Oil Spill Response Overview Handbook

Vision: "To Achieve Clean Gulf"
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Introduction and Summary

The Arabian Gulf and the Red Sea are primary marine areas and are under constant threat of environmental damage posed by oil spills.

As well as the environment, oil spills affect the fishing industry, vital facilities of the Kingdom's infrastructure such as desalination plants, power plants, refinery sea water intakes, conservation areas and community beaches.

Purpose of this Booklet

The purpose of this booklet is to demonstrate industry best practice when responding to marine oil spills, working in a safe and effective manner.

This includes:

- Hazard identification and safe working practices
- Efficient deployment of containment and recovery equipment
- Handling of hazardous materials
- Dispersant usage, practical considerations and regulatory information
- Waste management

Sources of Oil Spills

Oil spills can occur from a myriad of sources:

- Oil tanker collision and grounding
- Bunkering and cargo loading operation
- Emptying of bilge tank
- Pipeline failure on-shore and off-shore
- Well blow-out and accidents on-shore and off-shore
- Natural seepage
- War, sabotage or deliberate spills
Safety

During an oil spill, responders may be exposed to hazards from the spilt oil:

- **Dangerous gas levels.** Some oils will produce high levels of $\text{H}_2\text{S}$. This is a particularly dangerous gas and should be treated with extreme caution. At low concentrations this can be detected as a rotten egg smell, at higher concentrations it is not detectable by smell.
- Fresh oil will give off vapors as it evaporates. Gas monitoring should be conducted to ensure the atmosphere is safe for personnel to enter.
- Particular care should be taken in confined spaces where gasses are able to accumulate.
- Old oil stranded on a shoreline may give off gas as the weathered surface is broken to reveal fresh oil underneath.
- Chemical exposure.
- All hydrocarbons are carcinogenic, prolonged exposure of oil to the skin should be avoided.
- PPE should be worn as needed to prevent prolonged contact.
- Contaminated clothing should be cleaned/changed regularly.

Additional hazards are also encountered arising from the response techniques used to combat the spill:

- High pressure hydraulics.
- Rotating machinery.
- Working near water.
- Lines under tension.
- Lifting operations.
- Exposure to chemical dispersant.
- Manual handling.
- Vehicle movements.
- Flammability/explosion risk.

A risk assessment and toolbox talk should be carried out and followed for each operation. The specific hazards should be identified together with the mitigation measures needed.

PPE to be considered for use in an oil spill responses should include:

- Safety boots.
- Rubber boots.
- Long sleeve coveralls.
- Impervious suits.
- Gloves/gauntlets.
- Safety glasses/goggles.
- Hearing protection.
• Life jacket
• Hard hat

Safety procedures should be followed at all times.

Response Priorities

In the event of an oil spill, the following priorities should be used to guide the response:

1. Protection of human life
2. The protection of facilities critical to the health, safety and economy of GCC
3. To minimize disruption to trading/oil industry.
4. Minimize environmental damage

Pollution overflight

Following the report of a spill, a pollution engineer may conduct an overflight of the area to gain an understanding of the situation and quantify the volume of oil spilt. The information from this flight will be used to guide the response. Further overflights may be conducted as needed.

Deploy personnel and equipment near the source

Containment and recovery of the spill near the source is the preferred method of response. This would be done using booms and skimmers deployed from vessels. Dedicated pollution control vessels may be used (additional equipment may also be loaded onto other vessels to assist in the response). If containment and recovery is not possible then the following alternatives may be considered:

• **Mechanical Agitation** – The wash caused by vessels can be used to aid natural dispersion of small quantities of oil
• **Chemical Dispersion** – Under certain circumstances it may be appropriate to use chemicals to increase the dispersion rate of the oil. These can be applied either from a vessel or aircraft. Dispersants should only be used when permission has been granted by UAE concerned party.
• **Monitor and Evaluate** – Where conditions and the environment allows, personnel should maintain a process of monitoring and evaluating the spill.

Protect industrial facilities and environmental sensitivities

Industrial water intakes and environmental sensitivities may be threatened if the oil approaches a shoreline. Sensitive areas should be identified and protection put in place.
Shelline clean-up

Following the impact of an oil spill on a shoreline it is necessary to clean-up the stranded oil. There are various methods and equipment available, though often a clean-up operation using buckets, spades and rakes is the most effective option.

