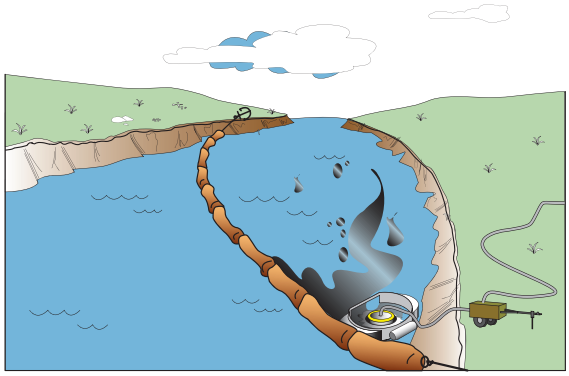
DIVERSION BOOM

OBJECTIVE & STRATEGY

DV

The objective of the Diversion Boom tactic is to redirect the spilled oil from one location or direction of travel to a specific site for recovery. For the purposes of maintaining consistent and clear terms, diversion is always associated with oil recovery, in contrast with the term deflection, which is used to describe the tactic where oil is redirected away from an area but not recovered.



TACTIC DESCRIPTION

The Diversion Boom tactic is for water-born spills where there is some current, usually from 0.5 to 3.0 knots. The boom is placed at an optimum angle to the oil trajectory, using the movement of the current to carry oil along the boom to a recovery location. The angle is chosen to prevent oil from entraining beneath the boom skirt. Oil can be diverted to a shoreline or away from a shoreline or shoal waters. This tactic is always associated with a recovery tactic, either Shoreside Recovery or Marine Recovery. Boom may be held in place by anchors, vessels, or a boom control device.

Anchor Systems

Boom is secured in place using standard anchoring systems (Figure DV-1). Anchor sizes vary depending on the boom type and the operating environment.

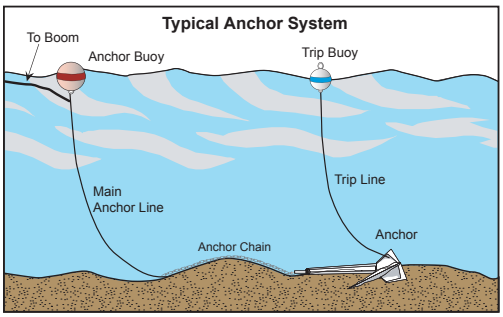


Figure DV-1. Typical anchor system.

Boom Control Devices

An alternative to anchoring deflection boom on the offshore end are boom control devices. Boom control devices have the advantage of allowing continuous control over the angle and position of the boom. They can also allow the boom to be moved to allow a vessel or drifting debris to pass by without interfering with the diversion operation. One type of boom control device is a vessel, which continuously controls the offshore end of the

Diversion Boom

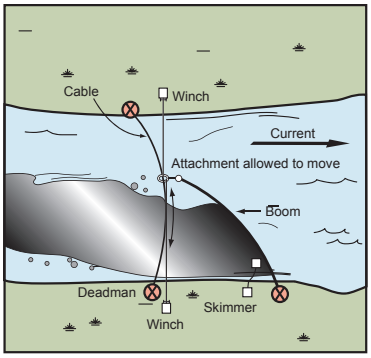


Figure DV-2. Diversion boom configuration using a trolley.

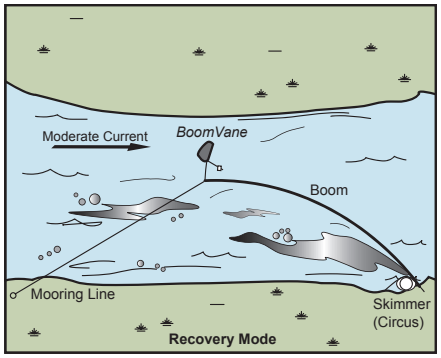


Figure DV-3. Diversion boom configuration using a BoomVane™.

boom. Controlling a diversion boom with a vessel takes considerable skill and a vessel suited for the purpose. Another type of boom control system is a trolley as shown in Figure DV-2. Trolleys require that a line be strung from one shoreline to another, thus they are mostly used in rivers. Trolleys may block a river to passage by vessels and they are susceptible to impacts from debris. A relatively new type of boom control device is built on the principle of a wing or rudder. Devices such as the Boom Vane™, allow the boom to be deployed and controlled from the shoreline (Figure DV-3). This decreases the need for vessels and anchor systems, while allowing superior control of the boom angle.

