crude: 105 Average of above: 73	Prudhoe Bay crude: 29 S. Louisiana crude: 91 Average of above: 58.5	Prudhoe Bay crude: 60 S. Louisiana crude: 78 Average of above: 69
Use in Fresh Water?	Not effective	Not effective	Yes		
Use in Salt Water?	Yes	Yes	Yes	Yes	Yes
Worker Safety (Level of Protection)	Level D	Level D	Level D	NP	NP
NCP Reported Toxicity of Dispersant Alone (LC-50, ppm) Note: a low value = high toxicity					
Inland silversides (96h)	25.2	14.6	3.5	1.9	407
Mysid shrimp (48h)	32.2	24.1	16.6	1.2	90.5
NCP Reported Toxicity of Dispersant & No. 2 Fuel Oil (1:10 ratio) (LC-50, ppm) Note: a low value = high toxicity					

	Corexit 9500	Corexit 9527	Dispersit SPC	JD-109	JD-2000
Inland silversides (96h)	2.61	4.49	7.9	3.8	3.6
Mysid shrimp (48h)	3.4	6.6	8.2	3.5	2.2
Solubility in Water	Soluble in fresh water; dispersible in sea water	Soluble	Soluble	Soluble	Dispersible in fresh and salt water
Application Assistance Information*	NSFCC Nalco/Exxon (800) 333-3714 (281) 263-7205	NSFCC Nalco/Exxon (800) 333-3714 (281) 263-7205	U.S. Polychemical Corp. 845-356-5530 800-431-2072	Vopak 937-643-1796	Vopak 937-643-1796
Unit Cost**	$17.65 per gal.	Unit cost = $16.85 per gal.	NP	NP	NP
Photograph of Product (photos are added as they become available)					

NP = Information Not Provided
NFSCC = National Strike Force Coordination Center

* For additional technical assistance on product application, contact the supplier listed on the NCP Product Schedule Notebook.

** Unit costs are based on 2002 information supplied by the vendors, where provided. For a more up-to-date cost estimate, contact the supplier listed in the NCP Product Schedule. Generally, product prices decrease as purchase volume increases, and may also vary between distributors.

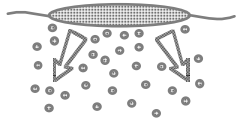
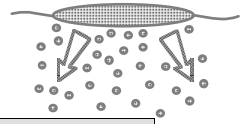


Table 17 Continued.

	Mare Clean 200	Neos AB 3000	Nokomis 3-F4	PetroBioDispers	Sea Brat #4
Dispersant Type	Concentrate; solvents are paraffinic hydrocarbons	Concentrate; solvents are paraffinic hydrocarbons	NP	NP	NP
Availability	Klinview Corporation 714-753-0821	NEOS Company Ltd. JAPAN 078-331-9381	Mar-Len Supply, Inc 510-782-3555	Petro Bio Corporation 203-966-4573	Petro Bio Corporation 203-966-4573
Application Rate	Apply a dispersant:oil ratio of 1:5 (53-66 gal per ton of oil)	Apply a dispersant:oil ratio of 1:4 to 1:2.4 (65-125 gal per ton of oil)	Apply a dispersant:water ratio of up to 1:30	5% to 10% solution	5% to 10% solution
Application Method	Spray neat as droplets	Spray neat as droplets	Spray on spill directly from drum using a "T" connection and hose	Recommended application is by aircraft, fireboat monitors or similar apparatus	Recommended application is by aircraft, fireboat monitors or similar apparatus
Temperature Limitations	Above 21°F	Above 32°F	Above 32^{O}	No known restrictions	No known restrictions
EPA Dispersant Effectiveness Test (%)	NP	NP	NP	Prudhoe Bay Crude: 56 S. Louisiana Crude: 53 Average of above: 54.5	Prudhoe Bay Crude: 56 S. Louisiana Crude: 53 Average of above: 54.5
Vendor Lab Report on Effectiveness (%)	Prudhoe Bay crude: 64 S. Louisiana crude: 84 Average of above: 74	Prudhoe Bay crude: 20 S. Louisiana crude: 90 Average of above: 55	Prudhoe Bay Crude: 62 S. Louisiana Crude: 65 Average of above: 63.5	Prudhoe Bay Crude: 51 S. Louisiana Crude: 63 Average of above: 57	Prudhoe Bay Crude: 51 S. Louisiana Crude: 63 Average of above: 57
Use in Fresh Water?	Yes	Yes	Yes	Yes	Yes
Use in Salt Water?	Yes	Yes	Yes	Yes	Yes
Worker Safety (Level of Protection)	NP	NP	NP	NP	NP
NCP Reported Toxicity of Dispersant Alone (LC-50, ppm) **Note: a low value = high toxicity**					
Inland silversides (96h)	1,996	91.1	29.8	13.5	13.5
Mysid shrimp (48h)	938	33	32.2	78.9	78.9
NCP Reported Toxicity of Dispersant & No. 2 Fuel Oil (1:10 ratio) (LC-50, ppm) **Note: a low value = high toxicity**					
Inland silversides (96h)	42.0	57.0	100	6	6
Mysid shrimp (48h)	9.84	25.0	58.4	2.7	2.7



	Mare Clean 200	Neos AB 3000	Nokomis 3-F4	PetroBioDispers	Sea Brat #4
Solubility in Water	NP	NP	Soluble	Soluble	Soluble
Application Assistance Information*	Taiho Industries Co., Ltd. 81-33-445-8111	NEOS Company, Ltd. Kobe 078-331-9384	Mar-Len Supply, Inc 510-782-3555	Petro Bio Corporation 203-966-4573	Petro Bio Corporation 203-966-4573
Unit Cost**	NP	NP	NP	NP	NP
Photograph of Product (photos are added as they become available)					

NP = Information Not Provided

NFSCC = National Strike Force Coordination Center

* For additional technical assistance on product application, contact the supplier listed on the NCP Product Schedule Notebook.

** Unit costs are based on 2002 information supplied by the vendors, where provided. For a more up-to-date cost estimate, contact the supplier listed in the NCP Product Schedule. Generally, product prices decrease as purchase volume increases, and may also vary between distributors.

ELASTICITY MODIFIERS

(These Products would be listed under Miscellaneous on the NCP Product Schedule)

Mechanism of Action

- Elasticity modifiers increase the viscoelasticity of the treated oil to improve the efficiency of removal by skimmers or other methods.
- They are composed of long-chained, oil-soluble organic polymers, such as polyisobutylene (a chewing gum additive).
- They dissolve in the oil, modifying the oil's mechanical properties.

When to Use

- Elasticity modifiers are more effective on light oil products, significantly increasing the skimming rate and reducing the amount of water collected.
- They should always be applied to contained slicks, so that the treated oil is immediately recovered.
- They are ideal for thin slicks of No. 2 fuel oil or diesel that are very difficult to recover with mechanical equipment or sorbents.
- Liquid Elastol is recommended by the manufacturer for use on medium to heavy oils.

Authority Required

- **Incident-specific RRT approval is required**. There are only two commercially available elasticity modifiers, Elastol Slurry and Liquid Elastol; both were formerly listed on the NCP Product Schedule. **NOTE**: As of December 2002, there were **NO** products listed on the NCP Product Schedule for this category.

Availability

- Both Elastol Slurry and Liquid Elastol are readily available from various suppliers.

General Application Requirements

- Liquid Elastol is sprayed at recommended application rates as follows: 1 gal of Liquid Elastol treats 13 gal of gasoline; 34 gal of diesel; 84 gal of medium oil; 150 gal of heavy oil.
- Slurry Elastol is educted into a water spray system for application at rates of 100-1,500 ppm (0.01-0.15%). One half-pound of Elastol slurry treats: 100 gal of gasoline; 200 gal of diesel; 300 gal of medium oil; and 500 gal of heavy oil. The slurry particles float on water.
- Water spray provides the energy required to mix the product into the oil. Water spray can be used to herd the treated oil towards the skimmer with minimal dispersion into the water column.
- Warm temperatures, wind, and wave action reduce the time for Elastol to dissolve in the oil. Dissolving time for Elastol Slurry is 1-2 hours.

- Special types of skimmers may be required; drum skimmers work best, whereas disk and oleophilic skimmers are less effective.
- Do not over apply product, which makes the oil very sticky and more difficult to recover.
- Treat heavy, weathered oils carefully since dissolving time is greatly increased and there is a risk of over application.
- Controlling the quantity of material applied to an oil slick is often very difficult. Thus, the potential to make the oil sticky and even more difficult to recover will be high, as will be the waste of product.
- Treated oil should be stored in wide-mouth containers, and not in bladders or containers with narrow openings where getting the treated oil out can be difficult.

Health and Safety Issues

- All products required Level D personal protection with splash protection. Respiratory protection is required when handling the dry slurry.

Limiting Factors/Environmental Constraints

- Water salinity has no impact on effectiveness.
- Low water/air temperatures make heavy oils more viscous and mixing of the product into the oil more difficult.
- Both Elastol Slurry and Liquid Elastol are insoluble in water.
- Liquid Elastol has very low toxicity; LC50 for mummichug (96 h) is >100,000 ppm and for brine shrimp (48 h) is >100,000 ppm.
- Elastol Slurry has low toxicity; LC50 for mummichug (96 h) is >18,000 ppm, for brine shrimp (48 h) is >18,000 ppm, and for water flea (48 h) is >5,000 ppm.
- Main environmental concern is for unrecovered, treated oil, which may be more persistent.
- Treated oil can be very sticky and is more likely to adhere to fur, feathers, vegetation, and dry shorelines (though less likely to adhere to wetted shorelines).

Monitoring Requirements/Suggestions

- None generally required other than good practice.
- Make sure that the product is not over-applied.

Waste Generation and Disposal Issues

- Since less water is picked up by skimmers, product use should reduce the amount of oily liquids generated.
- The recovered oil can be recycled for use; the product does not affect it.
- The viscoelastic properties of the treated oil can be broken by passing the oil through a shear pump. Also, dilution with untreated oil will render it non-viscoelastic.

References

Michel, J., C.B. Henry, and J.M. Barnhill. 1993. Use of Elastol during the Unocal spill on the Neches River, 24 April 1993. Prepared for Regional Response Team VI, NOAA, Seattle, WA. 10 pp.

Who to Call for More Information and Additional Resources

NOAA-HAZMAT, Seattle, WA 98115 Phone: 206-526-6317

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EMULSION TREATING AGENTS

(These Products would be listed under Miscellaneous on the NCP Product Schedule)

Mechanism of Action

- Used to:
  - prevent the formation of an emulsion (emulsion inhibitors); or
  - break the emulsion into separate oil and water phases (emulsion breakers).
- Also known as demulsifiers.
- Most are composed of water-soluble surfactants that modify the properties of the oil/water interface, by displacing, mixing with, or chemically neutralizing the naturally occurring emulsifying surfactants in the oil, thus inhibiting or destabilizing the emulsion.
- Definition: Emulsions can contain 20-80% water, increasing the volume of oily material by up to a factor of four; can increase the oil viscosity by many orders of magnitude, greatly reducing effectiveness of skimmers and pumps.

When to Use: Emulsion Inhibitors

- To prevent emulsification of oil on the water surface.
- To increase the window of opportunity for other response options, such as dispersants or in situ burning. Used in field trials in the North Sea in conjunction with dispersants.
- For oils known to form stable emulsions, use to:
  - prevent an increase in the volume of oily material to be recovered, or
  - increase the recovery rate of skimmers.

When to Use: Emulsion Breakers

- To break emulsions.
- To increase the effectiveness of other response options such as dispersants or in situ burning. Lab tests showed that treatment with emulsion breakers allowed successful burning of otherwise unignitable emulsions.
- In containers, use to separate water from the oil, so it can be discharged, allowing more effective storage and transport, particularly for on-water systems. A high recovery skimmer can exceed its onboard storage in hours.

Authority Required

- **Incident-specific RRT approval is required** to use emulsion treating agents in the open environment or in closed containers where the separated water is discharged back into the environment without treatment.
- **Incident-specific RRT approval is NOT required** if applied in closed containers and if the separated water is sent to a treatment facility (e.g., wastewater treatment plant).

CAUTION: Contact treatment facility prior to product use.

- **NOTE**: As of December, 2002, there is only one product listed on the NCP Product Schedule (Zyme-Flow; under Miscellaneous Oil Spill Control Agents) that meets the definition of an emulsion treating agent for this Job Aid. Refer to Table 18.

