Guidance for Preparing Vessels to Create Artificial Reef Habitat

OIL AND FUEL

Narrative Clean-up Goal: Remove liquid hydrocarbons (fuels, oils) and semi-solids (greases) so that: no visible sheen is remaining on the tank surfaces (this includes all interior fittings, piping, structural members) or on the water surface when the equipment is flooded after sinking; no film or visible accumulation (e.g., spills on decking or carpet) is remaining on any vessel structure or component.

Environmental Impacts

The impacts of fuel and/or oil introduced into the marine environment are influenced by a variety of factors, including the physical properties of the oil, whether the oil is petroleum based or non-petroleum based, and the hydrodynamic properties of the receiving waters. Each type of oil has distinct physical properties that affect the way it disperses and breaks down, the hazard it may pose to ecosystems, and the likelihood that it will pose a threat to manmade resources. For example, the rate at which surface dispersion occurs will help to determine the effect of an oil spill on the environment. Most oils spread horizontally into a smooth and continuous layer, called a "slick," on the water surface.

Petroleum based and non-petroleum based oils can have both immediate and long-term adverse effects on the environment. These oils can be dangerous, or even deadly to wildlife. Light refined petroleum products, such as gasoline and kerosene, spread on water surfaces. The risk of fire and toxic exposure is high, but the products evaporate quickly and leave little residue. Alternatively, heavier petroleum based refined oil products may pose lesser fire and toxic hazards and do not spread on water as readily. However, heavier oils are more persistent in the environment, and may present a greater clean-up challenge.

Many non-petroleum oils have physical properties similar to those of petroleum based oils. For example, their solubility in water is limited, they both create slicks on the water surface, and they both form emulsions and sludge. In addition, non-petroleum oils tend to be persistent, remaining in the environment for long periods of time.

Oil spills can harm the environment in several ways, including the physical damage that directly impacts wildlife and their habitats, and the toxicity of the oil and its constituents, which can poison exposed organisms. Spilled oil in the environment immediately begins to disperse and degrade, with concomitant changes in physical and chemical properties. As these processes occur, the oil threatens natural resources, including birds and mammals as well as a wide range of marine organisms linked in a complex food web. Some organisms can be seriously injured (non-lethal effects) or killed (lethal effects) very soon after contact with the oil in a spill (acute effects), however; non-lethal toxic effects are often more subtle and often longer lasting (chronic tests).

What are oil and fuel?

For purposes of this guidance, the term oil includes crude oil; petroleum and petroleum-refined

products (e.g., diesel fuel, gasoline, kerosene, and bunkers); and non-petroleum oils such as synthetic oils (e.g., silicone fluids), tung oils, wood-derivative oils (e.g., resin/rosin oils), animal fats and oil, and edible and inedible seed oils from plants.

Some common refined petroleum products and their characteristics are as follows:

- ***No. 2 Fuel Oil*** is a lightweight substance that flows easily, spreads rapidly, and disperses readily. It is neither volatile nor likely to form emulsions.

- ***No. 4 Fuel Oil*** is a medium weight substance that flows easily and is readily dispersed if treated promptly. It has a low volatility and moderate flash point.

- ***No. 5 Fuel Oil (Bunker B)*** is a medium to heavyweight substance with a low volatility and moderate flash point. Dispersion is very difficult and potentially impossible.

- ***No. 6 Fuel Oil (Bunker C)*** is a thick substance that is difficult to pump and requires preheating for use. No. 6 fuel oil may be heavier than water. It is not likely to dissolve, and is likely to form tar balls, lumps, or emulsions. No. 6 fuel oil is very difficult or impossible to disperse. It has a low volatility and moderate flash point and is especially persistent in the environment.

Where are oils and fuels found in a ship?

Diesel fuel and fuel oil may be contained in various tanks throughout a ship. For example, lubricating oil is found in engine sumps, drums of unused lubricating oil in ship storerooms or engineering spaces, and sludge in fuel and cargo tanks. Hydraulic systems and components also contain oils.

The vessel's piping and tank arrangements generally will contain some oil, fuel, sludge, and associated residues. Fuel oil may be found in both integrated and freestanding tanks throughout the ship. Lubricating oils may be found in a variety of tanks depending on their individual use. System oils are generally located in engine room sump tanks, while cylinder oils and lubrication oils will be stored in tanks dedicated for a specific purpose.

"Used oil" -- any oil that has been refined from crude oil or any synthetic oil that has been used and, as a result of such use, is contaminated by physical or chemical impurities -- also may be found on ships. Used oil includes spent lubricating fluids that have been removed from engine crankcases, transmissions, and gearboxes; industrial oils such as compressor, turbine, and bearing oil; metal working oil; and refrigeration oil.

