NON-MECHANICAL RECOVERY

INTRODUCTION

Non-mechanical response describes spill response methods where chemical countermeasures or similar tools are used to treat spilled oil in order to minimize the environmental impacts of the oil spill. Non-mechanical response methods require special authorization or approval by state and federal authorities. Non-mechanical response tactics are used in cases where mechanical response is not feasible or when mechanical response must be augmented due to the size of the spill.

There are two main types of non-mechanical response tactics included in this manual.

- ***Dispersant Tactics*** involve the application of chemical formulations that contain surface active agents (surfactants) that lower the surface tension between oil and water, promoting the formation of oil droplets and reducing the tendency of oil to stick to other droplets or surfaces, thereby enhancing dispersion into the water column. In Alaska, dispersant tactics are only applicable to on-water oil spills.
- ***In-situ Burning Tactics*** involve the collection and concentration of oil within a designated area, the controlled burning of that oil, and the removal of the burn residue. In-situ burning tactics are organized based on the spill location and type of environment.

DISPERSANT APPLICATION

OBJECTIVE & STRATEGY

DS

The objective of the Dispersant Application tactic is to chemically disperse spilled oil while it is floating on the sea's surface. Dispersants do not remove the oil, but break it into very small droplets that mix into the upper water column, promoting rapid degradation. Dispersants are used to augment mechanical recovery. Dispersants are usually applied as a spray from an airplane, helicopter, or boat. Correct targeting is essential to ensure effective dispersant application, as are several other factors, including dispersant droplet size, concentration, and rate of application.

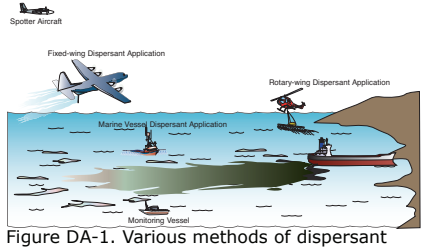

Figure DA-1. Various methods of dispersant applications on spilled oil.

Dispersant application differs from mechanical response methods because the State of Alaska and the Alaska Regional Response Team (ARRT) require that authorization be obtained prior to use in certain coastal areas. The ARRT's Dispersant Use Guidelines, which outline the approval process, may be found in the Unified Plan. The general strategy is to:

1. Identify the location and extent of the spill.
2. Determine that other mechanical methods for recovery are not feasible or must be augmented.
3. Obtain regulatory approval through the Unified Command.
4. Select equipment and a configuration that best supports the operating environment.
5. Mobilize personnel, appropriate chemical dispersants, and application equipment to the location.

6. Calculate application dosage and rates.
7. Apply dispersants to thickest areas of oil slick.
8. Monitor the dispersant application, using the appropriate protocols, to ensure accuracy, effectiveness, and to prevent misapplication.

TACTIC DESCRIPTION

Spill Detection

Effective dispersant application requires accurate spill detection. The slick location, thickness, and movement must be clearly identified and communicated to response managers and operations personnel. Spill detection can be accomplished through visual observation, infrared imagery, or satellite imagery (see Discharge Tracking Open Water).

Application Systems

Dispersants are applied using either a vessel- or aircraft-mounted spraying unit. All spray systems consist of tanks for dispersant storage; a power source (gasoline engine or electrical power source); a pump; control valves and metering equipment; spray arms; and nozzles (Figure DA-2).

Spray systems need to be able to apply the appropriate dispersant dosage in droplets that are the appropriate size. Droplets that are too small can be subject to wind drift; those that are too large will pass right through the oil slick. Both the flow rate and the droplet size are a function of the spray bar pressure and nozzle type. Application systems should be calibrated prior to use, preferably with the specific dispersant type to be used.

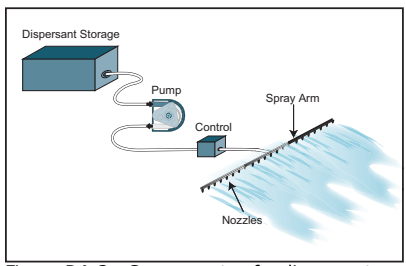

Figure DA-2. Components of a dispersant application system.

Aerial application can be accomplished from either fixed-wing or rotary-wing aircraft. Aerial application systems are usually faster than vessel-based systems because aircraft travel at much higher speeds than boats. However, aerial application

may be less precise than vessel-based systems, resulting in irregular application or loss of dispersants. Aerial systems apply dispersants at a constant rate and cannot be adjusted during the sortie except by changing aircraft speed. Aerial systems may also be more limited by low visibility than vessel application.