Availability

- Readily available from many commercial vendors; a mature product for the oil production industry.
- Developing technology for open-water application; needs more research before use during spill emergencies is viable.
- Potential benefits can be significant when on-scene storage of oily liquids is limited.

General Application Requirements:

- Use systems similar to dispersants (aerial, vessel, hand-held spraying systems), but have lower application rates (100-2,000 ppm). Higher rates are for breaking emulsions; lower rates are for inhibiting emulsification.
- Like dispersants, some mixing energy, either by wave action or mechanical action, is needed. For emulsion breakers, separation time should be within 1-2 hours.

Health and Safety Concerns

- Most products would require Level D personal protection, and a respirator when working with a product in confined spaces (e.g., filling spray systems on aircraft).

Limiting Factors/Environmental Constraints

- Not possible to predict the most effective product for each emulsion, but there are standard tests to measure a product's effectiveness for specific emulsions.
- In field trials of open-water application, treated slicks spread over larger areas and more readily dispersed into the water below.
- Over time (at a rate which is unknown), anionic products will leach out of the oil and an emulsion can form (or re-form). The rate of leaching is higher in fresh water.

- Very few products have toxicity data available, making it difficult to evaluate products for their potential impacts.
- May enhance solubility of oil in the separated water relative to conventional recovery approaches. The presence of dispersed oil and greater solubility of the aromatic compounds could produce discharge water more toxic than that normally generated during gravity separation. Thus, separated water may have to be treated before discharge under certain conditions.
- Use is cautioned when in proximity to water treatment plants.

Monitoring Requirements/Suggestions

- Since there is little spill-related experience in the US, monitoring should be conducted to document product effectiveness and effects.

Waste Generation and Disposal Issues

- Use of emulsion treating agents would reduce the amount of oily material generated for handling, transport, and disposal. In containers, separated water would likely have to be tested and/or treated prior to discharge in accordance with applicable state requirements.

References

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Fiocco, R.J., K.W. Becker, M.A. Walsh, J.N. Hokstad, P.S. Daling, and A. Lewis. 1995. Improved laboratory demulsification tests for oil spill response. In: Proc. 1995 Intl Oil Spill Conference, American Petroleum Institute, Washington, DC. pp. 165-170.

Knudsen, O.O., P.J. Brandvik, and A. Lewis. 1994. Treating oil spills with W/O emulsion inhibitors – A laboratory study of surfactant leaching from the oil to the water phase. In: Proc. 17th Arctic and Marine Oil Spill Program Technical Seminar, Environment Canada, Ottawa, Canada. Pp. 1023-1034.

Who to Call for More Information and Additional Resources

American Petroleum Institute, Washington, DC 20005 Phone: 202-682-8300

USEPA ERT, Edison, NJ 08837 Phone: 732-321-6740

Table 18. Characteristics of Emulsion Treating Agents Listed on the NCP Product Schedule (as of December, 2002).

	Zyme-Flow
General Description	Concentrate; contains surface active agents; designed to make heavy crudes pumpable and to break adhesion between oil and soil, rock, or sand
Availability	United Laboratories, Inc. 630-377-0900 / 800-323-2594
Application Rate	Dilution rate of emulsion treating agent:oil varies from 1:50 to 1:200.
Application Method	Pressure spray or soak with agitation
Temperature Limitations	> 0ºF
Use in Fresh Water?	Yes
Use in Salt Water?	Yes
Worker Safety (Level of Protection)	Level D
Toxicity (LC-50, ppm) **Note: a low value = high toxicity**	Values derived from using concentrated product (no dilution)
Inland silversides (96 h)	35
Mysid shrimp (48h)	26
Solubility in Water	Soluble
Is Treated Oil Recoverable?	Yes
Other Information	Effective in all non-frozen waters; salinity not a factor; will not emulsify oil; separated water can be collected and reused pH: 7.0 to 8.0
Application Assistance Information*	United Laboratories, Inc. 630-377-0900 800-323-2594
Unit Cost **	Unit Cost = $29.90 per gal.
Photograph of Product (photos are added as they become available)	

* For additional technical assistance on product application, contact the supplier listed on the NCP Product Schedule Notebook.

** Unit cost estimates are based on 2002 information supplied by the vendor. For a more up-to-date cost estimate, contact the supplier listed in the NCP Product Schedule. Generally, product prices decrease as purchase volume increase, and may also vary between distributors. Product application rates often vary greatly depending on use.

FIRE-FIGHTING FOAM

(These products are not required to be listed on the NCP Product Schedule)

Disclaimer: Decisions for Public Safety Issues for Fires are under the Purview of the Lead Public Emergency Response Agency.

Understanding the Problem

There are two types of fires:

Class A fires: involve combustible products such as vegetation, wood, cloth, paper, rubber, and many plastics.

Class B fires: involve flammable liquid fuels. There are two liquid fuel categories:

- hydrocarbon fuels, such as gasoline and crude oils; as well as ethylene, propylene, and butylene
- alcohol fuels, or polar solvents that mix easily with water, such as acetone, ethanol, and isoproponal.

Foams are used for extinguishing flammable and combustible liquids as well as non-liquids. Unlike other extinguishing agents like water, dry chemicals, CO_2, etc., a stable, aqueous foam can extinguish a flammable or combustible liquid fire by one or more of following mechanisms of:

- Cooling the fuels and any adjacent metal surfaces;
- Separating the flame/ignition source from the fuel surface;
- Suppressing the release of flammable or toxic vapors that can mix with air;
- Smothering the fuel surface fire; and
- Preventing reflash or reignition of the fuel

Water alone is not always effective as an extinguishing agent on flammable liquids. Water, when used on hydrocarbon fuels, has a specific gravity denser than most hydrocarbon fuels, so when the water is applied directly to the fuel surface, the water will typically sink beneath the fuel surface and will have little or no impact on reducing the fire. Additionally, if the liquid fuel burns hotter than 212ºF, then there is the possibility of the water boiling beneath the flammable liquid, causing the inadvertent spread of the hydrocarbon fuel during the water boil off process. Because of these and other reasons, foams have become the industry standard for dealing with hydrocarbon fuels and other flammable liquids that are transported, processed, stored, or used as an energy source (Chemguard, Inc., 2001).

Foams are a stable mass of small air-filled bubbles that have a lower density than oil, gasoline, or water. Foams are composed of three ingredients: water, foam concentrate, and air. When mixed in the correct proportions, these three ingredients form a homogenous blanket that is used to smother flames and induce vapor suppression. Modern day foams can be used in fresh, brackish, and high salinity waters.

When addressing a flammable fuel fire, the responder must determine if the product involved is a standard hydrocarbon fuel or polar solvent fuel. Some foam concentrates are designed specifically for hydrocarbon fuels and do not work with polar solvents and vice versa.

When to Use Fire-Fighting Foam

Class A Fires: Foam is used to:

- make water go further; foam holds water, then slowly releases it
- increase the wetting characteristics from the surfactants in the foam, which makes the water penetrate the fire better
- cling to fuels
- act as a thermal barrier
- Class B Fires: Foam is used to:
- separate, forming a cohesive floating blanket which acts as a barrier between the fuel and fire
- cool, lowering the temperature of the liquid
- suppress, or smother, preventing the release of vapors, thus ignition or re-ignition. Film-forming products can produce a film to suppress formation of flammable vapors

Types of Foam Concentrates

There are 8 general types of foams that are available in application rates of 1, 3, or 6%, depending on the fire source or fuel type.

- Protein foams are used in 3% and 6% concentrations.
  - Consists of protein hydrolysate, foam stabilizers and preservatives
  - Intended of for Class B hydrocarbon fires, however it can be used on Class A fires
  - Must be applied gently or indirectly to the fuel source
  - Must be applied with an air aspirating discharge device

- Fluoroprotein foams are used in 3% and 6% concentrations.
  - Consists of same ingredients as protein foams with the addition of fluorocarbon surfactants
  - Intended for Class B hydrocarbon fires, however it can be used on Class A fires
  - More resistant to fuel contamination/pickup and more mobile than protein foam
  - Can be applied directly and from a distance
  - Recommended application with air-aspirating discharge device

- Aqueous Film Forming Foams (AFFF) are used in 1%, 3%, and 6% concentrations.
  - Ingredients consist of synthetic foaming agents, solvents, fluoro-chemical surfactants, salts, and foam stabilizers
  - Intended for Class B hydrocarbon fires, however it can be used on Class A fires
  - Forms an aqueous film on the surface of the fuel
  - Can be applied using aspirating or non-aspirating discharge devices

- Film Forming Fluoroprotein foams (FFFP) are used in 3% and 6% concentrations.
  - FFFP is a combination of AFFF and Fluoroprotein foam
  - Intended for Class B hydrocarbon fires, however it can be used on Class a fires
  - Contains quick knockdown of AFFF along with burnback resistance of Fluoroprotein foam
  - Can be applied using aspirating or non-aspirating discharge devices

- Alcohol Resistant Aqueous Film Forming Foam (AR-AFFF) is used in 3% and 6% concentrations.
  - Consists of AFFF as a base with an added high molecular weight polymer
  - Intended for both types of Class B fires, however it can be used on Class A fires
  - When used on a polar solvent fuel, it protects the foam from being destroyed or absorbed by the fuel
  - Can be used as 3% concentrate on hydrocarbon fuel and 6% on polar solvent fuel
  - Can be applied using aspirating or non-aspirating discharge devices

- Alcohol Resistant Film Forming Fluoroprotein (AR-FFFP) is used in 3% and 6% concentrations.
  - Consists of FFFP as a base with an added high molecular weight polymer
  - Intended for both types of Class B fires, however it can be used on Class A fires
  - When used on a polar solvent fuel, it protects the foam from being destroyed or absorbed by the fuel
  - Can be used as 3% concentrate on hydrocarbon fuel and 6% on polar solvent fuel
  - Can be applied using aspirating or non-aspirating discharge devices

- Medium and High Expansion Foams are used in 1%-3% concentrations.
  - Consists of hydrocarbon surfactants and solvents
  - Intended for both types of Class B fires as well as Class A fires
  - Expansion ratio of 300:1 to 1,250:1 for high expansion and 50:1 to 300:1 for medium expansion foam
  - Contains very little water and is suitable for rapid smothering and cooling
  - Must be applied using an expansion foam generator

- Class A foam is used in .1%-1% concentrations.
  - Consists of biodegradable mixture of foaming and wetting agents
  - Intended for Class A fires, however it may be effective on some Class B fires
  - Reduces surface tension and produces foam which allow greater penetration and allow water to remain and cling to horizontal and vertical surfaces
  - Must be used with an air aspirating system

Limiting Factors

- Optimal foam production occurs at 40-100°F.
- Most products are effective with fresh or seawater.
- Foams generated separately from protein, fluoroprotein, FFFP, and AFFF can be applied in sequence or simultaneously.
- Most foam products may be mixed with dry chemical extinguishing agents to provide greater fire protection capability. However, foam products of different type and manufacturer should never be mixed.

Environmental Concerns

Many products contain synthetic surfactants and solvents (e.g., diethylene glycol butyl ether) that fall under CERCLA and EPCRA reporting requirements for releases or discharges to the environment.

- Most uses would be under the thresholds for non-manufacturing facility.
- Some large-scale uses might trigger reporting under CERCLA. Check the MSDS to determine if releases have to be reported.

Recent work by Oregon State University has shown that foams have impacted groundwater at military bases in Florida and Nevada that had fire-training facilities no longer in use. Concentrations of foams detected in groundwater at these sites ranged from 0.1 to 7.1 ppm; some of the groundwater samples at the higher concentrations actually foamed.

It is not known if the surfactants in the foams will affect the transport and biodegration of other contaminants associated with the foam during its use (e.g., fuel components and solvents), potentially causing an additional source of groundwater contamination.

Discharge to wastewater treatment facilities:

- Foam solutions cause copious foaming in aeration ponds, even at very low concentrations, which can interfere with wastewater treatment.
- High BOD in foam can cause shock loading and plant upset.
- Foam concentration in influent water should not exceed 1,700 ppm (1 gal of foam solution to 588 gal of influent water). Defoamers can reduce but not eliminate foaming. There are no other known pretreatment options.
- Foam solutions have tendency to emulsify fuels, which will interfere with operation of oil/water separators as part of storm water treatment or pre-treatment prior to discharge to wastewater facilities.