Offshore Containment and Recovery Techniques

Available Boom

Several types of boom are available. These can be broadly broken down into the following categories:

Permanent Floatation Boom – Very rapid to deploy and useful as an initial action, poor wave following characteristics means that effectiveness can be limited in rough conditions. Small draught allows it to be used in shallow water areas.

Air Inflation Boom – Slower to deploy and requires additional equipment for deployment. Deeper draught and excellent wave following characteristics make it more effective at containing oil, even in moderate conditions.

Methods of Use

Once deployed, a boom is usually towed between two vessels in a ‘U’ or ‘J’ shape to collect oil. A boom should not be towed at a speed exceeding 1.0 knot, above this speed the current will cause the oil to undercut the boom. Boom can also be deployed around a vessel and anchored to contain the oil at source.

Recovery

Once a quantity of oil has been collected, a skimmer is used to recover the oil to a storage tank. Skimmers are usually powered by a separate hydraulic power pack which drives the built in pump and any other moving parts. There are many different types of skimmer, but can be broadly broken down into two categories:

- Oleophilic – Uses oleophilic disks and brushes to pick up oil from the water surface. These skimmers can be used with light to medium viscosity oils, and are capable of collecting a high proportion of oil with minimal water. They are of limited use with emulsified oil.
- Weir – The top of the skimmer sits just below surface allowing oil to weir over the top and into the pump whilst the water remains. These skimmers are best suited to light to medium viscosity oils. Higher proportions of water will usually be collected with a weir
skimmer, especially in rough weather. However, it is possible to use them with emulsified oils.

**Shoreline Protection Techniques**

If an oil spill threatens to impact a shoreline then measures should be taken to limit the potential damage. Environmental and industrial sensitivities should be given priority protection.

Boom can be deployed to prevent the oil reaching the shoreline or penetrating tidal inlets, it can also be used to deflect oil away from sensitive areas or to intercept oil spreading down a coastline, preventing contamination of further areas.

The boom used is generally smaller than that used offshore. Oil Companies holds both foam filled and air inflation boom. In addition, shore sealing boom requiring filling with air and water can also be used. Boom should be placed at sufficient angle to the current to prevent the oil undercutting the boom.

**Shoreline Clean-up Techniques**

Once oil has impacted a shoreline, it is necessary to clean-up the oil in order to return the beach to its pre-spill condition.

There are many methods that may be used to achieve this:

- **Manual clean-up** – Teams of laborers equipped with absorbents, buckets, spades, rakes, bin bags, etc. can clean-up the beach. Care should be taken to minimize secondary contamination through site setup, decontamination procedures and waste management
- **Beach Cleaners** – There are machines that can be used to recover tar balls from a beach. Under certain conditions these can be very effective and reduce the overall manpower requirement
- **High volume low pressure flushing** – Large volumes of sea water can be pumped onto the beach to flush oil from a beach; the re-mobilized oil can be contained in a horseshoe boom and then collected by a skimmer
- **High pressure washing/steam cleaning** – These methods can be used on concrete/manmade surfaces to remove oil. Any organisms living on the surface are likely to be killed so this method should be used with caution

**Sorbent Materials**

Sorbent materials can come in the form of pads, boom and viscous sweep (pom-poms). They are useful for cleaning small amounts of oil, but due to the large quantities of oiled waste produced, should not be used extensively for oil recovery in a large response.
How and when to use Oil Spill Booms

Oil Spill booms come in a variety of shape and sizes sold by manufactures worldwide. A wide selection of booms located within the operational regions, booms are primarily used to:

- Contain oil
- Aid with the collection of oil
- Deflect oil to a gathering point
- Protect sensitive areas

Air filled boom

Shore sealing boom

Foam filled boom
Example of Boom Deployment at Sea

‘U’ configuration

‘U’ configuration

‘T’ configuration
‘V’ configuration

Side sweep configuration
Oil Spill Skimmers

There are many available types of skimmer available to use, however the choice of skimmer selection is critical in that you have to select the correct one for the job.