The term "*application rate*" refers to the volume of sprayed product divided by the surface area covered by the spray and is usually expressed in liters/hectare or gallons/acre. The term "*coverage rate*" refers to the surface area covered by the spray divided by the length of time required to spray it, and is usually expressed in hectares/hour or acres/hour. The "*encounter rate*" refers to the area of oil that can be sprayed in a specific time. This can be calculated as the ship or aircraft spraying speed multiplied by the width of the spray deposits on the surface.

"*Payload*" refers to the total amount of dispersant carried by the aircraft or ship. Each dispersant application run is referred to as a sortie.

Dispersants are applied either pre-diluted or neat. Conventional dispersants are applied neat, at a comparatively higher application rate. Concentrated dispersants may either be diluted and then applied at a similar rate as conventional dispersants, or they may be applied neat at a lower application rate.

Dispersant Stockpiles

Some dispersants have a limited shelf life; therefore, stocks must be periodically rotated. Before a dispersant can be used in US waters, it must be approved by the EPA. Approved dispersants are listed in Subpart J of the National Oil and Hazardous Substances Pollution Contingency Plan. In Alaska, dispersant stockpiles are maintained by some of the Primary Response Action Contractors.

Regulatory Approval

In Alaska, dispersants may be used for on-water spills in the open, protected, or calm water operating environments. The ARRT Dispersant Use Guidelines divide Alaska waters into three zones, based on the requisite approval criteria. In Zone 1, dispersants use is pre-authorized and only requires approval of the Federal On-Scene Coordinator, although

state and federal authorities must be notified. In Zone 2, dispersant use is conditional and requires the consultation with and approval of state and federal authorities. In Zone 3, the use of dispersants is not recommended in most instances. The Unified Plan contains maps with Zone designations for Prince William Sound and Cook Inlet.

Dispersant effectiveness depends on the type of dispersant, type and weathering state of the oil product, sea state, sea salinity, and wind. Viscous and emulsified oil does not disperse well. Dispersants work best when there is wave energy to mix the dispersant into the oil. Most dispersants work better in salt water than in fresh water.

Operating Environments

Dispersant Application is utilized in the following operating environments:

- Open Water,
- Protected Water, and
- Calm Water.

Deployment Configurations

Before dispersant applications proceed, a small test should be conducted where dispersants are sprayed on a portion of the slick. Once dispersant operations are underway, a monitoring/observation program should be established to monitor the effectiveness of the application.

Dispersants should be applied to the areas of the slick with moderate to high thickness, and not to sheen areas. Application runs should begin at the edge of the slick and proceed using parallel, continuous runs, treating the slick from upwind.

AERIAL APPLICATION

Aerial spraying can be done from helicopters as well as from small or large fixed-wing aircraft. Aerial application methods are more commonly used than vessel-based systems. Aerial application allows dispersants to be applied neat, or undiluted, which is preferable to the dilution required for vessel-based spraying. Aerial systems can also cover a larger area than vessel-based systems.

DSf Fixed-wing Application Systems

Fixed-wing aerial application may be accomplished by a variety of aircraft, ranging from large multi-engine cargo aircraft, such as Lockheed's C-130 HERCULES, to small single-engine planes, such as Cessna's 188 AGWAGON (Figure DA-3). Fixed-wing aircraft application systems provide a constant application rate, and are generally used for neat application. Like all aerial application systems, fixed-wing aircraft may operate independent of sea state. However, runways and other infrastructure are necessary to support dispersant operations.

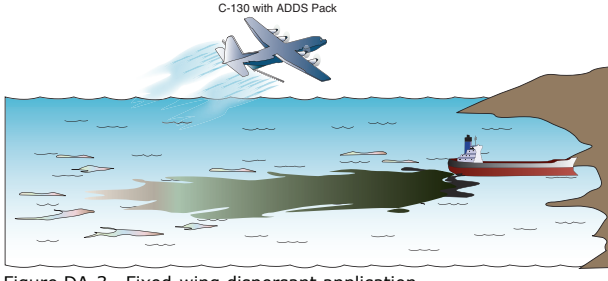

Figure DA-3. Fixed-wing dispersant application.