DISCHARGES TO WATERBODIES WITHOUT TREATMENT:

- Can cause foaming in rivers and streams at very low concentrations.
- The surfactants are the primary cause of environmental concerns for toxicity and persistence. There are very limited aquatic toxicity data available, and toxicity will vary widely depending on the product composition. Most available data show LC50s for fathead minnow and water flea in the range of 200-2000 ppm and for rainbow trout and bluegill in the range of 500-1500 ppm, indicating that toxicity is relatively low. LC50s for algae were lower, in the range of 140-180 ppm.
- Fluoro-chemical surfactants are very resistant to degradation. They also leach through soils, potentially contaminating ground water.
- Surfactants in foam solutions have a tendency to emulsify fuels, and used foam solutions will probably be heavily contaminated with the fuel.

Guidelines for Use

- Wherever possible, used foam solution should be collected and disposed of properly (discharge to wastewater treatment plant or hazardous waste facility)
- In the absence of existing containment (e.g., storm-water sewer in a facility), use manual containment, including:
  - blocking sewer drains and diverting fire-fighting runoff to collection.
  - building portable dikes on land.
  - deploying booms in water to contain foam for recovery.
- Be prepared to handle large volumes of fire-fighting water.

- Be aware that foam will emulsify light fuels, increasing the potential for dispersion into the water column.
- Do not allow foam to drift into areas where it could come into contact with wildlife, such as birds and marine mammals, because the surfactants could interfere with the waterproofing of fur and feathers.

References

NFPA. 1998. Standard for Low-Expansion Foam. Prepared by Technical Committee on Foam, National Fire Protection Association, Inc., Quincy, Mass., 62 pp.

American Chemical Society's ASAP email announcement. July 14, 1999. Groundwater Impacted by Fire-Fighting Foams. To be published in Environmental Science & Technology Journal.

Who to Call for More Information and Additional Resources

NOAA-HAZMAT, Seattle, WA 98115 Phone: 206-526-6317

National Institute of Standards and Technology, Fire Research Laboratory, Gaithersburg, MD 20899 Phone: 301-975-5900

National Foam, Inc. Phone: 610-363-1400

USEPA Oil Spill Center/Scientex, Inc., Arlington, VA Phone: 202-260-2342 or 703-603-9918

Chemguard, Inc., Mansfield, TX 76063 Phone: 817-473-9964

Ansul, Inc., Marinette, WI 54143 Phone: 715-735-7411

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Table 19. Characteristics of fire fighting foams (Taken from Chemguard, Inc., 2001).

	Protein Foam	Fluoroprotein Foam	Film Forming Fluoroprotein (FFFP)
Description	Composed of hydrolyzed protein, foam stabilizers, and preservatives	Composed of hydrolyzed protein, foam stabilizers, preservatives, and fluorocarbon surfactants	Derivative of AFFF and Fluoroptotein foam where additional fluorocarbon surfactants have been added
How does It work	Produces a highly stabilized air foam. Relatively slow moving foam when used to cover the surface of a flammable liquid.	Produces a stable foam for vapor suppression Rapid spreading foam creates cooling effect Is also used in storage tanks with hydrocarbon fuels	Forms a film on the surface of the fuel depriving the fire of air Reduces surface tension of water
Logistical Needs	Must always use an air aspirating-type discharge device	Can be used through non-aspirating discharge device For sub-surface injection it can be applied with a high back pressure foam maker	Can be used through non-aspirating discharge devices
Equipment	Balanced and In-line Balanced pressure pump proportioning equipment Balanced pressure bladder tank proportioners Around the pump proportioners Fixed or portable in-line venturi proportioners Hand line nozzles with fixed induction	Balanced and In-line Balanced pressure pump proportioning equipment Balanced pressure bladder tank proportioners Around the pump proportioners Fixed or portable in-line venturi proportioners Hand line nozzles with fixed induction	Sprinkler heads and spray nozzles Air aspirating hand lines and monitor nozzles Foam makers
Coverage/ Technique Required	**Application technique is critical**	Use subsurface method of forcing expanded foam through base of storage tank	Can be applied directly to the fuel Use subsurface method of forcing expanded foam through base of storage tank
Application Rates	3% to 6% application rate 0.16 gpm/sq. ft. for hydrocarbon fuels with low water solubility	3% to 6% application rate 0.16 gpm/sq. ft. for hydrocarbon fuels with low water solubility	3% to 6% application rate 0.10 gpm/sq. ft. for hydrocarbon fuels with low water solubility

	Protein Foam	Fluoroprotein Foam	Film Forming Fluoroprotein (FFFP)
Operational Limitations			
Pros	Recommended for laying a foam blanket on runways prior to a distressed aircraft landing	More resistant to fuel contamination/pickup than protein foams. Foam blanket is more mobile when discharged onto flammable liquids Allows discharging foam to be applied directly onto the fuel surface Foam blanket will not become saturated by fuel vapors	Fast fire knockdown speed Long lasting heat resistance High vapor suppression
Cons	Can become contaminated with fuel if plunged directly into the fuel surface. Slow knockdown speed	Fairly slow knockdown speed	

Table 19. Continued

	Aqueous Film Forming Foam (AFFF)	Alcohol Resistant Film Forming Fluoroprotein Foam (AR-FFP)	Alcohol Resistant Aqueous Film Forming Foam (AR -AFFF)
Description	Manufactured from synthetic materials such as: hydrocarbon surfactants, solvents, fluoro-chemical surfactants, salts, and foam stabilizers	Consists of FFFP as a base with an added high molecular weight polymer	Consists of AFFF as a base with an added high molecular weight polymer
How Does it Work?	Foam blanket drains water creating an aqueous film over the fuel that deprives the fire of air The fast moving blanket moves over the fire creating more insulation As the foam drains water it creates more film healing the areas where the foam has been disturbed	When used on a polar solvent fuel, it protects the foam from being destroyed or absorbed by the fuel	The foam creates a membrane rather than a film which separates the water in the foam blanket from the attack of the fuel
Equipment	Balanced and In-line Balanced pressure pump proportioning equipment Balanced pressure bladder tank proportioners Around the pump proportioners Fixed or portable in-line venturi proportioners Hand line nozzles with fixed induction		Balanced and In-line Balanced pressure pump proportioning equipment Balanced pressure bladder tank proportioners Around the pump proportioners Fixed or portable in-line venturi proportioners Hand line nozzles with fixed induction
Logistical Needs	Can be applied using aspirating or non-aspirating discharge devices	Can be applied using non-aspirating discharge device however an aspirating device is recommended for polar solvent fuels	Can be applied using non-aspirating discharge device however an aspirating device is recommended for polar solvent fuels
Coverage/ Technique Required	Can be applied directly to the fuel Use subsurface method of forcing expanded foam through base of storage tank	Should be applied gently however it can resist fuel contamination and be mixed with hydrocarbon fuels without affecting performance	Should be applied gently so a membrane is allowed to form disabling the fuel from contaminating the foam
Application Rate	1%-6% application rate 0.10 gpm/sq. ft. on hydrocarbon fuels with low water solubility	3% for hydrocarbon fuels 6% for polar solvent fuels 0.10 gpm/sq. ft. on hydrocarbon fuels with low water solubility	3% for hydrocarbon fuels 6% for polar solvent fuels 0.10 gpm/sq. ft. on hydrocarbon fuels with low water solubility
Operational Limitations			

	Aqueous Film Forming Foam (AFFF)	Alcohol Resistant Film Forming Fluoroprotein Foam (AR-FFP)	Alcohol Resistant Aqueous Film Forming Foam (AR -AFFF)
Pros	Fast fire knockdown speed	Can be used on more applications than standard FFFP or fluoro-protein foam concentrates Quick fire knockdown speed High vapor suppression	
Cons	Fairly low heat resistance Fairly low vapor suppression		Fairly low heat resistance

Table 19. Continued.

	Medium and High Expansion Foam	Class A Foam Concentrate
Description	Manufactured from a combination of hydrocarbon surfactants and solvents	Biodegradable mixture of foaming and wetting agents
How Does it Work?	Fire control and extinction is achieved by smothering and cooling	Reduces surface tension of water allowing for greater penetration Gives water foaming ability allowing it to cling to surfaces without runoff
Equipment	High Expansion foam generators: mechanical blower or water aspirating Balanced pressure bladder tank type proportioner Balanced and In-line Balanced pressure pump proportioning equipment In-line fixed or portable venturi type proportioners (eductors) Around the pump type proportioners	Compressed air systems Balanced pressure pump or bladder tank fixed sprinkler system In-line fixed or portable venturi type proportioners (eductors)
Logistical Needs	Always applied using an air aspirating discharge device	Can be applied with regular water stream equipment
Coverage/ Technique	Can be applied directly to the fuel because of the low density foam	Can be applied directly to the Class A fire source
Application Rate	1% to 3% application rate Medium expansion: 50-300:1 High expansion: 300-1,250:1	0.1% to 0.5% application rate
Operational Limitations		
Pros	Low water content reduces water damage Vapor suppression Useful when runoff is not desirable	Effectiveness of water is increased up to 5 times
Cons	Not suitable for outdoor use Poor heat resistance	

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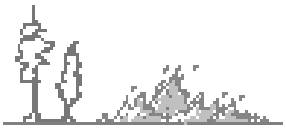


IN SITU BURNING ON LAND

Description

- This guidance covers use of in situ burning of oil on land, including wetlands. The objective is to remove free oil and oily debris from the substrate by burning the oil in place.
- This section does NOT address disposal issues by incineration.

When to Use

Consider *in situ* burning under these conditions:

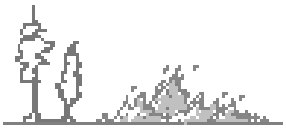
- To quickly remove oil to prevent it's spread to sensitive sites or over large areas.
- To reduce the generation of oily wastes, especially where transportation or disposal options are limited.
- Where access to the site is limited by shallow water, soft substrates, thick vegetation, or the remoteness of the location.
- As a final removal technique, when other methods begin to lose effectiveness or become too intrusive.

Favorable conditions include:

- Remote or sparsely populated sites (at least 0.5-1 mile from populated areas).
- Calm winds (so the smoke plume rises high into the air and for better fire control).
- Fresh crudes or light/intermediate refined products that burn more readily and efficiently.
- Mostly herbaceous vegetation, though some shrubs and trees are fire tolerant.
- Dormant vegetation (not in the active growing season).
- Unvegetated areas, such as dirt roads, ditches, dry streambeds, idle cropland).
- In wetlands, when there is a water layer covering the substrate (prevents thermal damage to soil and roots, and keeps oil from penetrating substrate). However, a water layer is not mandatory, at a minimum, the soils should be water saturated.
- Snow and ice that provides natural containment and substrate protection.

Authority Required

- For inland burns, approval from the appropriate state agencies (including the agency regulating air quality) is required. Approval process may vary by region/state. Consult with RRT for approval guidance.



- **Incident-specific RRT approval is not required unless an accelerant (burning agent) is used**; but, Trustee notification is strongly recommended, and may be required by the RRT. ISB MOUs are located in Volume II of this Selection Guide.
- A burn plan should address health and safety issues, burn methods, monitoring plans, and post-burn cleanup and restoration.

General Application Requirements

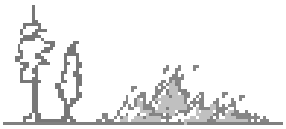
- Notify local fire and police departments prior to the burn, and secure the site. Must have concurrence with local public safety official.
- Areas outside of the planned burn area are wetted down or protected with a firebreak, if needed.
- The free oil and/or oiled combustible materials (vegetation, logs, debris) are ignited. A common accelerant used in prescribed burns is a 70/30 mix of diesel and gasoline, though flame or drip torches, flares, lighters, blowtorches, hay, and varsol have been used at oil spills.
- After the initial burn, it may be necessary to re-ignite any remaining oil, extinguish hot spots, or remove burn residues.

Health and Safety Issues

- Make human health and safety of responders and potentially affected populations of primary concern.
- Site conditions (particularly wind speed and direction) will determine whether the smoke plume poses a threat to the public, thus each spill has be evaluated on a case-by-case basis.
- Have a plan for extinguishing the fire. The local fire department may not have the resources to standby, so have a backup plan.

Limiting Factors/Environmental Constraints

- Heavy, weathered, or emulsified oils may not ignite, even with accelerants.
- A crust or residue is often left behind after burning and may need to be broken up or removed, to speed revegetation.
- Prolonged flooding of a burned wetland may kill burned plants if they are completely submerged.
- Erosion may be a problem in burned areas if plant cover is reduced; short-term erosion control measures may be needed.
- The site may need protection from overgrazing, especially since herbivores may be attracted to new growth at burned sites.
- Fire ecologists and practitioners can provide valuable knowledge and experience on the appropriateness of burning oil in different habitats.