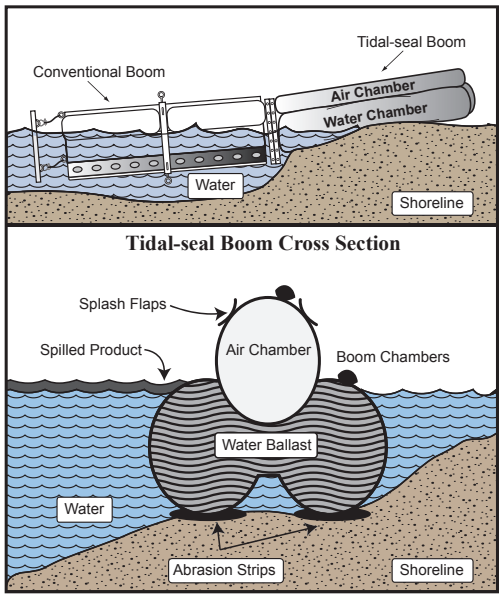
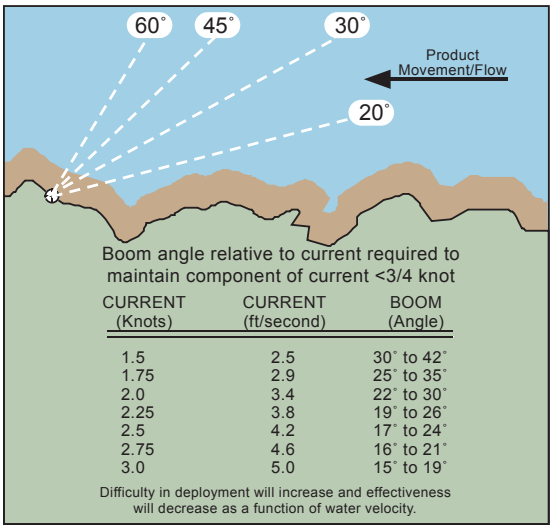


Figure DV-4. Tidal-seal boom configuration.

Tidal-seal Boom

A special type of boom, tidal-seal boom, is used on some boom arrays where the array contacts the shoreline to prevent oil from escaping. Tidal-seal boom typically contains three chambers as shown in Figure DV-4. Two of the chambers are filled with water, and contact the shoreline in shallow water and shoreline areas. The third chamber is usually filled with air, and provides flotation as the water level rises. Tidal-seal boom should be used in areas with a smooth bottom of gradual slope and avoided where there are large rocks and sharp breaks in the bottom. If tidal-seal boom is not available, sorbent materials such as pom-poms or snare on rope can be placed next to or attached to conventional boom to hinder oil entrainment under the boom at the beach water interface. Plans should be made to change out oiled sorbent on each low water tide cycle.



CURRENT (Knots)	CURRENT (ft/second)	BOOM (Angle)
1.5	2.5	30˚ to 42˚
1.75	2.9	25˚ to 35˚
2.0	3.4	22˚ to 30˚
2.25	3.8	19˚ to 26˚
2.5	4.2	17˚ to 24˚
2.75	4.6	16˚ to 21˚
3.0	5.0	15˚ to 19˚

Figure DV-5. Boom angles for various current velocities.

Boom Angle

Figure DV-5 is used to select the appropriate boom angle to keep oil from entraining under the boom. Note that the angle relative to the current decreases rapidly as the current increases. Where currents exceed 3 knots the boom must be almost parallel to the current to prevent entrainment. In currents exceeding 3 knots, a cascade of boom arrays may be used; the first boom array will slow the velocity of the slick allowing subsequent arrays to deflect the oil.

Operating Environments

DV-O OPEN WATER

Diversion Boom is rarely used in the open water environment. Diversion Boom system components (vessels, boom and anchors) for open water operations should be able to deploy and operate in seas up to 6 feet and in winds of up to 30 knots. Open water systems are usually deep draft, operating at depths of greater than 6 feet.

DV-P PROTECTED WATER

Vessels, boom and anchors for protected water Diversion Boom systems should be able to deploy and operate in seas up to 3 feet and winds up to 25 knots. Protected water diversion boom systems are often based on vessels of opportunity, such as fishing vessels. Protected water systems may be deep draft or shallow draft, depending on the water body.