Large, multi-engine planes are best equipped for handling large off-shore spills. Aircraft dispersant spraying has many significant advantages, including rapid response, good visibility, high treatment rates, and optimum dispersant use. Usually, aircraft allow treatment of spills at greater distances from shore than with vessels. A number of planes originally designed for agricultural or pest control operations have also been modified for dispersant application. The endurance, fuel consumption, turnaround time, payload, and the ability to operate from short or improvised landing strips are all important. In addition, the aircraft should be capable of operating at low altitude and relatively low speeds (50-150 knots) while remaining highly maneuverable. Fixed-wing aircraft can operate independent of sea state; however, fixed-wing operations are limited to daylight conditions with relatively good visibility and flying conditions.

The Airborne Dispersant Delivery System (ADDS) pack is a portable dispersant spraying unit that can be rapidly fitted inside an available aircraft. The ADDS pack, and other similar devices, remove the need to dedicate specially fitted aircraft to dispersant operations.

DSr Rotary-wing Application Systems

Helicopters (rotary-wing aircraft) may also be used to apply dispersants (Figure DA-4). One benefit of rotary wing aircraft over fixed wing aircraft is their ability to adjust speed and therefore application rate. Helicopter application systems apply neat dispersants. Limitations of rotary-wing application systems are small load size, and short flying time and distance. Rotary-wing aircraft can be configured to use either an internal or, more commonly, an underslung bucket application system.

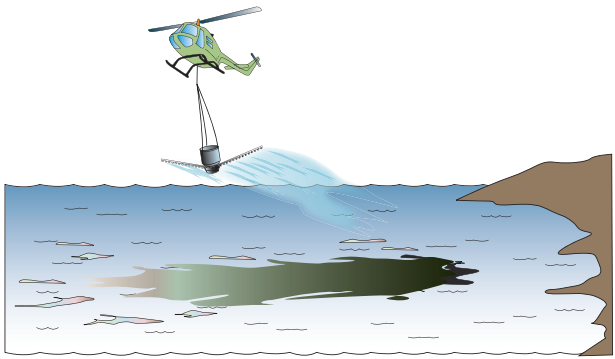

Figure DA-4. Rotary-wing aircraft dispersant application.

In general, helicopters have a faster transit speed than vessels, even when carrying a slung load. The hovering ability of a helicopter also makes it ideal for some nearshore operations. Helicopters can operate independent of sea state; however, helicopter operations are limited to daylight conditions with relatively good visibility and flying conditions.

The dispersants load that a helicopter can carry varies by model. Transit distance and prevailing conditions also factor into determining the load size.

DSv VESSEL-BASED APPLICATION SYSTEMS

Dispersants can also be applied from vessels (Figure DA-5). Unlike aerial application systems, vessel-based systems provide the ability to adjust dispersant dosage during operations, which may lead to more effective application or dosing. However, vessel-based application systems operate more slowly than aerial systems, and are sea state dependent. They cover a much smaller area of spill, and are generally favored for small slicks. Vessels that are used to spray dispersants need to be equipped with a boom system, an adapted fire monitor system, or a ducted fan.

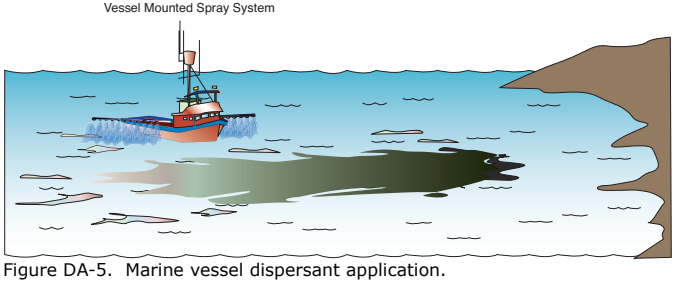

Figure DA-5. Marine vessel dispersant application.

Boom systems spray dispersant through a set of nozzles fixed on outboard booms. Typically, the booms are mounted as far forward as possible to ensure the dispersant is applied ahead of the bow wave. This helps to mix the dispersant and oil properly. Spray units can be portable or permanently installed on a vessel. Systems are available that deliver neat dispersant or, with a separate water pump, apply dispersant diluted with water.