Monitoring Requirements/Suggestions

- Since there is very poor documentation on the effectiveness and effects of burning oil on land, monitoring of any burn site is very important.
- Air quality monitoring may be required at the edges of populated areas. USCG and USEPA both have teams with expertise and equipment to provide air monitoring. Follow the SMART (Specialized Monitoring of Applied Response Technologies) plan provided in Volume II of this Selection Guide.
- Describe and photograph the burn site before and after the burn, record detailed information on the burn, including duration, residue type and volume, water depth before/after the burn, visible impacts, post-burn activities (e.g., residue removal methods), restoration efforts and results, etc.

Waste Generation and Disposal Issues

- *In situ* burning should significantly reduce the amount of oily wastes generated.

References

Dahlin, J.A., S. Zengel, C. Headley, and J. Michel. 1999. Compilation and review of data on the environmental effects of in situ burning of inland and upland oil spills. American Petroleum Institute, Washington, DC.

J. Michel, Z. Nixon, H. Hinkeldey, and S. Miles. 2002. Recovery Of Four Oiled Wetlands Subjected To *In Situ* Burning. Prepared for American Petroleum Institute, Washington, DC. API Pub. No. 4724.

S.L. Ross Environmental Research, Ltd. 1998. Identification of oils that produce non-buoyant in situ burning residues and methods for their recovery. Prepared for American Petroleum Institute and Texas General Land Office by S.L. Ross, Ottawa, Canada. 50 p.

Who to Call for More Information and Additional Resources

Al Allen, Spiltec, Inc., Woodinville, WA 98072 Phone: 206-869-0988

Louisiana State University, Baton Rouge, LA Phone: 504-388-4295

USCG National Strike Force Coordination Center, Elizabeth City, NC Phone: 252-331-6000

USEPA ERT, Edison, NJ 08837 Phone: 732-321-6740

USCG Response Plan Equipment Caps Review (1999) http://www.uscg.mil/vrp/capsreview.htm

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IN SITU BURNING ON INLAND WATERS

Description

- To remove oil from the water surface by burning the oil in place.
- This section does NOT address disposal issues by incineration.

When to Use

- Consider *in situ* burning under these conditions:
  - To quickly remove oil to prevent its spread to sensitive sites or over large areas. Removal rates of 50,000 gal/hour can be achieved for a burn area of 10,000 ft^2; under prime conditions, removal efficiencies can exceed 90%.
  - When oil recovery is limited by available oil storage and handling capabilities.
  - To reduce the generation of oily wastes, especially where transportation or disposal options are limited.
  - Where access to the site is limited by shallow water, ice, or the remoteness of the location.

Authority Required

- Approval from the appropriate state agencies (including the agency regulating air quality) is required. Approval process may vary by region/state. Consult with RRT for approval guidance.
- **Incident-specific RRT approval is not required unless an accelerant (burning agent) is used**; but, Trustee notification is strongly recommended and may be required by the RRT. ISB MOUs are included in Volume II of this Selection Guide.
- Burn Plan is required and should address health and safety issues, burn methods, monitoring plans, and post-burn cleanup and restoration. Use the ISB Evaluation & Response Checklist included in Volume II of this Selection Guide.

General Application Requirements

- Notify local fire and police departments prior to the burn, and secure the site.
- Burning oil generates large volumes of black smoke, so consider using radio broadcasts to notify the public and broadcast to mariners of a safety zone in navigable waters.
- The oil slick must be thick enough to ignite and sustain the burn.
- The oil must be heated to a temperature at which the oil will be vaporized and support combustion in the air above the slick (the hydrocarbons vapors burn, not the liquid itself).
- Accelerants include:
  - gelled gasoline, which is commonly used for aerial ignition;

  - sodium and gasoline, solid propellants (rocket fuels)
  - hand-deployed igniters include rags, paper, sorbents, etc. soaked in a 70/30 mix of diesel and gasoline; lighters; flares; and torches.
- Once 1m2 of burning slick as been established, ignition can be considered accomplished.

Health and Safety Issues

- Make human health and safety of responders and potentially affected populations of primary concern.
- Site conditions (particularly wind speed and direction) will determine whether the smoke plume poses a threat to the public, thus each spill must be evaluated on a case-by-case basis.
- Have a plan for extinguishing the fire. For slicks contained in booms, the burn can be terminated by releasing the boom and allowing the oil to spread to less than the minimum thickness.

Limiting Factors/Environmental Constraints

- Oil thickness: minimum ignitable thickness for fresh, volatile, crude oil is 1 mm; for aged, unemulsified crude oil and diesel fuels, 2-5 mm; for residual fuel oils, about 10 mm. Oil must be contained, either naturally, such as by ice, or by booms.
- Maximum wind speed: about 20 knots (10-12 m/s); seas should not exceed 2-3 ft. Consideration should be made as to the direction of the smoke plume and its proximity to populated areas.
- Effect of emulsification: little effect on up to 12% water; notable decrease between 12-25% water; and zero burn efficiency for stable emulsified oil with >25% water, based on lab tests. Will vary with the stability of the emulsion.
- Good visibility: Essential. Burns should be conducted during daylight hours and under VFR conditions so the burn can be observed from aircraft.
- Consult with state and federal resource managers: Need to determine if there are any biological resources of concern in the area, or special constraints.
- Recovery of burn residue: Can form a semi-solid, tar-like layer and may need to be recovered. Rules of thumb for residue thickness:
  - Crude oil up to 10-20 mm, residue thickness is 1 mm.
  - Thicker crude slicks generate thicker residues; emulsified slicks are much greater.
  - For light and middle distillate fuels, residue thickness is 1 mm, regardless of slick thickness.
- Sinking burn residue: The burn residue from crude oil burns may sink. Recent studies have predicted that about half of international crude oils would tend to sink in seawater, but only after cooling.
  - It may be possible to collect the burn residues while they are still hot and buoyant. Nets deployed under the burn area might allow capture of sinking residues.
- Recovery of sunken burn residue: It may be necessary to recover sunken burn residue from the bottom, if the amounts are significant and site conditions conducive.

Monitoring Requirements/Suggestions

- Air quality monitoring may be required at the edges of populated areas. USCG and USEPA both have teams with expertise and equipment to provide air monitoring. Follow the SMART (Special Monitoring of Applied Response Technologies) plan contained in Volume II of this Selection Guide.
- The NRT recommends, as an air quality guideline, an upper limit of 150 micrograms of PM-10 per m3 of air, averaged over 1 hour.

Waste Generation and Disposal Issues

- *In situ* burning should significantly reduce the amount of oily wastes generated.

References

Buist, I.A., S.L.Ross, B.K. Trudel, E. Taylor, T.G. Campbell, P.A. Westphel, M.R. Myers, G.S. Ronzio, A.A. Allen, and A.B. Nordvik. 1994. The science, technology, and effects of controlled burning of oil spills at sea. MSRC Tech. Report Series 94-013. Marine Spill Response Corporation, Washington, DC 382 p.

Buist, I.A. 1998. Window of opportunity for *in situ* burning. Paper presented at the MMS *In situ* Burning of Oil Spills Workshop, New Orleans, LA. Nov. 2-4, 1998. Minerals Management Service, Washington, DC. 9 p.

NRT. 1995. Igniters and ignition technology for *in situ* burning of oil. Fact Sheet prepared by the National Response Team Science and Technology Committee. October 1995.

S.L. Ross Environmental Research, Ltd. 1998. Identification of oils that produce non-buoyant *in situ* burning residues and methods for their recovery. Prepared for American Petroleum Institute and Texas General Land Office by S.L. Ross, Ottawa, Canada. 50 p.

Who to Call for More Information and Additional Resources

- Al Allen, Spiltec, Inc., Woodinville, WA 98072 Phone: 206-869-0988
- Louisiana State University, Baton Rouge, LA Phone: 504-388-4295
- USCG National Strike Force Coordination Center, Elizabeth City, NC Phone: 252-331-6000
- USEPA ERT, Edison, NJ 08837 Phone: 732-321-6740
- USCG Response Plan Equipment Caps Review (1999) http://www.uscg.mil/vrp/capsreview.htm

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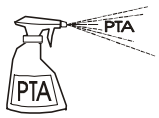

SHORELINE PRE-TREATMENT AGENTS

(Products in this Category would be listed under Miscellaneous on the NCP Product Schedule)

Mechanism of Action

- Shoreline Pre-treatment Agents are applied to the substrate prior to oil landfall to prevent oil from adhering to, or penetrating, the substrate.
- There are two subclasses of products:
  - Film-forming Agents: form a physical barrier that prevents the oil from adhering, staining, absorbing, and contaminating the shoreline, and
  - Wetting Agents: affect the oil/water interface and thus help the water displace the oil from the substrate.

When to Use

- Oil is heading towards a sensitive shoreline resource (e.g., marsh, sheltered tidal flat) or a resource of historical/archaeological importance.

Authority Required

- **Incident-specific RRT approval is required. NOTE**: As of December 2002, there is no category designated for shoreline pre-treatment agents on the NCP Product Schedule.

Availability

- No products are currently available in the US. However, products in this category are being used in Europe.
- There is the potential use of Surface Washing Agents serving as shoreline pre-treatment agents. The use of a listed product in this manner is the decision of the incident-specific RRT.

General Application Requirements

- The characteristics of a shoreline pre-treatment agent include:
  - Product needs to be sprayed as a thin, even coating on the substrate;
  - Are readily available;
  - Dissolve or degrade in seawater;
  - Rapid drying time;
  - Low permeability to oil penetration;
  - Readily adhere to intertidal substrates (e.g., sand, gravel, bedrock); and
  - Not be wetted by oil.
- Narrow window of opportunity for use. Timing of application is critical when using shoreline pre-treatment agents; products need to be applied to the oil/shoreline interface just prior to stranding of oil for effective use.
- Oil spill trajectory monitoring would have to be closely monitored.

Health and Safety Issues

- Refer to health and safety information from Surface Washing Agents when proposing to use a surface washing agent as a shoreline pre-treatment agent.

Limiting Factors/Environmental Constraints

- Biodegradability of the product – product should degrade rapidly without toxic by-products.
- Products should have low contact toxicity as it is applied directly on the intertidal substrates.
- Products should have low application rates and low aqueous toxicity values so that impacts to intertidal and subtidal resources are minimal.
- Products used as a film could potentially smother intertidal biota by reducing oxygen levels.

Monitoring Requirements/Suggestions

- Make sure that the product is not over-applied.

Waste Generation and Disposal Issues

- Not an issue; product should rapidly degrade within the water column or on the substrate surface.

References

Walker, A.H., J. Michel, G. Canevari, J. Kucklick, D. Scholz, C.A. Benson, E. Overton, and B. Shane. 1993. Chemical Oil Spill Treating Agents. Marine Spill Response Corporation, Washington, DC. MSRC Technical Report Series 93-015. 328 p.

Walker, A.H., J.H. Kucklick, and J. Michel. 1999. Effectiveness and Environmental Considerations for Non-dispersant Chemical Countermeasures. Paper 147: An issue of special reports reviewing oil spill countermeasures. *Pure Appl. Chem*., 71(1).

Who to Call for More Information and Additional Resources

USEPA ERT, Edison, NJ 08837 Phone: 732-321-6740

USEPA Oil Program Center, Washington, DC Phone: 703-603-9918

NOAA-HAZMAT, Seattle, WA 98115 Phone: 206-526-6317

American Petroleum Institute, Washington, DC 20005 Phone: 202-682-8300

Environment Canada, Emergencies Sciences Division, Ottawa, Canada

CEDRE, BP 20 413 - 29604 BREST cedex - France Phone: 33 (0)2 98 33 10 10

MAFF, Nobel House, 17 Smith Square, London, Phone: 020 7238 3000

SOLIDIFIERS

(Products in this Category are listed under Miscellaneous on the NCP Product Schedule)

Mechanism of Action

- Solidifiers are products which, when mixed with oil, turn the oil into a coherent mass.
- Most products are synthetic polymers that either physically or chemically bond with organic liquids, not allowing the material to be squeezed out. There is usually little change in the specific gravity of the treated oil.
- Products that are essentially sorbents are not included because they are considered to be mechanical countermeasures.

When to Use

- To immobilize the oil, to prevent further spread, or penetration into the substrate. In some cases, the edge of the oil can be treated, forming a solidified barrier to prevent further spreading.
- Solidification can eliminate the free product thereby reduce the vapor pressure of volatile oils.
- Product booms or pillows could be deployed along sensitive areas before the oil approaches, or downstream of oil containment areas to recover sheens.
- Solidifiers are well suited for small spills on land to prevent, for example, run-off into drains and rivers.