DV-C CALM WATER

Calm water diversion boom systems are composed of vessels, booms and skimmers that should be able to deploy and operate in seas of 1 foot and winds up to 15 knots. Calm water diversion boom systems are usually based on small fishing vessels, work-boats or skiffs fitted with portable skimmers and primary storage devices. Calm water diversion boom systems typically work in depths as shallow as 3 feet.

DV-F FAST WATER

Fast water diversion boom systems are designed to operate in moving water where the current exceeds 0.8 knots. This includes rivers and areas with significant tidal current. Vessels, boom and anchors used in tidal waters should be able to deploy and operate in seas up to 1 feet in winds up to 15 knots. Fast-water diversion boom systems are equipped with high-current boom and skimmers. These systems are usually deployed from small vessels or skiffs.

DV-I BROKEN ICE

Diversion boom is difficult in the Broken Ice environment due to ice interfering with the boom. A boom control system may be used to quickly collapse the boom system to avoid ice impacts. Vessels used in broken ice should have sufficient hull strength to safely work in ice.

Diversion Boom

Deployment Configurations

There are many variations for deployment of Diversion Boom. Several configurations are described below, but responders should consider the actual conditions and modify their deployment accordingly.

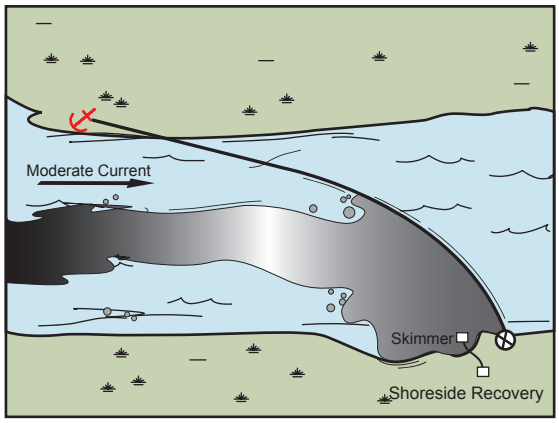


Figure DV-6. Single boom diversion configuration.

SINGLE BOOM – DIVERT INSHORE

A basic diversion technique is to divert oil from a current to a recovery site along a shoreline (Figure DV-6). The recovery site is chosen where there is minimal current (an eddy, quiet water, or collection beach) and a suitable recovery system can be deployed. In some cases, with approval, a trench can be dug to create a quiet skimming area. The boom is then anchored at the site and deployed at an optimum angle to the current and secured/anchored to divert the oil to the shoreline for recovery. The offshore end of the boom can be secured with an anchor in the water, an anchor on a far shore, a boom control device or with a vessel.

DIVERT OFFSHORE

A single boom can also be set to divert oil away from the shore or shoal water, where it can be recovered by On-water Free-oil Recovery or Marine Recovery Systems.

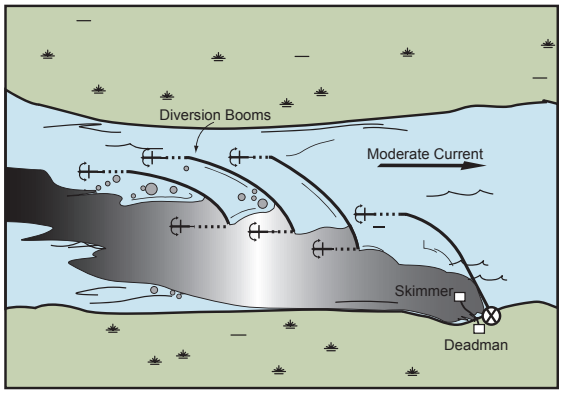


Figure DV-7. Cascade boom diversion configuration.

CASCADE

Several booms can be deployed in a cascade configuration when a single boom cannot be used because of fast current or because it is necessary to leave openings in the boom for vessel traffic, etc. (Figure DV-7) This configuration can be used in strong currents where it may be impossible to effectively deploy one continuous section of boom. Shorter sections of boom, when used in a cascade deployment, are easier to handle in faster water, thereby increasing safety and efficiency. Additional equipment will be required to set and maintain this system in comparison to the single boom configuration.