- Belt Skimmers-used primarily on crude, fuel oil and emulsified oils
- Disk Skimmer-used primarily on crude oils and heavy diesel
- Weir Skimmers-used primarily on all types of spill except asphalt
- Drum Skimmers-used primarily for diesel and light crude oil spill
- Rope Skimmers-used primarily for crude oils and light emulsified type oil (shore line)
- Brush Skimmers-used primarily on light to medium crude oils
- Mechanical Skimmers-used primarily on heavy crude oils, fuel oils and emulsified oils
- Side collectors-mounted on boats they are used to collect crude, fuel oil and emulsified oils

Note: The condition of the sea state either enhances or hinders the rate at which a skimmer can recover oil. Skimmers usually work most effectively in around 3ft swells or less. Seas that have a swell of more that 3ft will not allow the skimmer to perform as intended. A decision would have to be made on either to adopt a wait and see position as the sea will automatically agitate the oil and the oil may disperse naturally, (vessels will aid in agitation) or to apply dispersant.
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Window of Opportunity for Response

In most cases, responders are called to an oil spill within the first hour of the spill/notification. It is up to the responders to evaluate and quantify the size of the spill in order to mitigate the spill. Fresh oil on water is the best scenario for recovering oil at sea, and fresh oil is also best for applying dispersant. (Depending on where the oil is in relation to the land, the responder may opt to either recover the oil at sea or spray dispersant).

Logistics

Most oil spills occur at sea and depending on the window of opportunity, spill responders have to act quickly to combat the spill to prevent the spill from reaching the land or sensitive areas. This sounds easier said than done as there is a large logistical chain that supports clean-up and recovery operations at sea.

- Full PPE
- Trained people
- Vessels/boats
- Booms
- Skimmers
- Aerial support/planes/helicopters
- Consumable material, i.e. absorbent pads and booms/rubber gloves
- Food/water/toilets/showers (welfare facilities)
- Generators/lighting
- Accommodation
- Waste disposal route
- Incident Command Centre (ICC)
- Vehicles/cranes/hi-ab/front end loaders
- Communications/radios/mobiles

Natural Dispersion

Under certain conditions it may be suitable to allow the oil to disperse naturally and break down in the environment; this should always be monitored and evaluated. The conditions when this is usually chosen are when:

- Located far offshore away from any environmental sensitivities
- Relatively light oil that will break down rapidly
- Small quantity
- Rough weather conditions to agitate the oil
Agitation

It is possible to assist dispersion of oil by using vessels in the area for ‘prop washing’; this is using the wake generated by a vessel to agitate the oil. This is generally only effective for sheen. The vessel would proceed along the slick steering a zig-zag formation or straight line. Spraying with high pressure hoses can also agitate. Two examples of vessel agitation:
Chemical Dispersion

If containment and recovery of an oil spill is not possible, then use of chemical dispersants may be considered. These can be delivered from a vessel or aircraft. Dispersant use is regulated and subject to the following limitations:

- Seek authorization from the oil spill response coordination.
- The use of dispersant is regulated by the UAE environmental protection party.
- Dispersants work best on oils with low viscosity. Above 2,000 centistokes dispersants will not be effective.
- Viscosity of spilled oil increases with time, there will be a period of time when dispersants will be effective, but performance will decline with time.
- The window of opportunity for using dispersants is typically within hours to 1 or 2 days after an oil spill. After that, natural weathering of an oil slick on the surface of the sea caused by impacts such as the heat from the sun or buffeting by waves, makes oil more difficult to disperse.

Dispersant works by combining with the oil, forming small particles that can easily mix into the water column. By dispersing the oil over such a large volume of water the oil is quickly broken down into other products.

As of 01 January 2014, the Regional Organization for the Protection of the Marine Environment (ROPME) and Marine Emergency Mutual Aid Centre (MEMAC) stipulate that the following types of dispersant can be used:

- Corexit EC9500A (for sea and beach, but not rocky shore use)
- Dasic Slickgone NS
- Finasol OSR 51
- Finasol OSR 52 / Ecosperse 52
- OD 4000 (PE 998)
- Radiagreen OSD
- Super – Dispersant 25

Guidelines for using dispersant:

- Dispersant should not be used on sheen
- Dispersant may not be effective on heavily weathered or viscous oil. The dispersant is likely to run off the oil rather than penetrate through the layer
- Dispersant is not usually, but can sometimes be effective, on emulsified oil. A test spray should be carried out to test effectiveness before large scale application
- The exact correct dosage rate must be determined at the time by observation, however, for modern type 3 dispersants, an application rate of 1:20 is typical.
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• Dispersant application is typically effective between wave heights of 0.2m – 0.4m, below this, there will not be adequate mixing of the dispersed oil, above this, the oil is likely to be partially submerged and the dispersant will blow away before making contact

When to use Chemical Dispersants

Once an oil spill has been evaluated and assessed to use oil spill dispersant, only then should dispersant be applied (if ratified by the PME).