Authority Required

- **Incident-specific RRT approval is required**. Consultation with trustees is recommended.
- **NOTE**: As of December 2002, four products are listed as Miscellaneous Oil Spill Control Agents on the NCP Product Schedule, (Alsocup, Cheap Insurance, Waste Set PS 3200, and Waste Set 3400) (Table 20). These products are considered solidifiers as described in this Selection Guide.
- There are two additional products (Enviro-Bond 403 and Rubberizer) that have received sorbent status by the EPA, but are included in Table 20 of this Section; these products are considered solidifiers as defined in this Selection Guide. Additionally, Appendix K contains information on solidifier products that are not currently listed on the NCP Product Schedule.

General Application Requirements

- Most products are granular and can be placed in booms or pillows or applied dry, by hand or with a portable broadcast system to cover large areas. In recent tests, an all-fiber blower worked better than an air-blast pesticide sprayer and a hydro-seeder..
- On floating oil, mixing is usually needed, and can be done with a strong water spray. Booms and pillows can be used like similar sorbent products.
- Free product application rates vary from 10-50 percent by weight of the liquid to be recovered. Controlling application rates can be difficult, and they are usually higher than specified because of overspray under field conditions.

- Solidification (cure time) can occur immediately or take up to 18 hours to form a firm, cohesive mass.
- For free product used on land, recovery is usually by manual pickup or sweeping, and is limited primarily by access. On water, the treated oil must be contained and recovered, using fish netting, wire screens, or hand tools (e.g., rakes, shovels).

Health and Safety Issues

- Workers spreading powdered solidifiers should wear appropriate breathing protection to prevent inhalation of any product dust.
- Solidified oil on surfaces may increase the chance of slips, trips, and falls.

Limiting Factors/Environmental Constraints

- Effectiveness is likely to decrease for emulsified, weathered, thick, or heavy oils because of the difficulty of mixing the product into viscous liquids.
- Water salinity does not have an effect on solidification. Low water temperatures slow solidification, mostly by increasing the oil's viscosity.
- Most all products float even after interacting with oil. Under 40 CFR Subpart 300.910 - Authorization of Use, the use of sinking agents or products that will cause the oil to sink is prohibited. 40 CFR Subpart 300.900 is included in its entirety as Appendix F in this Volume.

> **CAUTION**: Reject any products that could cause the oil to sink, such as clays.

- When waves are present, formation of small clumps and not one large mass is likely.
- Solidifiers have relatively low toxicity, and many products are considered to be non-toxic. However, for free product there may be concern about the fate and secondary effects of treated and unrecovered oil and unreacted product, since in the field, overspray on water is likely. Thus, applications should be done in small, controllable areas.
- Like sorbents, the use of solidifiers requires access to deploy, and then recover the product. The potential for physical disturbance of habitats, as well as smothering by excess loose product, should be considered.
- Solidifiers will inhibit the natural processes of dispersion and evaporation, which act to remove oil from the surface of the water.
- If not recovered, solidified oil will weather very slowly, thus residues may be very persistent.
- Use of solidifiers may impair the operation of conventional recovery equipment.
- Options available for waste disposal may be limited for the solidified oil.

Monitoring Requirements/Suggestions

- None generally required other than good practice.

Waste Generation and Disposal Issues

- Most products pick up oil with minimal increase in volume.
- Most solidifiers are not reversible, so the solid material has to be stored and properly disposed of. Though producers may state that the solidified material can pass leachate tests (and thus be disposed of in non-hazardous landfills), each case will have to be tested.
- Disposal options for large volumes would include use as a fuel source in cement kilns, incinerators, etc. These options would require time for testing and permitting.

References

PERF, 1994. Solidifiers for oil spill response: Phase 1: Solidifier materials and effects on oil. Petroleum Environmental Research Forum (PERF) Project No. 92-16.

PERF, 1996. Oil spill solidifiers for upstream/downstream land application. Petroleum Environmental Research Forum (PERF) Project No. 94-14.

Who to Call for More Information or Additional Resources

Environment Canada, Emergencies Sciences Division, Ottawa, Canada Phone: (613) 988-9622

USEPA Oil Program Center, Washington, DC Phone: 703-603-9918

NOAA-HAZMAT, Seattle, WA 98115 Phone: 206-526-6317

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Table 20. Characteristics of Solidifier Products evaluated by PERF (1994, 1996) and/or on the NCP Product Schedule (as of December, 2002).

	Alsocup	CI Agent Blue	Enviro-Bond 403	Rubberizer	Waste Set PS 3200	Waste Set PS 3400
General Description	Granular material	White, odorless powder; block co-polymers	Granular material; block co-polymer	Granular material; mixture of hydro-carbon polymers	White, odorless powder; block co-polymer	White, odorless powder; block co-polymer
Listed in US?	**YES**	**YES**	**NO;** Received Sorbent Letter From EPA	**NO;** Received Sorbent Letter From EPA	**YES**	**YES**
Availability within 48 h	Stockpiles of 2,000 lbs in Chino, CA and 58,000 lbs in Ohio	50,000 lb in 72 hrs 20,000 lb in 48 hr 10,000 lb stockpile in Louisville 20,000 lb in Detroit	45,000 lb. NE 40,000 lb. SE 65,000 lb. Central 80,000 lb. SW 30,000 lb. W	10,000 lb stockpile, San Diego, CA and Houston, TX	Stockpile in Grand Rapids, MI	Stockpile in Grand Rapids, MI
Application Rate, % by weight of product to oil (per manufacturer)	10	10-30	14-25	18	20; may vary with viscosity and temperature	20; may vary with viscosity and temperature
Application Rate (lab test, with med. crude, Environment Canada)	Not tested	Not tested	18	24	Not tested	Not tested
Application Rate (PERF tests)	Not tested	diesel: 39 medium crude: 35 Bunker C: 36	diesel: 35 medium crude: 37 Bunker C: 38	diesel: 35 medium crude: 47 Bunker C: 50	Not tested	diesel: 35 medium crude: 30 Bunker C: 35
PERF Test Comments	NP	Product formed a firm pancake with gasoline, diesel, and Arab medium and Alaska North Slope crudes. With Bunker C and Maya crude, the material solidified but remained sticky	Formed a firm pancake with gasoline and Maya crude. Other oils solidified, but remained either sticky or gummy.	Product solidified all oil types. With gasoline, the pancake was firm; with diesel, it was firm but fell apart when lifted. Crude oils and bunker C solidified but did not form a cohesive mass	Not tested	Product formed a firm pancake with gasoline and all crude oils. The Maya crude was solidified after 2 days of stirring. Diesel and bunker C did not form a cohesive pancake; however, the materials solidified

	Alsocup	CI Agent Blue	Enviro-Bond 403	Rubberizer	Waste Set PS 3200	Waste Set PS 3400
Cure Time	Gasoline/Diesel – instantaneous; oil or hydraulic fluids will solidify to form a weak pancake that will break apart when disturbed. Can be removed with a pump.	Gasoline/Diesel-instantaneous; Oil/Hydraulic Fluids-1-2 minutes up to 1 hour	5 minutes	20 minutes	< 1 minute	< 1 minute
Solidification Process (from PERF report)	Chemical bond with oil; oil cannot leach once bound with Alsocup	Oil is absorbed into the interior of the particle where a chemical reaction takes place	Chemical bond with oil by cross linking polymers. No heat reaction	Solidification is by a physical bond	Oil is absorbed into the particle interior where a chemical reaction takes place	Oil is absorbed into the particle interior where a chemical reaction takes place
Use in Fresh Water?	Yes	Yes	Yes	Yes	Yes	Yes
Use in Salt Water?	Yes	Yes	Yes	Yes	Yes	Yes
Can the Oil be Returned to a Liquid	No	No	No	No	Yes; patented process	Yes; patented process
Disposal/Recycling Issues	Jelled mass may be recycled for use in rubber products	Can be disposed of in sanitary landfills in most cases	Can be disposed of in sanitary landfills or used as co-generation, or incineration	NP	NP	NP
Toxicity (LC-50, ppm) Note: a low value = high toxicity	Mummichug >100 (96h); Brine shrimp >100 (48h)	Mummichug 2,227 (96h); Brine shrimp 2,617(48h)	Brine shrimp >100,000 (48h)	NP	Mummichug >10,000 (96h); Brine shrimp 5431 (48h)	Mummichug >10,000 (96h); Brine shrimp >10,000 (48h)
Solubility in water	Insoluble	Insoluble	Insoluble	Insoluble	Insoluble	Insoluble
Other Information	Does not absorb water; agitation (manual or wave action) is necessary	See website: www.itscheapinsurance.com www.onsitewastemgmt.com	Web site: www.enviro-bond.com		Land use preferred	Water use preferred

	Alsocup	CI Agent Blue	Enviro-Bond 403	Rubberizer	Waste Set PS 3200	Waste Set PS 3400
Application Assistance Information*	ALSOCUP 714-490-1613	OnSite Waste Management. 502-241-1996 800-255-6073	On site management: 231-258-0400	HAZ_MAT Response Technologies, INC. 800-542-3036	C.B. Environmental, Inc. 616-784-0770	C.B. Environmental, Inc. 616-784-0770
Unit Cost**	NP	Unit cost = $6 to $16 per lb.	$3.10-$3.75 per lb. depending on quantity	NP	NP	NP
Photograph of Product (photos are added as they become available)						

NP = Not provided

* For additional technical assistance on product application, contact the supplier listed on the NCP Product Schedule Notebook.

** Unit costs are based on 2002 information supplied by the vendors, where provided. For a more up-to-date cost estimate, contact the supplier listed in the NCP Product Schedule. Generally, product prices decrease as purchase volume increases, and may also vary between distributors. Product application rates often vary greatly depending on use.

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Sorbents

(These Products may be listed under Miscellaneous on the NCP Product Schedule)

Mechanism of Action

- Sorbent is a general term applied to both absorbents and adsorbents. The source of these products can be natural or synthetic. They can be organic, inorganic, or mixed in composition. Proper use of these materials depends on the type of spill, location, and type of sorbent to be used. (ASTM definition)
- *Absorption* – a process where the material taken up is distributed throughout the body of the absorbing material. (The body of the absorbing material must swell.)
- *Adsorption* – a process where the material taken up is distributed over the surface of the adsorbing material
- Sorbing material can include: natural organic substance, synthetic organic substance, an inorganic substance, or a mixture of the three. The material may also be treated with oleophilic and hydrophobic compounds to improve performance.
- Typically low density (less than 1.0 g/cm3) allowing the sorbent to float on water.
- Sorbents are produced in the following forms: sheets, pads, blankets, and mats; loose unconsolidated particulate material; pillows and socks; booms; sweeps; and agglomerated unit (e.g., pom pom, yarn, or netting).
- Efficiency depends upon the capacity of the particular sorbent, wave or tidal energy, and viscosity and stickiness of the oil.

When to Use

- In nearshore, calm areas where oil needs to be recovered.
- Spill conditions vary widely. See Table 21 for an analysis of the type oil types best suited for each sorbent product category.
- When the decision-maker wants or is willing to try sorbents that are different from those normally used.

Authority Required

- **Incident-specific RRT member approval is NOT required** if the product is **NOT required** to be listed on the NCP Product Schedule under the Miscellaneous Oil Spill Control category. **Incident-specific RRT member approval WOULD be required** for sorbents that are required to be listed on the NCP Product Schedule. Refer to Appendix G for the list of products that have been evaluated by USEPA and determined not required to be listed on the NCP Product Schedule. A draft copy of the official USEPA letter for sorbents not required to be listed on the NCP Product Schedule is provided in Appendix C.

Availability

- Varies widely. See Table 21 for a description of the sorbent characteristics in addition to the three traditional sorbent materials (polyurethane, polyethylene, and polypropylene). **NOTE**: As of December, 2002, there were no sorbent products listed on the NCP Product Schedule.
- This Selection Guide does not address individual product costs due to the very large number of products available, in various forms, for the sorbent categories listed in Table 21.

General Application Requirements

- In general, sorbent material is placed on land, the water surface (fresh/estuarine/salt) or along the shore at the waterline.
- Recovery of all sorbent material is **mandatory**. Loose particulate sorbent material must be contained in mesh or other material before applying to water. Loose sorbent can be applied to water or hard surface, such as concrete floors as long as it can be completely recovered.

Health and Safety Issues

- Varies widely. In general, only potential health effect could result from inhaling loose particulate.