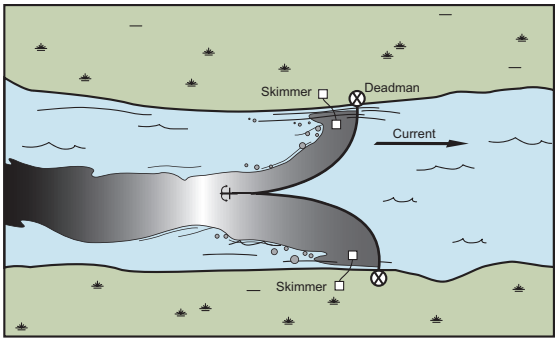


Figure DV-8. Closed chevron diversion configuration.

CHEVRON

Chevron boom configurations may be used in fast water. Two booms are

deployed from an anchor in the middle of the stream/river and then attached to each bank (Figure DV-8). A closed chevron configuration is used to divide a slick for diversion to two or more recovery areas. An open chevron can be used where boat traffic must be able to pass (Figure DV-9). In the open chevron configuration the two booms are anchored separately midstream, with one anchor point up-stream or downstream of the other. An inverted chevron can also be used to funnel an oil slick to a marine recovery unit anchored mid-channel (Figure DV-10).

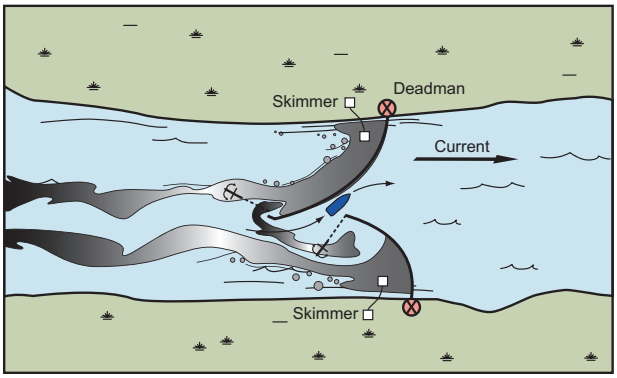


Figure DV-9. Open chevron diversion configuration.

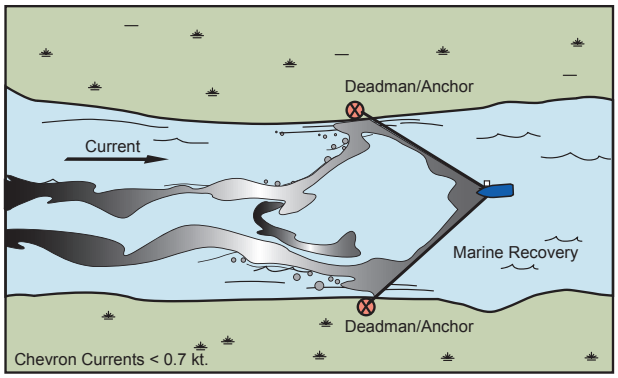


Figure DV-10. Inverted chevron diversion boom configuration.

DEPLOYMENT CONSIDERATIONS AND LIMITATIONS

SAFETY

- Daily weather evaluation is recommended, and should include distance to safe harbor, transit times and exposure of vessels.
- Vessel masters should have experience in the appropriate operating environment and tactic. Local knowledge is preferred.
- Vessels, including skiffs, must have a minimum of two crew aboard.
- Vessels setting anchors and tending the boom should be able to safely transit seas which exceed the boom's operating limitation.
- 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.
- Extreme care should be used when taking strains on anchoring systems using the aft cleats of small vessels and skiffs.
- Extreme care should be given when selecting deadmans for the anchoring systems onshore.
- Buoy lights should be considered for night operations.
- Response personnel should wear PPE as required by the incident-specific Site Safety Plan.

- For fast water deployments, consider adding a spotter/rescue person downstream for potential recovery of a casualty, i.e. overturned boat or man overboard.
- Anchor trip lines should be made of material strong enough to handle a moderate strain during boom reconfigurations. Responders normally used the trip line to reposition and reset the anchors.