Vessel Preparation

The aim of hydrocarbon clean-up is to remove liquid hydrocarbons (fuels, oils). Although it is impossible to remove all hydrocarbon contaminants, a very thorough clean-up is achievable. In general, all liquid hydrocarbons and semi-solids (greases) should be drained, flushed, and

cleaned from fuel/lube and fluid system equipment (including piping, interior fittings, and structural members) so that no visible sheen remains on the tanks or other associated fluid system structures or on the water surface when the equipment is flooded after sinking. The opening and cleaning of pipes varies according to the type of hydrocarbon product that was in the lines. No visual evidence of hydrocarbon weeping (oozing or releasing drops of liquid) should exist at openings. Suggested cleaning methods for liquid hydrocarbons (fuels, oils, and semi-solids) are found in Appendix F.

If structural tanks are flooded, oil absorbent pads and excess loose oil absorbent material should be removed and liquid hydrocarbons should be cleaned from the tanks so that no visible sheen is present on the water surface. An alternative and very effective option for hydrocarbon clean-up is removal of the equipment and piping.

During vessel preparation, an economical way of managing used oil is recycling. It should be noted that additional used oil might be generated during the final preparation of the vessel prior to sinking. Such used oil should be removed from the vessel before sinking. It may be acceptable to leave old oil and grease in place if it is determined visually to be dried/solidified and therefore is not likely to cause a sheen.

Fuel and Oil Tanks

All fuels and lubricants should be drained from the tanks and the tanks flushed. Merely sealing tanks, whether as the sole means of fuel and oil tank preparation or in combination with partial tank draining, is insufficient. Over time, the integrity of the sealed tanks will eventually be compromised as marine growth density increases and the ship's underlying structural components decay. The placement of the Liberty ship Joseph L. Meek, sunk off Escambia County, Florida in 1976, demonstrated that corrosion of the ship's metal will eventually release residual fuel sealed in tanks into the environment. Although sealing the tanks without removing the contents is not sufficient for managing fuel and oil on a vessel intended to serve as an artificial reef, fuel/lube and fluid system equipment and piping intended to stay on the vessel should be sealed as necessary for the purpose of towing stability once the fuel/oil has been removed. Because these systems need to be opened during vessel preparation for draining and flushing the systems clean, sealing these systems may be necessary to help maintain vessel stability during transit to the designated artificial reef site.

There are several accepted and widely used methods to clean fuel and oil tanks. The appropriate method will be determined by the type of hydrocarbons in the tank, the amount of residue in the tank, and the extent of any hard or persistent deposits or residues. In general, lower quality fuels and heavy oils will require more cleaning effort. Similarly, tanks for dirty or water-contaminated oils will require more cleaning effort.

When cleaning tanks, the following factors should be considered: worker access and safety issues, machinery and resources available, and the methods or facilities available to deal with the cleaning residues. It may be necessary to experiment with several cleaning methods to see which best suits the particular circumstance.

Some methods for cleaning tanks are detailed in Appendix E. Regardless of the selected tank cleaning method, the effluent and water must be collected, treated, and disposed of in

compliance with applicable regulations. Large volumes will require the services of a pumper truck or barge, while smaller quantities should be collected and stored in drums. Caution should be used during all transfer operations to avoid spills. If transferring large quantities of oil or oil contaminated liquid, a containment boom around the vessel should be used to minimize the extent or spreading of an accidental release.

Structural and Non-structural Tanks
All structural and non-structural tanks are assumed to be contaminated by hydrocarbons until proven otherwise. Structural tanks include, but are not limited to: fuel storage/settling/service/day tanks, cargo tanks, oil tanks, structural hydraulic tanks, fresh water tanks, ballast tanks, stabilizer tanks, black and gray water tanks, voids, and cofferdams.

Tank interiors including deckheads should be cleaned of all hydrocarbons. No visible hydrocarbons should remain on the tank surfaces (this includes all interior fittings, piping, structural members), or on the water surface when flooded after sinking. No emulsified oil, as determined by visual inspection, should remain. Oil absorbent pads and excess loose oil absorbent material should be removed before sinking.

Gauges and Gauge Lines
Pressure gauges and gauge lines are assumed contaminated with the product that they were intended to measure. Fluid filled gauges should be removed. Pressure gauges and gauge lines should also be removed to prevent oil seepage from these lines. Lines that remain in place should be flushed, and the lines cleaned.

Special care should be exercised with mercury thermometers and pressure (typically vacuum) measuring devices. These should be removed intact from the vessel. Temperature gauges that do not contain any hazardous material can remain in its position. Other measuring instruments should be removed from the vessel or opened for cleaning, examination, and possible removal.

Combustion Engines
Combustion engines include any reciprocating engine in which fuel is consumed (diesel, gasoline, gases), stirling cycle engines, and gas turbines. The entire fuel/oil system should be drained and flushed. Any items (e.g., oil filters and strainer elements) that can not be flushed should be removed.

Combustion engines and associated manifolds should be thoroughly drained, flushed, and cleaned. Machinery need not be removed if it is completely drained and the sumps flushed and cleaned. Sometimes, engines are removed for reuse or to assure that all oil is removed before reefing. In some cases, it might be less expensive to remove and dispose of the engines than to clean the oil from them. Some methods for cleaning combustion engines are detailed in Appendix E.