Limiting Factors/Environmental Constraints

- All sorbents, conventional or alternative, must be retrieved for proper disposal. Sorbent use may be better for recovering small quantities of oil in order to avoid generating excessive amounts of waste.
- Oiled and unoiled sorbents left in place too long can break apart and present an ingestion hazard to wildlife, or smother animals and plants.
- Not enough is known about the long-term impacts from some of the sorbents.
- Access for deploying and retrieving sorbents should not adversely affect wildlife nor impact soft or sensitive habitats (marshes, sheltered tidal flats, etc.).
- Should not be used in a manner that might endanger or trap wildlife.

Monitoring Requirements/Suggestions

- Monitoring of all sorbent use locations is very important to ensure that all sorbent can be recovered for proper disposal.
- Monitoring may be even more important for sorbents to ensure that oiled sorbents do not sink, break down, etc. over time.

Waste Generation and Disposal Issues

- Sorbents must be collected and properly disposed of. Check product specific requirements on the following table.
- Care should be taken to select and use sorbents properly, to prevent generation of large quantities of lightly oiled sorbent.
- Recycling of sorbents, rather than disposal, should be emphasized.

References

Cooper, D., S. Penton, K. Rafuse, and A.B. Nordvik. 1994. An evaluation of oil sorbent materials. In: Proc. 1994 Arctic and Marine Oil Spill Program (AMOP). Environment Canada, Vancouver, BC, Canada, pp. 581-592.

Overstreet, R. and J.A. Galt. 1995. Physical processes affecting the movement and spreading of oils in inland waters. NOAA Hazardous Materials Response and Assessment Division, Seattle, WA. Report No. HMRAD 95-7. 46 pp.

ASTM International, 2001. Standard Methods of Testing Sorbent Performance of Absorbents. Standard No. F716-82. Book of Standards Vol 11.04, pp.927 – 931

ASTM International, 2001. Standard Methods of Testing Sorbent Performance of Absorbents. Standard No. F726-81. Book of Standards Vol 11.04, pp.932 - 938

Who to Call for More Information and Additional Resources

USEPA Oil Program Center, Washington, DC Phone: 703-603-9918

USCG Research and Development Center, Groton, CT Phone: 860-441-2733

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Table 21. Characteristics of Sorbents. Developed from Cooper *et al.* (1994).

	Imbiber Beads™	Pristine Sea I	Sorbent Clay/Treated Clay	Natural Organic	Wood Fiber (Cellulose)
General Description	The oil is absorbed into the interior of the hydrophobic particles. The beads swell up to 3 times their original size ***Received sorbent certification letter as stated in NCP300.915(g)(4) Certification***	Oleophilic treated clay. A sorbent material consisting solely of materials listed in section 300.915 (g) (1) of the NCP	Composed of fine particles of aluminum silicates and other materials or any such material that has been treated to be hydro-phobic and/or oleophilic; loose	Composed of naturally derived materials (not including wood fibers) such as peat moss, millet, cotton, etc.; loose	Cellulose-based sorbents such as wood chips, sawdust, cork, and any paper derivatives. Includes cellulose-based sorbents that contain synthetic polymers used for structural integrity; varies
Example		Treated hydor-phobic/Oleophilic clay	Treated Kitty Litter	Puffed Millet Bagasse	Cellulose Fiber Mat
Oil Viscosity Effectiveness Range[1]; (average gm Oil per gm sorbent)	Not tested by Cooper *et al*., 1994	10 to 15,000 cP; (<10) Relatively consistent in sorbent capability.	10 to 15,000 cP; (< 10) Relatively consistent in sorbent capability	10 to 15,000 cP; (< 10) Relatively consistent in sorbent capability	10 to 50,000 cP; (<20) Relatively consistent in sorbent capability
Anticipated Value	May reduce vapor rates five to six times	Readily available	Readily available		

1 For relative oil/product viscosity scales, refer Table 22.
2 Traditional sorbent materials.

Table 21. Continued.

	Feathers	Treated Natural Organics	Treated Wood Fiber (Cellulose)	Expanded Mineral
General Description	Any sorbent that uses feathers as its oleophilic component, including feathers contained in polysheath;	Composed of naturally derived materials (not including wood fibers) such as peat moss, millet etc., which has been treated to become hydrophobic and/or oleophilic (e.g., Natural Sorb);	Cellulose-based sorbents such as wood chips, sawdust, cork and paper derivatives which have been treated to become hydrophobic and/or oleophilic;	Formed from minerals that expand upon heating to yield low bulk density material such as perlite and vermiculite
Example	Untreated Waterfowl Feathers	Heat Treated Peat Ammoniated Bagasse	Treated Cellulose Treated Coconut fibers	Vermiculite
Oil Viscosity Effectiveness Range[1]; (average gm Oil per gm sorbent)	10 to 50,000 cP; (< 60) Greatest sorbency between 100 to 3,000 cP	10 to 15,000 cP; (~ 10) Relatively consistent in sorbent capability	10 to 50,000 cP; (< 10 for cellulose; < 20 for coconut fibers) Greatest sorbency for coconut fibers between 3,000 to 15,000 cP	10 to 15,000 cP; (< 10) Relatively consistent in sorbent capability
Anticipated Value	Readily available			

1 For relative oil/product viscosity scales, refer to Table 22.
2 Traditional sorbent materials.

Table 21. Continued.

	Foamed Glass	Polyurethane[2]	Polyethylene[2]	Polypropylene[2]
General Description	Formed from amorphous silicate glass foam, consisting of spheroid-shaped particles with numerous cells and characterized by very low bulk densities	Formed for many of the various polymers that contain -NHCOO- linkages. Such polymers are generally foamed	Formed from polymers of ethylene	Formed from polymers of propylene. Generally bonded together by heat or needle punching and usually come in the form of pads or mats
Example	Sodium/Calcium Borosilicate Glass	Polyurethane Foam	Polyethylene Pulp	Polypropylene Mat
Oil Viscosity Effectiveness Range[1]; (average gm Oil per gm sorbent)	10 to 100 cP; (< 10) Product samples unavailable; testing incomplete	10 to 50,000 cP; (10 > 30) Greatest sorbency between 10 to 1,000 cP	10 to 50,000 cP; (10 > 20) Greatest sorbency between 100 to 8,000 cP	10 to 50,000 cP; (10 > 20) Relatively consistent in sorbent capability
Anticipated Value	Hard to find			Readily available; Sorptive capacity typically 10-25 times its weight.

1 For relative oil/product viscosity scales, refer to Table 22.
2 Traditional sorbent materials.

Table 21. Continued.

	Cross-Linked Polymers	Other Polymers	Silicate Sorbents	Mixtures
General Description	Plastic sorbents formed from molecules lightly cross-linked to each other, which imparts imbibing qualities to the material, i.e., alkylstyrenes	Polymer-based sorbents that fall outside the other polymer categories such as rubber, collagen, and polymers of formaldehyde	Formed from silicates, not including clays and treated clays, such as diatomaceous earths and synthetic silicate sorbents. These sorbents are normally finely divided powders	Formed from mixtures of various materials. A single type of sorbent contained within a polysheath does not qualify as a mixture
Example	Alkylstyrene Copolymer	Polyamine Flakes Ground Rubber Flexible Collagen Sponge	Natural Diatomaceous Earth	Wood Fiber, Clay, and SiO2, combined
Oil Viscosity Effectiveness Range[1]; (Average gm Oil per gm sorbent)	10 to 15,000 cP; (<< 10) Relatively ineffective for all oil viscosities tested	10 to 15,000 cP; (10 > 70 for polyamine flakes; << 10 for ground rubber; 20 > 80 collagen) Greatest sorbency between 100 to 8,000 cP for polyamine flakes Greatest sorbency between 10 to 100 cP for collagen	10 to 3,000 cP; (< 10) Relatively consistent in sorbent capability	10 to 15,000 cP; (< 10) Relatively consistent in sorbent capability
Anticipated Value				

1 For relative oil/product viscosity scales, refer to Table 22.
2 Traditional sorbent materials.

Table 22. Viscosity ranges for oils used in testing by Cooper *et al*. (1994) and other familiar substances (Overstreet and Galt, 1995) at room temperature.

Liquid	Actual Viscosity (cP) of Oil Products (Cooper *et al.*, 1994)	Relative Viscosity (cP) of Oil and Other Products (Overstreet & Galt, 1995)
Water	-	1
Kerosene	-	10
Albert Sweet Mixed Blend (ASMB)	37	-
SAE 10 motor oil	-	100
Saudi Light Crude Oil	250	-
Weathered Saudi Light Crude Oil	700	-
Glycerin or castor oil	-	1,000
Weathered Saudi Light Crude Oil	1,100	-
17% ASMB / 83% Bachaquero Mixture	3,400	-
Corn syrup	-	10,000
Bachaquero Crude	12,200	-
Weathered Bachaquero Crude	24,000	-
Extensively Weathered Bachaquero Crude	40,000	-
Molasses	-	100,000
Peanut butter	-	1,000,000

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SURFACE COLLECTING AGENTS
(This is a Category on the NCP Product Schedule)

Mechanism of Action

- Chemicals that " push" or "compress" oil on the water surface into a smaller area, to form thicker slicks that are more readily recovered.
- They exert a spreading pressure on the water surface greater than the oil slick. They contain special types of surfactants to reduce the surface tension of water, thus increasing the spreading pressure. Also called herding agents.
- Effective agents must have the following characteristics: Remain as a liquid at ambient temperatures of use; High spreading pressure (>35 x 10-7 Newtons/m); Low evaporation rate; Low water and oil solubility; Will not disperse or emulsify.

When to Use

- To push oil out from inaccessible areas (e.g., under piers) to recovery devices.
- To collect oil into a smaller area and thicker slick to increase recovery rates.
- For short-term protection in areas where deploying booms is not possible or could cause more damage (e.g., in very shallow water in front of a wetland).
- Herders are most effective where they have something to push against (e.g., docks or semi-enclosed areas). Their use in the open sea is more limited.

Authority Required

- **Incident-specific RRT approval is required. NOTE**: As of December, 2002, there were no surface collecting agents on the NCP Product Schedule. However, as defined in this document, the Product Rapidgrab 2000 (listed as a Miscellaneous Oil Spill Control Agent) is classified as a surface collecting agent and is addressed in Table 23.

Availability

- See the following table (Table 23) for the current availability of this product.

General Application Requirements

- The product is applied by spray systems (hand-held, vessel-mounted, or from aircraft) in very small quantities (1-15 gallons per linear mile) to the water surface at the perimeter of a slick.
- Do not allow the product to come into contact with operational parts of oil recovery devices because it will cause oil to be repelled from them.

Health and Safety Issues

- Use appropriate level of personal protection for each product (See product comparison tables on the following pages).

Limiting Factors/Environmental Constraints

- Limiting factors include rain, winds greater than about 5 mph, and moderate currents, all which will break the surface film, rendering the product ineffective.
- They are more effective on thin films and low viscosity oils.
- Because of their low application rates and low water solubility, acute toxicity is of most concern in very shallow waters.

Monitoring Requirements/Suggestions

- Visual monitoring to determine whether product use is effective, and when reapplication is needed.

Waste Generation and Disposal Issues

- None. The product does not change the physical condition or volume of the oil. The product is not recovered.

References

Walker, A.H., J. Michel, G. Canevari, J. Kucklick, D. Scholz, C.A. Benson, E. Overton, and B. Shane. 1993. Chemical Oil Spill Treating Agents. Marine Spill Response Corporation, Washington, DC. MSRC Technical Report Series 93-015. 328 p.

Who to Call for More Information and Additional Resources

NOAA-HAZMAT, Seattle, WA 98115 Phone: 206-526-6317.

Table 23. Characteristics of Surface Collecting Agents.

	RapidGrab 2000
General Description	Non-ionic liquid formulation with a specific gravity of 0.84
Is Product Listed for Use in US?	Yes. Listed under Miscellaneous on the NCP.
Availability within 48 h (see Note below)	GlobeMark Resources, Ltd. 937-643-1796
Application Rate (per manufacturer)	Spray neat as droplets on oil sheen
Spreading Pressure	NP
Solubility in water	Soluble in oil and solvents
Use in Fresh Water?	NP
Use in Salt Water?	NP
Toxicity (LC-50, ppm) Note: a low value = high toxicity	
Mummichug 96 h	5.1
Brine shrimp 48 h	2.3
Unit Cost	NP
Photograph of Product (photos are added as they become available)	

NP = Information not provided

Note: As of December, 2002, there were no Surface Collecting Agents on the NCP Product Schedule. For this Selection Guide, RapidGrab 2000 (listed on the NCP Product Schedule as a Miscellaneous Oil Spill Control Agent) is classified as a surface collecting agent due to its mechanism of action. The current availability of this product is not known.