• Always obtain several samples of the oil on water
• It is necessary to apply dispersant on a small area of the spill to field test the effectiveness of the dispersant, i.e. to ensure that the dispersant is dispersing the oil
• Only use dispersants on fresh black oil, dispersants will not work on emulsified oil (brown oil) or sheen hydrocarbons and diesel type spills
• Oils that are in excess of 12-hours old (maximum window of opportunity) should be field tested (to ensure the effectiveness of the dispersant) since the majority of the light ends of the crude oil would have evaporated, especially during the hot months of summer, by then an emulsification would have formed
• Milky water is a good indication that the dispersant is not working, or has been applied to the water and not to the oil
• Dispersed oil has a milky coffee appearance where the dispersant has been applied. When the dispersant is applied to a slick, the droplets of oil are surrounded by surfactant substance, stabilizing the dispersion to promote rapid dilution there is a need for water movement or agitation
• Always stand up wind of the dispersant spray arms (if possible) to avoid indigestion of fumes
• Always use rubber gloves and full Personnel Protective Equipment (PPE) when handling chemical dispersant and oil

Dispersants have little effect on very viscous (thick), floating oils, as they tend to run off the oil into the water before the solvent can penetrate. As a general rule, dispersants are capable of dispersing most liquid oils and emulsions with viscosities of less than 2000 centistokes, equivalent to a medium fuel oil at 10-20°C. They are unsuitable for dealing with viscous emulsions (mousse) or oils which have a pour point near to or above that of the ambient temperature. Even those oils which can be dispersed initially become resistant after a period of time as the viscosity increases as a result of evaporation and emulsification. For some particular oils, the time available before dispersant stops being effective depends upon such factors as sea state and temperature but is unlikely to be longer than a day or two. Dispersants can, however, be more effective with viscous oils on shorelines because the contact time may be prolonged allowing better penetration of the dispersant into the oil. There are three main types of dispersants:
• **Type 1** dispersants are based on hydrocarbon solvents with between 15% to 25% surfactant. They are sprayed neat onto the oil as pre-dilution with sea water renders them ineffective. Typical dose rates are between 1:1 and 1:3 (dispersant:oil)

• **Type 2** dispersants are dilutable concentrate dispersants which are alcohol or glycol (oxygenated) solvent based with a higher surfactant concentration. Dilution is normally 1:10 with sea water

• **Type 3** dispersants are also concentrate dispersants with a similar formulation to type 2 products. However, they are designed to be used neat and typical dose rates are between 1:50 and 1:30 (neat dispersant:oil)

Type 1 and type 2 dispersants require thorough mixing with the oil after application to produce satisfactory dispersion. With type 3 products, the natural movement of the sea is usually sufficient to achieve this. The lower application rates required with concentrates mean that types 2 and 3 have largely superseded type 1 dispersants for application at sea

## Tips on how to use Dispersants

You must be striving to achieve the “ideal” application with a boat spray system, then the following factors need to be taken into account:

• The height and separation of the nozzles should be such as to create a uniform coverage of dispersant across the swath

• The height of the nozzles above water needs to be such that there is no overlap of spray cones, leading to overdosing

• The nozzles need to be sufficiently low as not to allow wind to carry the spray, but high enough in relation to the sea state

• The height of the nozzles can often be varied using drop-down extension tubes

• The spray should consist of uniform small droplets, almost like a shower and not an aerosol

• In flat calm conditions and depending on type and spray pattern of nozzles used, a typical nozzle height might be 0.5-1.0m above the water surface

• In flat calm conditions a secondary vessel, astern of the vessel applying dispersant, should agitate the water via prop washing or via hose application
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Tips on how to use Dispersants:
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  - The height of the nozzles above water needs to be such that there is no overlap of spray cones, leading to overdosing.
  - The nozzles need to be sufficiently low as not to allow wind to carry the spray, but high enough in relation to the sea state.
  - The height of the nozzles can often be varied using drop-down extension tubes.
  - The spray should consist of uniform small droplets, almost like a shower and not an aerosol.
  - In flat calm conditions and depending on type and spray pattern of nozzles used, a typical nozzle height might be 0.5-1.0m above the water surface.
  - In flat calm conditions a secondary vessel, astern of the vessel applying dispersant, should agitate the water via prop washing or via hose application.
The Science behind Dispersants

Dispersants are made of an active component (surfactant) carried in a solvent (carrier). The surfactant molecule of which is composed of organic carbon chains, has an affinity for oils and greases (oleophilic) as well as an affinity for water (hydrophilic).