DEPLOYMENT

- Calm/Protected/Fast water environments are most commonly used for this tactic.
- If the spill is in still water under calm conditions, consider Containment Booming.
- Boom control devices, such as the Boom Vane™, allow diversion booms to be set and retrieved from shore without a vessel. They also allow for continuous adjustment of boom angles.
- Do not assume 100% efficiency with one boom system.
- When deployed by vessels/crews of opportunity, remember that this tactic requires more training and skill than towing a U-boom.
- Readjust angles and widths between boom sections as necessary to meet changing conditions.
- Continuous monitoring of system efficiency is required.
- Planning for a marine environment should be based on average high tidal conditions.
- A Title 41 Fish Habitat permit is required to work inside any anadromous stream. Due to the possibility of contaminating spawning habitat, avoid diverting and/or collecting oil inside a stream mouth if possible.
- See Shoreside Recovery for methods to keep oil from contaminating beaches at recovery points.
- Anchor systems must be selected based on the maximum stress that might be expected to occur on the boom array, considering stronger currents and winds than when the anchor is set.
- The scope of the anchor line should be at least 3 times the depth of the water. If the anchor fails to hold, try increasing the line scope to five times the depth of the water and/or double the length of the anchor chain. Finally, if additional anchor holding is required, anchors can be ganged or set in series.
- All screw pin shackles shall be seized with wire.
- If wildlife or historic properties are encountered, see Wildlife Checklist on page A-19 or Historic Properties Checklist on page A-20.

REFERENCES TO OTHER TACTICS

Other tactics associated with Diversion Boom include:

- SR Shoreside Recovery
- DF Deflection Booming
- MR Marine Recovery
- C Containment Booming
- FO On-water Free-oil Recovery

EQUIPMENT AND PERSONNEL RESOURCES

Commonly used resources for this tactic include: vessels; boom; anchoring, mooring, or control systems; and response personnel. Configuration and specific resources required will be determined by site conditions, spilled oil type and volume, area of coverage, and resource availability. Resource sets may need to be refined as site-specific requirements dictate.

*Open Water Diversion Boom System** DV-O

Typical Equipment	Function	Quantity	Notes
Oil boom, > 36” height	Divert and concentrate oil	Site-specific	Depending on configuration, currents, sea states, and oil concentration
Large anchor systems or shore-based anchors	Keep boom in selected configuration	Site specific	Depending on configuration, currents, and sea states
Boom control device	Controls boom angle	1 optional	Control devices are useful for adjusting the boom angle and avoiding debris
Recovery system	Remove oil	Site Specific	Select the appropriate recovery system for the situation, depending on configuration
Typical Vessel	**Function**	**Quantity**	**Notes**
Class 2, 3, 4, or 5 *At least one vessel with a crane is recommended*	Deploying/tending anchors and boom	2 to 4	Depending on configuration, currents, and sea states. Boom rollers and deck winches may also be useful when heavy response equipment is used.
Typical Personnel	**Function**	**Quantity**	**Notes**
Field Team Leader	Supervises operations	1	
Vessel Operators, open water	Masters of response vessels	2 to 4	Depending on number of vessels
Skilled Technicians	Crew vessels and operate response equipment	2 to 4	Depending on number of vessels, configuration, recovery system
General Technicians	Work under the direction of skilled technicians or vessel operators	2 to 8	Depending on number of vessels, configuration, recovery system

*Diver.sion Boom may be difficult to deploy and operate in the open water environment.

Diversion Boom

Protected Water Diversion Boom System

DV-P

Typical Equipment	Function	Quantity	Notes
Oil boom, 18" to 42" height	Divert and concentrate oil	Site-specific	Depending on configuration, currents, sea states, and oil concentration
Tidal-seal boom	Seal containment across the inter-tidal zone	Site-specific, optional	Best for sand and gravel beaches with gradual slope
Medium anchor systems or shore-based anchors	Secure boom in selected configuration	Rule of Thumb - 1 anchor per 200 ft. of boom	Depending on configuration, currents, and sea states
Boom control devices	Controls boom angle	1 optional	Control devices are useful for adjusting the boom angle and avoiding debris
Recovery system	Remove oil	Site-specific	Select the appropriate recovery system for the situation, depending on configuration
Typical Vessel	**Function**	**Quantity**	**Notes**
Class 3, 4, 5, or 6 At least one vessel with a crane is recommended	Deploying/tending anchors and boom	2 to 4	Depending on configuration, currents, and sea states. Boom rollers and deck winches may also be useful when heavy response equipment is used.
Typical Personnel	**Function**	**Quantity**	**Notes**
Field Team Leader	Supervises operations	1	May not always be on-site
Vessel Operators, protected/ calm-water	Masters of response vessels	2 to 4	Depending on number of vessels
Skilled Technicians	Crew vessels and operate response equipment	2 to 4	Depending on number of vessels, configuration, recovery system
General Technicians	Work under the direction of skilled technicians or vessel operators	2 to 8	Depending on number of vessels, configuration, recovery system