Specially adapted fire monitors can be used to apply diluted dispersant. Fire monitors are low-cost, rugged, and easily installed and operated. The high pump capacity of this type of system allows the vessel to travel at a greater speed and eliminates the problems caused by booms striking the water surface as the vessel pitches and rolls during operations. A boat equipped with two fire monitors may be able to cover three to four times the area of a boom-equipped boat.

Table DA-1. Comparison of different vessel-based application systems.

System	Advantages	Disadvantages
Conventional spray-boom (diluted dispersant)	• Uniform dosage across swath. • Wide range of adjustment possible for vessel speed and dosage without changing nozzles.	• Heavy piping suspended over side. • Loss of dispersant effectiveness due to dilution prior to application. • Limitation of swath to boom length. • Fine droplets easily blown off target due to wind. • Need to change nozzles to adjust vessel speed or dosage.
Conventional spray-boom (un-diluted/ neat dispersant)	• Uniform dosage across swath. • Most effective use of dispersant.	• Heavy piping suspended over side. • Fine droplets easily blown off target due to wind. • Limitation of swath to boom length. • Small nozzles tend to clog easily. • Need to change nozzles to adjust vessel speed or dosage.
Fire monitor	• Covers 3-4 times area of boom systems. • Droplets are less sensitive to wind than system below. • Rugged enough to withstand permanent installation. • Can be permanently mounted without interfering with other operations.	• Variations in dosage across swath. • Slight loss of dispersant effectiveness due to dilution prior to application.
Ducted Fan	• Can cover 3-4 times area of boom systems. • No loss of effectiveness due to dilution before application.	• Very wind sensitive. • Need to change nozzles to vary dosage or vessel speed.

Source: Major, Nicholson and Chen, 1994

Table DA-2. Typical characteristics of dispersant spray equipment.

Platform	Dispersant Load (gallons)	Coverage (acres/hour)	Coverage (acres/day)*
Small boat	250	25	200
Small ship	800	50	400
Supply ship	2,500	75	600
Small helicopter	200	420	700
Large helicopter	525	690	2,000
Agriculture spray plane	100	420	700
DC-3	1,200	1,300	6,000
DC-4	2,100	2,100	12,000
DC-6	3,000	2,500	18,000
C-130 (Hercules)	3,500	2,500	21,500

*Presuming a working day of 8 hours and typical sorties 25 nm from base, and a target dosage of 38.5 gallons per acre.
Source: Fingas 2000

Table DA-3. Comparison of fixed-wing aircraft and vessel application systems.

	C-130/ADDS Pack	Typical Vessel System
Payload	5,000 gal	1,000 gal*
Maximum speed	150 kts	10 kts
Minimum speed	130 kts	3 kts
Maximum pump rate	800 gal/min	12 gal/min
Swath width	150-200 ft	90 ft
Mobilization time (hr)	8	5
Total time per sortie (hr)	2.7	5.7
Dispersant time window (hr)	81	84
Sorties possible per unit	14	7
Number of units	1	1
Dispersants applied (gal)	70,000	7,000
Maximum amount of oil that could be treated at dispersant:oil ratio of 1:20 bbl	33,000	3,300

** Depends on vessel size*

Monitoring and Observation

Determining whether the dispersants have actually reached the oil in the proper dosage and with sufficient coverage and whether the dispersant is effectively breaking up the oil requires monitoring. Monitoring allows the response team to determine whether the application method needs to be modified in any way and whether application needs to be repeated in some areas. NOAA has developed a dispersant use protocol – Special Monitoring of Advanced Response Technologies (SMART) – that should be used in conjunction with dispersant operations. The protocol offers three tiers of monitoring, based on the incident needs:

- Tier 1: Visual monitoring only (aerial observation if possible).
- Tier 2: Combination of visual monitoring with real-time on-site water column fluorometry at a single depth and water sample collection for later analysis and comparison.
- Tier 3: Expanded version of Tier 2, including fluorometric data and samples from multiple depths. It also includes an option to collect water quality information such as temperature, dissolved oxygen, pH, salinity, and conductivity using a portable analyzer to provide information on the fate and transport of the dispersed oil.