Non-combustion Engines, Shafting, Gearing and Stern Glands
Main gear boxes and associated clutches should be drained of all lubricating oils. Internal gear sprayers, lubricating lines, and other components should be removed, or drained. External pedestal and thrust bearings should be drained.

Stern tubes and seals, if of the oil bath type, should be drained of oil. Note that draining the stern tubes and seals may require extraordinary measures to preserve the watertight integrity of the vessel during the clean-up and salvage operation.

Vessels that are equipped with thrusters, Z-drives, or other methods of unconventional propulsion systems will be addressed on a case-by-case basis. The objective is that no hydrocarbons remain in the propulsion system.

Steering Gear
Hydraulic pumps and associated piping and fittings should either be removed or drained and flushed clean. Hydraulic telemotor systems should be treated similarly. Grease lines and reservoirs for rudder heads should be removed from the ship, or opened and cleaned. Vessels with combined propulsion and steering systems should be addressed in the same manner as that which is provided under the above mentioned "non-combustion engines, shafting, gearing, and stern glands" subsection.

Auxiliary Machinery
Auxiliary machinery that has a liquid hydrocarbon as its working fluid should be completely drained and flushed clean. Auxiliary machinery refers to machinery and components that are not an integral part of the main propulsion system of the vessel. The term can include but is not limited to: pumps, motors, compressors, galley equipment, capstans, elevators, and cargo handling machinery. Many pieces of auxiliary machinery have a lubricating oil system or are in direct contact with liquid hydrocarbons.

All lubricating oil system components should be stripped from auxiliary machinery, drained and cleaned. Lubricating oil sumps should be drained and cleaned.

Hydraulics
Unless there is acceptable proof to the contrary, all hydraulic systems should be assumed to have employed a hydrocarbon based fluid. Hydraulic lines should be removed from the vessel, or opened and blown through with air until clear. Hydraulic fittings (valves and valve blocks of all types, cylinders, pumps, accumulators, filters, coolers) should be removed from the ship or drained clean. Hydraulic sumps should be opened and drained clean.

Grease
All grease reservoirs should be removed from the ship, or opened and cleaned. Grease lines should be removed or blown through until clear and all visible grease accumulations should be removed so that no visible sheen is remaining on the water surface when these structures are flooded after sinking. Machinery that employs grease-packed gearboxes (common on deck machinery), as well as grease packed couplings, stuffing boxes, chain sprockets, and worm drives should be opened and cleaned of grease. Grease on chains and sprockets should be removed. Greased cables should be cleaned or removed from the vessel so that no visible sheen is remaining on the water surface when these structures are flooded after sinking.

Sealed rolling element bearings that contain grease can be left in-situ. Grease in other fittings such as stuffing boxes and glands can be left in situ if the seals are intact and the quantities are

small (for example, less than 100 milliliters evenly distributed throughout the component). Any grease on the outside of the sealed bearings should be removed.

Bilge Areas
The bilge area includes all areas that would be subject to contact with oily water, or may be a catch area for spills from cargoholds or storerooms, and interior surfaces which may have been subject to hydrocarbon contamination through sprays, spills, or disposal. Bilge areas also include the plating and all surfaces of attached stiffeners and fittings. Bilge areas should be free of visible oils, greases, and sludge. Oil or grease films evident to the touch should be removed. Any debris contaminated with hydrocarbons should be removed. Any cleaning fluids used to clean the bilge should be removed from the vessel. Accumulations of loose oil absorbent material should be limited to those amounts that cannot reasonably be picked up with brooms and vacuums.

Cleaning bilges is frequently complicated by poor access caused by piping, gratings, and equipment. In many cases, it is cheaper and easier to remove the dirty or contaminated items that limit access than to clean the items as well as the bilge. Once clean, bilges are very vulnerable to recontamination. Note the following recontamination issues:

- Piping, valves, and fittings in hydrocarbon systems will continue to drip for some time after initial draining. Over a short period of time, these drips can lead to a major rework cleaning effort. Therefore, drips should be captured whenever possible; drip pans should be emptied frequently.

- Containers used for clean-up are vulnerable to tipping and spilling, especially in conditions -- such as poor lighting -- that are often found in vessels undergoing sinking preparation. Remove containers used for clean-up when they are full.

- Water should not be allowed to enter bilges unless it is part of a planned clean-up effort. Water that otherwise enters the bilge should be handled as oily wastewater.

In general, the approach and methods recommended for cleaning bilges are the same as for cleaning tanks.

Decks and Floor Coverings
Oil and grease films on deck coverings should be cleaned. Decks and floor coverings include ceramic tile, linoleum and linoleum tile, carpet, and continuous floor coverings. In compartments subject to hydrocarbon spills during the vessel's life (e.g., workshops, compartments with fuel or oil tank overflows or tank covers), the deck covering and underlayment should be examined for oil saturation. Floor coverings or underlayment that has been saturated with hydrocarbons should be removed from the vessel.

Bulkheads and Deckheads
Bulkheads and deckheads should be cleaned of oil and grease films. Where it is evident that a spill or accumulation resulting from leaks has occurred, coverings should be removed to reveal the full extent of the spill or accumulation.