Calm Water Diversion Boom System

DV-C

Typical Equipment	Function	Quantity	Notes
Oil boom, 6" to 24" height	Divert and concentrate oil	Site-specific	Depending on configuration, currents, sea states, and oil concentration
Tidal-seal boom	Seal containment across the inter-tidal zone	Site-specific, optional	Best for sand and gravel beaches with gradual slope
Small anchor systems or shore-based anchors	Secure boom in selected configuration	Rule of Thumb - 1 anchor per 200 ft. of boom	Depending on configuration, currents, and sea states
Boom control devices	Controls boom angle	1 optional	Control devices are useful for adjusting the boom angle and avoiding debris
Recovery System	Remove oil	Site-specific	Select the appropriate recovery system for the situation, depending on configuration
Typical Vessel	**Function**	**Quantity**	**Notes**
Class 3, 4, 5, or 6 At least one vessel with a crane is recommended	Deploying/tending anchors and boom	1 to 3	Depending on configuration, currents, and sea states. Boom rollers and deck winches may also be useful when heavy response equipment is used.
Typical Personnel	**Function**	**Quantity**	**Notes**
Field Team Leader	Supervises operations	1	
Vessel Operators, protected/ calm-water	Masters of response vessels	1 to 3	Depending on number of vessels
Skilled Technicians	Crew vessels and operate response equipment	2 to 3	Depending on number of vessels, configuration, recovery system
General Technicians	Work under the direction of skilled technicians or vessel operators	2 to 8	Depending on number of vessels, configuration, recovery system

Fast Water Diversion Boom System

DV-F

Typical Equipment	Function	Quantity	Notes
Oil boom, 8″ to 24″ height	Divert and concentrate oil	Site-specific	Depending on configuration, currents, sea states, and oil concentration
Small anchor systems or shore-based anchors	Secure boom in selected configuration	Rule of Thumb 1 anchor per 200 ft. of boom	Depending on configuration, currents, and sea states
Boom control devices	Controls boom angle	1 optional	Control devices are useful for adjusting the boom angle and avoiding debris
Recovery system	Remove oil	Site-specific	Select the appropriate recovery system for the situation, depending on configuration
Typical Vessel	**Function**	**Quantity**	**Notes**
Class 3, 4, 5, or 6	Deploying/tending anchors and boom	1 to 3	Depending on configuration, currents, and sea states
Typical Personnel	**Function**	**Quantity**	**Notes**
Field Team Leader	Supervises operations	1	
Vessel Operators, protected/ calm-water	Masters of response vessels	1 to 3	Depending on number of vessels
Skilled Technicians	Crew vessels and operate response equipment	2 to 3	Depending on number of vessels, configuration, recovery system
General Technicians	Work under the direction of skilled technicians or vessel operators	2 to 8	Depending on number of vessels, configuration, recovery system

Broken Ice Diversion Boom System

DV-I

Typical Equipment	Function	Quantity	Notes
Oil boom, 8″ to 24″ height	Divert and concentrate oil	Site-specific	Depending on configuration, currents, sea states, and oil concentration
Small anchor systems or shore-based anchors	Secure boom in selected configuration	Rule of Thumb - 1 anchor per 200 ft. of boom	Depending on configuration, currents, and sea states
Boom control devices	Controls boom angle	1 optional	Control devices are useful for adjusting the boom angle and avoiding debris
Recovery system	Remove oil	Site-specific	Select the appropriate recovery system for the situation, depending on configuration
Typical Vessel	**Function**	**Quantity**	**Notes**
Class 2 or 3	Deploying/tending anchors and boom	1 to 3	Depending on configuration, currents, and sea states. Steel hull required.
Typical Personnel	**Function**	**Quantity**	**Notes**
Field Team Leader	Supervises operations	1	
Vessel Operators, protected/ calm-water	Masters of response vessels	1 to 3	Depending on number of vessels
Skilled Technicians	Crew vessels and operate response equipment	2 to 3	Depending on number of vessels, configuration, recovery system
General Technicians	Work under the direction of skilled technicians or vessel operators	2 to 8	Depending on number of vessels, configuration, recovery system

Diversion Boom

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