While observing dispersant applications, consider these important points:

- Observers should be trained in dispersant monitoring.
- The monitoring observer should not make operational decisions (e.g., how much dispersant to apply, when or where to apply it). These decisions are made by operational units.
- Oil surface slicks and plumes look different for many reasons; for example, oil or product characteristics, time of day (different sun angles), weather, sea state, and rate at which oil disperses.
- Low-contrast conditions (e.g., twilight, haze) make observations difficult.
- For best viewing, the sun should be behind you, with the aircraft at an altitude of 500-1000 feet observing the slick at a 30-degree angle.
- Appearances of dispersant action can range from brown to white (cloudy) to no visible plume. The visibility of the dispersed plume will vary according to water clarity. In some cases, remaining surface oil and sheen may mask oil dispersing under the slick and thus interfere with observations of the dispersed oil plume.
- Sometimes other things, such as suspended solids or algal blooms, may resemble dispersed oil.
- Dispersed oil plume formation may not be instantaneous after dispersant application. In some cases, such as when oil is emulsified, it can take several hours and may not show a visible plume at all.

DEPLOYMENT CONSIDERATIONS AND LIMITATIONS

SAFETY

- Daily weather evaluation is recommended, and should include sea state and visibility conditions as they affect application systems and monitoring.

- Vessel masters and pilots should have experience in the appropriate operating environment. Local knowledge is preferred.
- Vessels, including skiffs, must have a minimum of two crew aboard.
- If possible, vessels in transit to/from an operation or staging area should transit in pairs.
- A communications schedule should be established and followed, between vessels in transit and the Operations Section or Radio Dispatcher.
- Communication and clear understanding of responsibilities is crucial to execution and safety during the dispersant application process.
- Response personnel should wear PPE as required by the incident-specific Site Safety Plan.

DEPLOYMENT

- For dispersant use in Zones 2 and 3, consultation must be initiated with the ARRT, and the US Department of Commerce (NOAA, NMFS) and the US Department of the Interior must be consulted when practicable. For Zone 1, dispersant use must be approved by the FOSC and the ARRT must be notified.
- Wind conditions should be monitored.

REFERENCES TO OTHER TACTICS

Other tactics associated with Dispersant Application include:

- DT Discharge Tracking On Water

EQUIPMENT AND PERSONNEL RESOURCES

Resources for this tactic include a delivery vehicle (airplane, helicopter, vessel); a spray system with tanks to hold the dispersant; a control system; and dispersant monitoring team and equipment. Configuration and specific resources required will be determined by site conditions, spilled oil type and volume, area of coverage, as well as resource availability.

Table DA-4. US National Contingency Plan Recommended Dispersant Application Procedures for Corexit 9500 and Corexit 9527.

Product	Application Method	Concentration/ Application Rate	Conditions for Use
Corexit 9527	*Aerial spraying:* Apply undiluted at altitude 30-50 ft. Careful selection of spray nozzles critical to achieve proper dose (through droplet size control). 1/4-inch open pipe with aircraft traveling at 120 mph (104 knots) or more.	2-10 gallons per acre or a 1:50 to 1:10 dispersant to oil ratio is recommended	Timely application assures highest degree of success. Early treatment reduces mousse formation. Useful in saltwater.
	Boat spraying: Use spray booms mounted ahead of bow wake or as far forward as possible. Use low-volume, low-pressure pump to apply undiluted or use spray equipment designed for application of 5-10% solution. Apply as droplets, not fogged or atomized. Fire monitor modified with screen cap for droplet size can be used.	Application rate depends on type of oil, degree of weathering, temperature, and slick thickness.	
Corexit 9500	*Aerial spraying:* Apply undiluted at altitude 30-50 ft. Careful selection of spray nozzles critical to achieve proper dose (through droplet size control).1/4-inch open pipe with aircraft traveling at 120 mph (104 knots) or more.	2-10 gallons per acre or dispersant to oil ratio of 1:50 to 1:10 is recommended.	Timely application assures highest degree of success. Early treatment reduces mousse formation. Useful in freshwater or saltwater at any temperature. Viscous oils require higher dosage rates.
	Boat spraying: Use spray booms mounted ahead of bow wake or as far forward as possible. Use low-volume, low-pressure pump to apply undiluted or use spray equipment designed for application of 5-10% solution. Apply as droplets, not fogged or atomized. Fire monitor modified with screen cap for droplet size can be used.	Application rate depends on type of oil, degree of weathering, temperature, and slick thickness.	