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SURFACE WASHING AGENTS

(This is a Category on the NCP Product Schedule)

Disclaimer: Decisions for Public Safety Issues for Fires are under the Purview of the Lead Public Emergency Response Agency.

Mechanism of Action

- These products contain surfactants, solvents, and/or other additives that work to clean oil from substrates.
- Many products are essentially industrial cleaners that emulsify the oil, much in the same way that dishwashing soap cleans the grease off dishes. The treated oil is broken into small droplets that are kept in suspension by the surfactant (soap).

"Lift and disperse" products are those for which the product literature states that the oil is dispersed, emulsified, or encapsulated. Thus, the washwater from these products should not be flushed into waterbodies or left untreated, but must be contained, recovered, and properly treated.

"Lift and float" products are those where the released oil is not dispersed but readily floats on the water surface and is recoverable. Thus, the washwater from these products should not be flushed into waterbodies, but should be contained, recovered, and properly treated.

When to Use

- On hard-surface shorelines where there is a strong desire to remove residual oils.
- When the oil has weathered so that it cannot be removed from a substrate using ambient water temperatures and low pressures.
- When the oil is trapped in areas inaccessible to physical removal but which can be flushed and the washwaters contained, such as in sewers, storm drains, and ravines.
- For volatile fuel spills that have entered sewers, for vapor suppression, and to enhance flushing recovery, as long as all washwaters are recovered and prevented from being discharged into the environment.

Authority Required

- Incident-specific RRT approval is required to use surface washing agents in any manner that would cause for them to be released to the environment.
- Verify state requirements for discharge and waste management.

- **NOTE**: As of december, 2002, there were 21 surface washing agents listed on the NCP Product Schedule. **For this Selection Guide, PES-51 and PX-700 (listed on the NCP Product Schedule as Miscellaneous Oil Spill Control Agents) are classified as surface washing agents due to their mechanism of action**. Only products listed on the NCP Product Schedule are reported in Table 24. Appendix K contains information on Surface Washing Agents that have been removed from the NPC Product Schedule.
- Fire Departments and HAZMAT teams have the authority to "hose down" a spill using a chemical countermeasure if they determine that the spilled oil could cause an explosion and/or threaten human health.

CONTAINMENT AND RECOVERY SHOULD BE THE NORM, NOT THE EXCEPTION

Availability

- Varies widely by product. See Table 24 for specific products.

General Application Requirements

- Products are sprayed either neat or diluted with water. For small applications, hand-held units such as hudson sprayers are used; larger, diluted applications use eduction systems coupled with fire hoses, power washers, etc.
- Application rates vary widely and may be difficult to monitor and control.
- There is some period for soaking or scrubbing, and then the area is flushed with water. Heated water (in both spray and flush) is sometimes required for very sticky oils.
- All released oil must be recovered, so systems are needed to contain and treat the washwater from "lift and disperse" products, which can require considerable operational support.
- Washwaters from using "lift and float" products may be discharged after oil separation, **though** there will be site-specific requirements.

Health and Safety Issues

- All products required Level D personal protection with splash protection.
- Slips, trips, and falls from working on oily surfaces may be of concern.

Limiting Factors/Environmental Constraints

- On shorelines, there are usually restrictions on direct spraying of intertidal biota and flushing across sensitive substrates.
- Only those products which have been documented to be safe to use on vegetation should be applied to vegetated areas.
- Under no conditions should washwaters from land surfaces be allowed to enter waterbodies without proper treatment. Check with wastewater plant operators before washwaters are flushed into sewers to make sure that they can accept the wastes.

- Use lift and float products in open-water settings, to allow oil recovery. Exception would be in high energy environments where the oil cannot be recovered (so it would be better to let it disperse rather than re-oil adjacent areas).

Monitoring Requirements/Suggestions

- Conduct effectiveness testing of selected products to determine the best one for the spill conditions.
- May need effects monitoring if sensitive resources are at risk during use.
- On shorelines, "first use" monitoring of sensitive biota should be conducted to make sure that adverse effects are not occurring under actual use conditions.
- For land application, monitor downstream waterbodies to detect fish kills or other impacts from inadvertent discharges from the cleanup area. Immediately contain any discharges.

Waste Generation and Disposal Issues

- Because released oil must be recovered, waste generation is a function of recovery method. Sorbents are often used with "lift and float" products. Local conditions will determine whether the water must also be collected and treated, or can be discharged safely.
- When the oil is dispersed, all of the washwater must be contained and treated prior to discharge, often to wastewater treatment plants if the oil concentrations are low. For high oil concentrations, oil recovery can be increased by the use of emulsion-breaking agents.

References

Michel, J. and B.L. Benggio. 1995. Testing and use of shoreline cleaning agents during the *Morris J. Berman* spill. In: Proc. 1995 Intl. Oil Spill Conference, API Publication No. 4620, American Petroleum Institute, Washington, DC. pp. 197-202.

Revion 5 Regional Response Team Surface Washing Agent protocols.

Who to Call for More Information and Additional Resources

USEPA-ORD, Cincinnati, OH 48256 Phone: 513-569-7668

USEPA-ERT, Edison, NJ 08837 Phone: 732-321-6740

NOAA-HAZMAT, Seattle, WA 98115 Phone: 206-526-6317

Environment Canada, Emergencies Sciences Division, Ottawa, Canada Phone: (613) 988-9622

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Table 24. Characteristics of Surface Washing Agents Listed on the NCP Product Schedule (as of December, 2002).

	Aquaclean	Biosolve	CN-110	Corexit 7664	Corexit 9580
General Description	Alkaline, green, water-based detergent concentrate	Thick, pink, water-based detergent concentrate	Clear amber; slightly viscous liquid	Water-based concentrate containing non-ionic surfactants	Surfactants in a de-aromatized hydrocarbon-based solvent. Yellow.
Availability (amount per location)	As needed on demand; manufacturer at Madison, Indiana	At least 5,000 gal at Westford, MA; 200-1000 gal each in NY, CA, OK, IL, and Alberta, Canada	Varies; manufactured in Broussard, LA; distributed by LK Enterprises in Oceanside, CA	Varies; manufacturer at Sugar Land, TX	varies; Sugar Land, TX; 3-5 days lead time for production of 400 bbl/day
Application Rate	Spray 33%-50% solution to cover contaminated area	1:6 product to oil, applied as a .5%-6% solution	1:10 product to oil, applied as 1 gal (10% solution)/100 ft2	1:25 product to oil, applied as 1-3% solution at 1 gal/10-15 ft2	1:2.5 product to oil, applied at 1 gal (neat)/100 ft2
Application Method	Pressure spray solution on oiled area, then agitate using solid stream of rinse water	Pressure spray solution on oiled area, then agitate using solid stream of rinse water	Spray diluted product on oiled area, let soak, then rinse, preferably with fresh water. Diluted product can be sprayed prior to oil contamination to act as a repellant	Spray solution on oiled area, then rinse. Never spray as a fog or mist; droplets only	Spray neat product on oiled area, soak, then rinse with high-pressure water; for persistent oil, use hot-water rinse
Soak Time	3-5 minutes	None	30-60 minutes	None	0-30 minutes
Temperature Limitations	Water temp. should be above 41°F	Keep from freezing	Water temp. should be above 32°F	None	None
Effectiveness in Environment Canada lab test	Not tested	Not tested	Not tested	Freshwater: 25% Saltwater: 27%	Freshwater: 69% Saltwater: 53%
Use in Fresh Water?	Yes	Yes	Yes	Yes	Yes
Use in Salt Water?	? says to dilute product & rinse with fresh water	Yes	Yes	Yes	Yes
Toxicity (LC-50, ppm) Note: a low value = high toxicity	Mummichug 70.7 (96h); Brine shrimp 11.7 (48h) Did not enhance toxicity of No. 2 fuel oil	Fathead minnow > 750 (96h); Rainbow trout 9 (96h); Algae growth 30 (72h)	Did not enhance toxicity of No. 2 fuel oil	Mummichug >1,000 (96h); Rainbow trout 850 (96h); Zebra fish >10,000 (48h); Brine shrimp >10,000 (48h) Did not enhance toxicity of No. 2 fuel oil	Mummichug >10,000 (48h); Rainbow trout >10,000 (96h); Brine shrimp 2,400 (48h); Oyster larvae 38 (48h) Did enhance toxicity of No. 2 fuel oil for shrimp
Inland silversides 96 h	70.7	6.4	52,200	87	87

	Aquaclean	Biosolve	CN-110	Corexit 7664	Corexit 9580
Mysid shrimp 48 h	32.7	3.6	12,300	584	32
Solubility in water	100%	100%	100% in freshwater	100%	Insoluble
Other Information	100% solution pH = 11.8; 1% pH = 10; Manufacturer recommends use as industrial cleaner, not for use in the environment	Contains no nutrients, enzymes or bacteria cultures; primarily used for vapor suppression	pH = 11.4 Product can be used as a repellant - when applied to surface, will not allow oil to adhere	Can be used to water-wet surface so oil will not adhere to it	Lab and field tests on salt marshes and mangroves showing little effects on plants when exposed to this product
Is Treated Oil Recoverable?	No; the oil is dispersed	"Yes, the oil can be vacuumed or sorbed."	Yes; released oil can be skimmed	No; the oil is dispersed	Yes; at least partially
Application Assistance Information*	Madison Chemical Company, Inc. 812-273-6000	The Westford Chemical Corp. 978-392-0689 508-885-1113 800-225-3909	Chemex, Inc. 318-837-9148	NFSCC ABASCO 281-931-4400	NFSCC ABASCO 281-931-4400
Unit Cost**	Unit cost = $6.00 per gal.	Unit cost = $25.90 per gal.	$14-$16 per gallon	NP	NP
Photograph of Product (photos are added as they become available)					

* For additional technical assistance on product application, contact the supplier listed on the NCP Product Schedule Notebook.

** Unit costs are based on 2002 information supplied by the vendors, where provided. For a more up-to-date cost estimate, contact the supplier listed in the NCP Product Schedule. Generally, product prices decrease as purchase volume increase, and may also vary between distributors. Product application rates often vary greatly depending on use.

NP Not provided

NSFCC National Strike Force Coordination Center

Table 24. Continued.

	CytoSol	Do All #18	F-500	FM-186-2	Gold Crew SW
General Description	Biosolvent containing methyl esters derived from vegetable oils and bioremediation enhancers. No surfactants or emulsifiers. Amber color.	NP	NP	NP	Concentrated water based hydrocarbon-releasing agent. Suppresses VOC vapors while releasing entrapped oils.
Availability (amount per location)	Distributors: Point Richmond and Carson, CA; Seattle, WA	20 to 40 drums in Damon, Texas; 4-5 day lead time for additional product	Distributor in Fayetteville, GA	Distributor in West Sacramento, CA	3,500 gal, San Diego, CA 1,000 gal, Houston, TX
Application Rate	Between 0.5:1 and 1:1 product to oil applied neat	Dilute 1:50 to 1:3 product to water depending on application method	1 part product:8 parts hydrocarbon:32 parts water	Apply neat	Dilute 1:10 or higher depending on type of oil or refined product
Application Method	Spray neat product on contaminated area, let soak, then rinse with water deluge or gentle spray	Spray, mop, agitate, soak, steam or pressure wash product on affected area then rinse	Standard fire apparatus spray nozzle with agitation	Apply through power washer or steam powered unit, for pre-soak use hand pump sprayer	First soak, then pressure or steam wash the area with 1%-5% solution
Soak Time	At least 1 hour; longer in cold weather	Varies	NP	15-60 minutes depending on weather and oil type	15-60 minutes
Temperature Limitations	NP	None	33°-211°F	None	25°F to 120°F
Effectiveness in Environment Canada lab test	Not tested	NP	NP	NP	NP
Use in Fresh Water?	Yes	Yes	Yes	Yes	Yes
Use in Salt Water?	Yes	Yes	Yes	Yes	Yes
Toxicity (LC-50, ppm) **Note: a low value = high toxicity**	Did not enhance toxicity of No. 2 fuel oil for shrimp; slight increase in toxicity for silversides			Slight increase in toxicity of No. 2 fuel oil for shrimp; Did not enhance toxicity for silversides	
Inland silversides 96 h	738	66	1.2	160.7	13
Mysid shrimp 48 h	124	288	21	329.9	20

	CytoSol	Do All #18	F-500	FM-186-2	Gold Crew SW
Solubility in water	14 ppm in fresh water; 7 ppm in sea water	100% soluble	100% soluble	100% soluble	100% soluble
Other Information	Product tested on spills on mussel beds, gravel beach, and on stream vegetation, with good results Used during *New Carissa,* 1999.	pH: 13.1	Effective on both polar and non-polar hydrocarbons hctgreiner@aol.com	greierson@ecschem.com	pH: 9.76 www.GOLDCREW.net Vapor suppression Boom cleaning Bioaugmentation
Is Treated Oil Recoverable?	Yes; released oil can be skimmed. Remaining oil is biodegraded in 6-12 weeks	No, the oil is dispersed	NP	Yes	Yes
Application Assistance Information*	CytoCulture International, Inc. 510-233-0102	Studin & Associates 305-623-6379	Hazard Control Technologies, Inc. 770-719-5112 hctgreiner@aol.com	Environmental Chemical Solutions, Inc. 916-372-9140	Ara Chem, Inc. 619-286-4131 Gold Crew products and Services 888-414-8384
Unit Cost**	Unit cost = $6-$12 per gal	$13 per gallon	NP	NP	$28-$34 per gallon
Photograph of Product (photos are added as they become available)					

* For additional technical assistance on product application, contact the supplier listed on the NCP Product Schedule Notebook.