These two components working together when sprayed onto oil that is amenable to dispersant, too light and the dispersant will pass through into the water.

It works its way through the oil to the oil water interface where it reduces the surface tension between the oil and the water literally pulling the oil apart therefore aiding the oil to be dispersed into minute droplets (similar to the size of dust) in the water column they remain in suspension below the surface, so small they do not have the ability to resurface and re-coalesce into a slick.
This accelerates the natural process of degradation and dispersion, thus assisting the biodegradation of the oil in the environment.

Chemical dispersants are used during oil spills, for the purpose of protecting natural and sensitive socio-economic resources such as coastal and marine ecosystems. Their applicability, however, should be carefully established. It should only be accepted if it results in a Net Environmental Benefit, when compared to the effects caused by a spill with no treatment or employed as an alternative and/or additional option for the containment and removal of the oil. The efficiency of the dispersant, among other factors, is related to the degree of weathering of the oil at sea, weathered oils become more viscous and may also undergo emulsification, factors that reduce the efficiency of these chemical agents.

Therefore, the application of the chemical dispersants usually takes place within the first 12 hours following the spill. This is the window of maximum opportunity. The majority of products presently available have a reduced effect if applied after the weathering process of the oil has already begun or the formation of viscous emulsions (mousse).

**Oil Spill Dispersion on Water**

These photographs show the difference between natural dispersion and dispersant dispersion. The droplets can be clearly seen on the left (natural dispersion) and have the ability to recoalesce and rise to the surface again.

The chemical dispersion on the right shows the droplets the size of dust particles and as such do not have the ability to rise again. In most countries the use of dispersants is only allowed in a minimum of 1.5 knot current speed.
Waste Management

There are certain key steps to adhere to when dealing with waste, these are:

- **Plan** – waste will be generated by multiple sources throughout a response (PPE, sorbent materials, natural debris, sediments, dead wildlife, etc.)
- **Preparation** – waste storage facilities are imperative at each stage of a response, as well are types of storage:
  - Primary Storage = watertight bags, buckets, bins, skips, pits, etc.
  - Intermediate Storage = covered containers and tanks, trenches, pits, etc.
  - Final Storage = large volume storage, sorting and pre-treatment areas, etc.
- **Reduce** – the amount of waste entering the waste stream, segregate waste to minimize waste type mixing. Choose clean-up/removal of contaminant techniques with care for minimal excess waste
- **Reuse/recycle** – equipment, PPE, etc. during the response. Implement a ‘decontamination zone’ where personnel and equipment can be cleaned. Again, segregate waste by classifying and labelling (liquid, solid, special waste)
- **Dispose** – waste will need to be transported for disposal, disposal sites need to be decided as well as the method of transportation. Waste types can include recovered liquid, oiled sediments, oiled PPE, oiled debris, oiled wildlife, etc. Not all waste needs to be disposed of, waste can be recovered, treated and reused by:
  - Gravity separation
  - Emulsion breaking
  - Re-processing
  - Sand cleaning
  - Beach washing
  - Bioremediation
  - Incineration
  - Landfill
  - Road building

The priorities for the management of waste can be displayed as a hierarchy and can be used to minimize the total amount of waste generated and therefore the associated environmental and economic influence. The hierarchy is:

- Eliminate waste
- Reduce waste
- Recycle waste
- Treat and/or dispose of waste
There are certain key steps to adhere to when dealing with waste, these are:

- Waste Management
- Plan
- Reduce
- Reuse/recycle
- Treat and/or dispose of waste

- Minimal excess waste
- Waste type mixing. Choose clean-up/removal of contaminant techniques with care for materials, natural debris, sediments, dead wildlife, etc.

- Economic influence. The hierarchy is:
  - Treat and/or dispose of waste
  - Reuse/recycle
  - Reduce
  - Plan

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- Road building
- Landfill
- Incineration
- Bioremediation
- Re-processing
- Beach washing
- Gravity separation
- Sand cleaning
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- Emulsion breaking

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