RRT III FACT SHEET

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COLD WEATHER OIL SPILL RESPONSE

Oil Behavior in Cold Water

Typically, crude oils and high viscosity fuel oils are heated when shipped in cold regions. Crude oils that are spilled in these environments may exceed their pour point; thus becoming more viscous or tar-like as the oil quickly cools. Even lighter, refined products experience changes in their physical properties when spilled in cold water environments. They often turn into non-coalescing, semi-solid, smooth spherical particles making recovery difficult. Low temperature conditions can also slow weathering and evaporation and cause slicks to remain thicker and resist spreading.

Oil Behavior in Areas with Ice Cover

Oil may be on ice, under ice, incorporated into ice, or on water between pieces of ice. Typically the same behavior as described above will occur to oil spilled in ice conditions. In addition high ice concentrations may result in reduced emulsification due to lower wind and wave conditions. Oil spilled in ice is relatively thick (often centimeters thick) compared to spills in open water, which usually spread to thickness less than 1 millimeter. The presence of ice greatly reduces the rates of natural weathering for petroleum hydrocarbons. Any oil entrapment into ice during the freezing process will only serve to decrease evaporation and natural degradation of the oil. The greater thickness of oil slicks in ice-infested waters also slows evaporation rates.

In areas of strong currents large and small waterways rarely freeze completely across but would have ice in the parts of the river with much lower energy such as wide spots and low velocity sections. Other slow moving rivers and streams freeze completely across and remain that way until spring or a mid-winter thaw. Some rivers in industrialized areas may never freeze because warmer discharges into the waterway never allow the water to freeze.

In environments where there is extensive ice coverage on waterways for extended periods of the year, there are three types of ice that may be encountered:

- **Shorefast Ice** - this type of ice coverage is described as solid sheets of ice attached to the shore and/or the bottom, which protect the shore zone from wave action.

- **Fractured Or Deformed Ice**- Ice that is not attached to the shore or bottom and responds to wind and water currents by moving and deforming, leading to the formation of rafts, pressure ridges, rubble fields, and leads.

- **Ice Floes** - Ice floes are defined as any ice, floating freely on the water that can move under the influence of winds and currents. The most important factor influencing spill behavior and response in ice floes is the percentage of ice on the water surface.

Ice thickness will be affected by insulation of snow cover. A plowed or windswept area will have thicker ice, appearing as a ridge or bulge on the underside of the ice. This may create pockets in the underside of the ice from which oil can be recovered.

Oil Behavior in Snow

When oil is spilled on snow, it will penetrate the snow and fill the void space, causing some melt water to form and some possible compaction of the snow layer. Snow tends to absorb oil; preventing penetration into the ground layers and retarding lateral spreading of the oil. Snow is also an excellent heat absorbent, based on experiments with heated oil that showed heated oil reaching ambient temperatures within 5 minutes. The absorbent quality of snow will help to minimize potential thermal damage to the ground layers.

Snow may act as an effective physical barrier, resulting from the melting and refreezing of water and resultant blockage of the pores in the snowbody. This ice layer prevents the oil from penetrating. In addition, if air and snow temperatures are cold enough, more viscous oils may be cooled to the point where they form their own barriers to the spread of flowing oil; lighter oils may form oil/snow mulches containing 50% or more oil by volume.

Oil on Frozen Ground

Frost in the ground may be a responder's best friend by limiting petroleum penetration. However, frost may be absent or thinner near buildings, above pipelines or other utilities, or in different soil types. Petroleum may flow to these areas and infiltrate the ground as in summer.

RECOVERY STRATEGIES FOR OIL IN ICE AND SNOW

Finding Oil On and Under Ice

Helicopter observers are generally the safest and most effective method of finding and mapping oil on ice surface or within ice. Surveys can be done from shore. Very cautious surveys out on the ice can be done.

It can be difficult to detect oil entrapped under an ice cover. A visual inspection of a spill area may reveal likely areas for the oil to collect such as holes or pools in the ice. Areas such as snow packs can insulate the ice causing a trough in the subsurface of the ice where the oil may collect. Plowed or windswept areas have thicker ice, behind which oil may collect

Containing Oil on and Under Snow and Ice

Snow and Ice Berms

Snow and ice berms have been used with success. Snow acts as a barrier and picks up some of the product through wicking action. Generally, oil will penetrate no more than 6-8 inches into a snowberm. A water spray can also be used either alone or in conjunction with a snow berm, to gradually build up a layer of ice, which can then act as a containment device.

Ice Slotting

Oil moving under solid ice can be intercepted using slots cut into ice to create open water. Laboratory and field experiments have shown that slots cut at a 30-degree angle to the current with a width 1.5 times the thickness of the ice are best for oil containment and recovery. Each slot should be down current of the moving. Once oil has collected in the slot, it can be removed using a variety of recovery methods including sorbents, vacuum trucks, skimmers and pumps.

Plywood Barriers

Oil traveling under ice can be contained or directed by sheets of plywood inserted into a series of thin slots cut into the ice.

Siphon Dams & Straw Dams

Siphon or Water Bypass dams can be used to contain oil in moving waterways, which have little or no flow. The dam should be constructed where there are high banks buttressed to support oil and water pressure. Straw dams can also be placed in shallow slow moving waterways to create a temporary barrier that holds the product back and allows water to pass through.

Compressed Air Bubblers

Compressed air bubblers have been utilized as a containment strategy with some success, especially in calm situations. The procedure usually consists of pumping compressed air through a submerged pipe that has a regular series of holes. The desired outcome is that broken ice will pass over the bubbles while the bubble curtain contains the oil.

Removal and Recovery

Cutting Holes for Removing Oil under Ice

One of the easiest techniques for removing oil from under ice is by cutting a hole in the ice and pumping the oil out through the hole. This method of recovery works best with large, stationary pockets of oil.

Skimmers

In calm waters reports of recovery rates for skimmers vary between 41%-72% however these numbers do decrease as ice conditions increase. The highly viscous nature of oil in a cold water environment often makes recovery of the oil and the actual functioning of the machinery exceedingly difficult. The design of most skimming devices must be evaluated before oil recovery under broken ice conditions can take place. Drum and vortex skimmers have had a generally poor history of recovery in ice conditions. Weir skimmers fared slightly better, however problems with ice forming/collecting on the weirs can hamper recovery. The family of "rope mop or belt skimmer" is one of the best and most reliable skimmers for cold weather response. Rope mop skimmers have also been used to collect oil trapped under ice.

In-Situ Burning

In certain conditions, in situ burning of oil in a cold weather response can be a highly efficient removal technique. This method should be considered especially when other recovery techniques prove to be unsafe or ineffective such as on broken or rotten ice.
Oil saturated snow can also be burned with success, once ignited. As snow is melted, oil is released onto the melt pool, from which it burns. Consideration must be given as to how the oily melt pool will be contained.

Large areas of solid or broken ice can be used to contain burning oil as well as melt pools that tend to accumulate product that was trapped in or under the ice as the temperature warms.

In open water scenarios, fireproof boom may be used to contain oil while burning. The presence of small amounts of broken ice in a burning zone does not appear to significantly hamper burning operations.

Removing Ice Blocks and Snow and melting Out the Oil

If there is a large amount of oil trapped in ice or snow, physical removal of the contaminated substance to an area where it can be melted to recover the product may be an option. Heavy equipment like front-end loaders can remove large amounts of snow or ice to a roll-off box or other container. On site lined emergency ponds may be constructed. The substance is then heated onsite, removed to a heated storage area, or kept contained until a natural thaw occurs. The oil water mixture can then be sent through a treatment plant or oil water separator system to recover the product.