Vessel-based Dispersant Application System DSv

Equipment	Function	Quantity	Notes
Spray unit	Dispersant storage and spraying capability	Minimum 1 per dispersant vessel	
Consumables	**Function**	**Quantity**	**Notes**
Dispersant	Oil treatment	At least 1:20 dispersant to oil ratio for estimated oil being treated	Corexit 9500, Corexit 9527, or equivalent
Vessels/Aircraft	**Function**	**Quantity**	**Notes**
Spray vessel with crew	Application platform	1	Must be suitable for operating environment
Spotter aircraft with crew	Spill detection, tracking, and application	1	
Monitoring vessel with crew	Monitoring dispersant application	Minimum 1 depending on area of coverage	Must be suitable for operating environment
Communication systems (radios)	Intra-task force communications	3 minimum	All vessels and aircraft must be able to communicate on a common frequency
Personnel	**Function**	**Quantity**	**Notes**
Field Team Leader	Supervises operations	1	Must be trained in dispersant application
Dispersant application technicians	Operate spraying equipment	2 to 4	Must be trained in dispersant application with the spray system utilized in the operation. These technicians may also load dispersants into the vessel.
Aerial Observer	Visual observation of slick	2	Should be trained in aerial oil observation and dispersant monitoring/ reporting
Monitoring Team with equipment	Conducts monitoring using SMART protocol	2 to 3	Must be trained in SMART monitoring

Fixed-wing Aircraft Dispersant Application System DSf

Equipment	Function	Quantity	Notes
ADDS Pack or equivalent	Storage and application of dispersant	Minimum 1 per dispersant aircraft	System consists of a tank, twin spray booms and remote control to release dispersant. Tanks must be refilled on the ground using transfer pumps.
Transfer pumps	Refill dispersant tanks	1 to 3	Depending on configuration
Consumables	**Function**	**Quantity**	**Notes**
Dispersant	Oil treatment	At least 1:20 dispersant to oil ratio for estimated oil being treated	Corexit 9500, Corexit 9527, or equivalent
Vessels/Aircraft	**Function**	**Quantity**	**Notes**
Spray aircraft with crew	Application platform	1 per task force	Crew must be trained in dispersant application
Spotter aircraft with crew	Spill detection, tracking, and application	1	
Monitoring vessel with crew	Monitoring dispersant application	Minimum 1 depending on area of coverage	Must be suitable for operating environment
Communication systems (radios)	Intra-task force communications	3 minimum	All vessels and aircraft must be able to communicate on a common frequency
Personnel	**Function**	**Quantity**	**Notes**
Field Team Leader	Supervises operations	1	Must be trained in dispersant application
Dispersant Application Technicians	Operate spraying equipment	2 to 4	Must be trained in dispersant application with the spray system utilized in the operation. These technicians may also load the dispersants into the aircraft on the ground.
Aerial Observer	Visual observation of slick	2	Should be trained in aerial oil observation and dispersant monitoring
Monitoring Team and equipment	Conducts monitoring using SMART protocol	2 to 3	Must be trained in SMART monitoring

Rotary-wing Aircraft Dispersant Application System DSr

Equipment	Function	Quantity	Notes
Helicopter dispersant bucket system	Store and spray dispersants	Minimum 1 per dispersant vessel	Bucket system consists of storage tanks with spray booms attached. Tanks must be refilled on the ground using transfer pumps.
Transfer pumps	Refill dispersant tanks		
Consumables	**Function**	**Quantity**	**Notes**
Dispersant	Oil treatment	At least 1:20 dispersant to oil ratio for estimated oil being treated	Corexit 9500, Corexit 9527, or equivalent
Vessels/Aircraft	**Function**	**Quantity**	**Notes**
Helicopter and crew	Dispersant application platform	1 or 2 per task force	Crew must be trained in dispersant application
Spotter aircraft with crew	Spill detection, tracking, and application	1	
Monitoring vessel with crew	Monitoring dispersant application	1	Must be suitable for operating environment
Communication systems (radios)	Intra-task force communications	3 minimum	All vessels and aircraft must be able to communicate on a common frequency
Personnel	**Function**	**Quantity**	**Notes**
Field Team Leader	Supervises operations	1	Must be trained in dispersant application
Dispersant Application Technicians	Operate spraying equipment	2 to 4	Must be trained in dispersant application with the spray system utilized in the operation. These technicians may also load dispersants into the bucket on the ground.
Aerial Observer	Visual observation of slick	2	Should be trained in aerial oil observation and dispersant monitoring
Monitoring Team and equipment	Conducts monitoring using SMART protocol	2 to 3	Must be trained in SMART monitoring