** Unit costs are based on 2002 information supplied by the vendors, where provided. For a more up-to-date cost estimate, contact the supplier listed in the NCP Product Schedule. Generally, product prices decrease as purchase volume increase, and may also vary between distributors. Product application rates often vary greatly depending on use.

NP Not provided

NSFCC National Strike Force Coordination Center

Table 24. Continued.

	Nale It	Nature's Way Power Clean	PES-51	PX-700
General Description	NP	Aqueous blend of surfactants/emulsifiers, and select, aerobic microbes. No VOC's.	Clear liquid containing biosurfactants and d-limonene as a solvent	Liquid with surfactant and citric acid
Availability (amount per location)	Distributor in Elemore City, OK	660 gal immediately; 6,000 gal/day, Houston, TX, national distribution	2,000 gal, San Antonio, TX; 1,000 gal, Seattle, WA; 7 day lead time	+800 gal Cocoa, Fl; 48 hour production lead time
Application Rate	1:20 product:water	1:2.5 product to oil, applied as 1 gal (neat)/100 ft2 or 2-12oz./gallon of water	1:5 product to oil, applied as 1 gal per 150-200 ft2	1:1 (undiluted) for removal of oily sheen; 1:25 product to oil for equipment cleaning; 1:50 for immersing wildlife to remove oil
Application Method	May be applied with a pressure washer	Spray, pressure wash, mop, agitate and rinse; Hot water should not be used with this product.	Spray neat product on oiled area, then rinse with high-pressure, ambient water	Spray neat product on oiled area, then rinse with high-pressure, ambient water
Soak Time	NP	5minutes to overnight	2-5 minutes	N/A; may need to reapply with heavy oils
Temperature Limitations	None	32°F to 120°F	None	None
Effectiveness in Environment Canada lab test	NP	Not tested	Fresh water: 23% Salt water: 21%	Not tested
Use in Fresh Water?	Yes	Yes	Yes	NP
Use in Salt Water?	Yes	Yes	Yes	Yes
Toxicity (LC-50, ppm) **Note: a low value = high toxicity**	Toxicity of No.2 fuel oil is slightly increased for shrimp and silversides	Did not enhance toxicity of No. 2 fuel oil	Mummichug 1,425 (96h); Fathead minnow 810 (96h); Rainbow trout 14 (96h); Brine shrimp 665 (48h); Pacific oyster larvae 19 (48h); Bay mussel larvae 10 (48h) Did not enhance toxicity of No. 2 fuel oil	Toxicity data derived for concentrated (undiluted) product

	Nale It	Nature's Way Power Clean	PES-51	PX-700
Inland silversides 96 h	273.3	152	137	380
Mysid shrimp 48 h	69	193	54	297
Solubility in water	100% soluble	100% soluble	Insoluble	Soluble
Other Information	NP	Other Nature's Way products have microbes, and biocatalysts, but are not listed on the NCP. In TX is listed as a bioremediation enhancement agent	Extensive use in decon of response equipment On NCP Product Schedule as Miscellaneous Spill Control Agent	pH: 3.5 to 4.0 On NCP Product Schedule as Miscellaneous Spill Control Agent
Is Treated Oil Recoverable?	NP	No; the oil is dispersed	Yes; the treated oil readily floats	Yes; the treated oil readily floats
Application Assistance Information*	SPL Control LLC 580-788-2187	Integra Environmental, Ltd. 713-680-1234 877-866-9197 www.integraenvironmental.com	Practical Environmental Solutions, Inc. 210-822-4205 or 410-659-1699	Natural Resource Protection Corp. 888-633-6773 954-565-6148
Unit Cost**	NP	Unit cost = $8-$15 per gal.	$24.50-$28.60 per gal.	Unit cost = $42 per gal.
Photograph of Product (photos are added as they become available)				

* For additional technical assistance on product application, contact the supplier listed on the NCP Product Schedule Notebook.

** Unit costs are based on 2002 information supplied by the vendors, where provided. For a more up-to-date cost estimate, contact the supplier listed in the NCP Product Schedule. Generally, product prices decrease as purchase volume increase, and may also vary between distributors. Product application rates often vary greatly depending on use.

NP Not provided

NSFCC National Strike Force Coordination Center

Table 24. Continued.

	Petro-Clean	Petro-Green ADP-7	Petrotech 25	Premier 99	SC-1000
General Description	Light yellow liquid	Viscous, water-based detergent concentrate, amber colored	Viscous, green, water-based concentrate	Alkaline, red water-based detergent concentrate. Foamy	Highly concentrated liquid
Availability (amount per location)	NP	1,100 gal, Dallas, TX; can produce 550 gal/day	5-10,000 gal, Charlotte, NC; 10 day lead time for production	10,000 gal, Pembroke, FL; 14 days lead time for production	20 drums in Phoenix, AZ; 2 week lead time
Application Rate	Varies; 0.5% to 6% solution	25 gallons of product per 1 ton of oil applied as 2-3% solution at 100 barrels/acre	1:10 product to oil as a 3-10% solution or undiluted	Dilution of concentrate with water ranges from 1:5 product to water to as little as 1:50.	1:1 to 1:350 product to water depending on application method and surface type
Application Method	Spray, power washers, or with eductor	Spray neat or diluted product on contaminated area, then rinse with high-pressure water	Spray 10-40% solution, using either hot or cold water, on contaminated area, then rinse with hot or cold water; or spray neat product, then wipe or scrub before rinse	Spray/mop 5-20% solution on contaminated area, scrub, then rinse well	Spray solution on oiled area, let soak, then rinse with water
Soak Time	NP	None	None	None	1-10 minutes
Temperature Limitations	Above 35°F	None	None	Above 32°F	28°-280°F
Effectiveness in Environment Canada lab test	Not tested	Not tested	Not tested	Not tested	Not tested
Use in Fresh Water?	Yes	Yes	Yes	Yes	Yes
Use in Salt Water?	Yes	Yes	Yes	Yes	Yes
Toxicity (LC-50, ppm) **Note: a low value = high toxicity**	Did not enhance toxicity of No. 2 fuel oil	Slightly enhanced toxicity of No. 2 fuel oil	Mummichug 4,830 (96h); Rainbow trout 1,460 (96h) Brine shrimp 2,480 (48h) Slightly enhanced toxicity of No. 2 fuel oil for mysid shrimp	Did not enhance toxicity of No. 2 fuel oil	
Inland silversides 96 h	100	11.6	601	566	26

	Petro-Clean	Petro-Green ADP-7	Petrotech 25	Premier 99	SC-1000
Mysid shrimp 48 h	110	10.6	350	95	15
Solubility in water	100% soluble	100% soluble	100% soluble	100% soluble	99.9% soluble
Other Information	pH = 8.05 (10% solution) www.alabastercorp.com	pH = 10.5	Approved in France as a dispersant	pH = 12.5 www.goldcoastchem.com	pH: 10.2-10.5
Is Treated Oil Recoverable?	No; the oil is dispersed.	No; the oil is dispersed	No; the oil is dispersed	No; the oil is dispersed	Yes
Application Assistance Information*	Alabaster Corp. 281-487-5482 800-609-2728	Petro-Green, Inc. 972-484-7336	Petrotech America Corp. 617-491-6660	Gold Coast Chemical Products 954-893-0044 954-893-8884 fax	Gemtek Products 602-265-8586 800-331-7022
Unit Cost**	NP	Unit cost = $10.64 per gal.	Unit cost = $7.50 per gal.	Unit cost = $7.95 per gal.	$316.25 per drum (55 gal)
Photograph of Product (photos are added as they become available)					

* For additional technical assistance on product application, contact the supplier listed on the NCP Product Schedule Notebook.

** Unit costs are based on 2002 information supplied by the vendors, where provided. For a more up-to-date cost estimate, contact the supplier listed in the NCP Product Schedule. Generally, product prices decrease as purchase volume increase, and may also vary between distributors. Product application rates often vary greatly depending on use.

NP Not Provided

Table 24. Continued.

	SX-100	Simple Green	Split Decision	Topsall #30
General Description	NP	Green water-based detergent concentrate	Water-based concentrate	Alkaline, pink water-based detergent concentrate
Availability (amount per location)	Distributor in Colorado Springs, CO	Distributor- Sunshine Makers; Huntington Harbor, CA	3 Distributors in Texas	Distributors in FL and LA
Application Rate	Up to 1:200 product to water, contact manufacturer for specific rates	1:4 product to oil; Dilution of concentrate with water ranges from 1:50 to full strength	Dilution of concentrate with water ranges from 1:3 product to water to as little as 1:50.	1:5 product to oil
Application Method	Contact manufacturer for specific application methods	Spray solution on oiled area, let soak for 5-10 minutes, then rinse with water	Spray diluted concentration (with water) on oiled surface or water	Spray/mop .2-20% solution on oiled area, scrub, then rinse well
Soak Time	NP	5-10 minutes	None	3 minutes
Temperature Limitations	32°-130°F	Keep from freezing	Keep from freezing	Air and water temp above freezing
Effectiveness in Environment Canada lab test	NP	Not tested	Not tested	Fresh water: not tested Salt water: 14%
Use in Fresh Water?	Yes	Yes	Yes	Yes
Use in Salt Water?	Yes	Yes	Yes	Yes
Toxicity (LC-50, ppm) **Note: a low value = high toxicity**	Did not enhance toxicity of No.2 fuel oil for shrimp of silversides	Mummichug 1,690 (48h); Brine shrimp 610 (48h); Grass shrimp 270 (48h); Green lipped mussel 220 (48h); Mud snail 410 (48h) Did not enhance toxicity of No. 2 fuel oil		Rainbow trout 354 (96h) Did not enhance toxicity of No. 2 fuel oil
Inland silversides 96 h	32	28	8.3	157
Mysid shrimp 48 h	32	78	8.2	116

	SX-100	Simple Green	Split Decision	Topsall #30
Solubility in water	100% soluble	100% soluble	100% soluble	100% soluble
Other Information	Effective on spills where landfall has occurred or for soil remediation efforts	Extensive use on ships, boats, boom, pilings, survival gear, breathing apparatus, tools, shoreline flora and fauna, etc.	Works best when applied with pressure washing equipment. Can be diluted up to 1 oz per gallon of water. Mild agitation is usually necessary if applied without pressure.	pH = 12.6 Product is not recommended for open-water oil dispersant use.
Is Treated Oil Recoverable?	NP	No; the oil is dispersed	Yes, forms a loose emulsion with oil that separates within seconds; treated oil can be skimmed from the rinse water or absorbed with an oil sorbent	No; the oil is dispersed
Application Assistance Information*	X Products and Services 719-576-8047	Sunshine Makers, Inc. 800-228-0709 562-795-6000	Mantek 972-438-0202	Stutton North Corporation 504-626-3900
Unit Cost**	NP	$8-$12 per gallon	$27.50 - $32.50 per gal.	$13.95 - $16.95 per gal
Photograph of Product (photos are added as they become available)				

* For additional technical assistance on product application, contact the supplier listed on the NCP Product Schedule Notebook.

** Unit costs are based on 2002 information supplied by the vendors, where provided. For a more up-to-date cost estimate, contact the supplier listed in the NCP Product Schedule. Generally, product prices decrease as purchase volume increase, and may also vary between distributors. Product application rates often vary greatly depending on use.

NP Not Provided