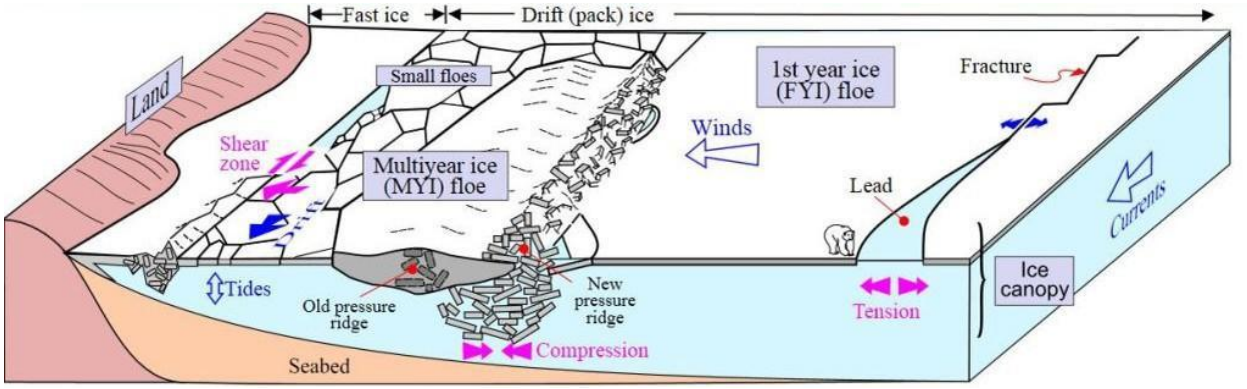
Solicitation # E15PS00027 -
Innovative Methods to Remove Surface Oil under Arctic Conditions

BSEE Objectives*: Traditional methods of recovering surface oil are challenged by the Arctic operating environment. Environmental conditions may preclude human response. Technologies/methods submitted under this topic should be new, innovative concepts. Technologies submitted should be proof-of-concept level projects. New methods should include demonstration in relevant environments.*

1) What are the Challenges for Spilled Oil Recovery in Arctic Conditions?
There are multiple challenges in operating ships in the Arctic, let alone vessels tasked with recovering spilled oil on the water surface. These include:

i. Presence of ice in the water, ranging from slush to icebergs to solid, fast ice.
ii. Intense cold, combined with wetness from spray and precipitation create a significant hypothermia hazard for humans.
iii. Extended periods of darkness during winter months.
iv. As the Arctic ice cap recedes, storm systems are more energetic, larger, and last longer.
v. Likely spill areas are further from suitable support ports than in more temperate regions.

The conventional methods of recovering oil on sea-going skimmers - including booms, bow sweep arms and suspended disk/brush/drum (DBD) skimmers are unlikely to survive Arctic operations, if they can even be deployed. In heavy, dynamic (moving) ice, they are crushed.



Fast ice (left, along shoreline) versus drift ice (right) in a hypothetical sea ice dynamics scenario


Kulluk drill ship in Beaufort Sea drift ice with OSV Tug Kalvik

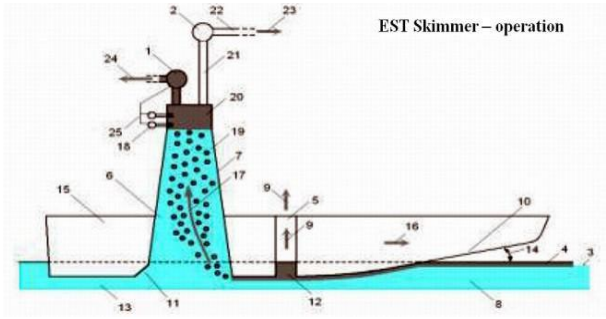
The images above speak to where the an Arctic off-shore oil spill is likely to happen, either at the drill rig or at the seafloor below it, or a spill from the various ships operating for exploration, production or transport of the oil, e.g., drill ships, oil service vessels (OSV), tankers.

2) The Extreme Spill Technology (EST) Gravity Tower Vessel

The EST technology is fundamentally different than conventional mechanical oil skimmers in general use today. Rather than trying to 'slice', or use surface tension to 'pull' the oil off the water surface, the EST system gathers the oil between the catamaran hulls on either side of the vessel, forcing it below the vessel and directs it into the raised, gravity-driven, collection tower. The bottom of the centre section of the hull sits just below the water surface, eliminating waves and free-surface effect at the concentration area ahead of the collection tower. Just as oil floats on the water surface, it also floats to the top of the EST collection tower. When sufficient oil has collected at the top of the tower, a sensor starts the oil recovery pump. When the water level rises to replace the removed oil, a second sensor stops the pump before water is collected.

The EST oil spill recovery vessel (OSRV - as a barge or self-powered ship) can operate without the use of booms or bow sweep arms because they are designed to have wide bow areas to funnel the oil. The oil collection function is integral to the vessel shape and gravity towers. There are no significant moving parts beyond the pumps and valves.

An early version of the EST skimmer has been tested at OHMSETT, and in calm waters, proved it could collect over 90% of oil it encountered, with virtually no water collected. In waves - representing conditions where conventional skimmers would be ineffective or completely unable to operate - the EST skimmer still collected in excess of 70% of the oil it encountered, again with minimal water content. As a result of the OHMSETT testing, additional testing and modeling, the next generation of the EST vessel will be even more effective. EST has proprietary rights to the OHMSETT data collected, but will make it available to the BSEE project.



EST skimmer - illustrating operating principle

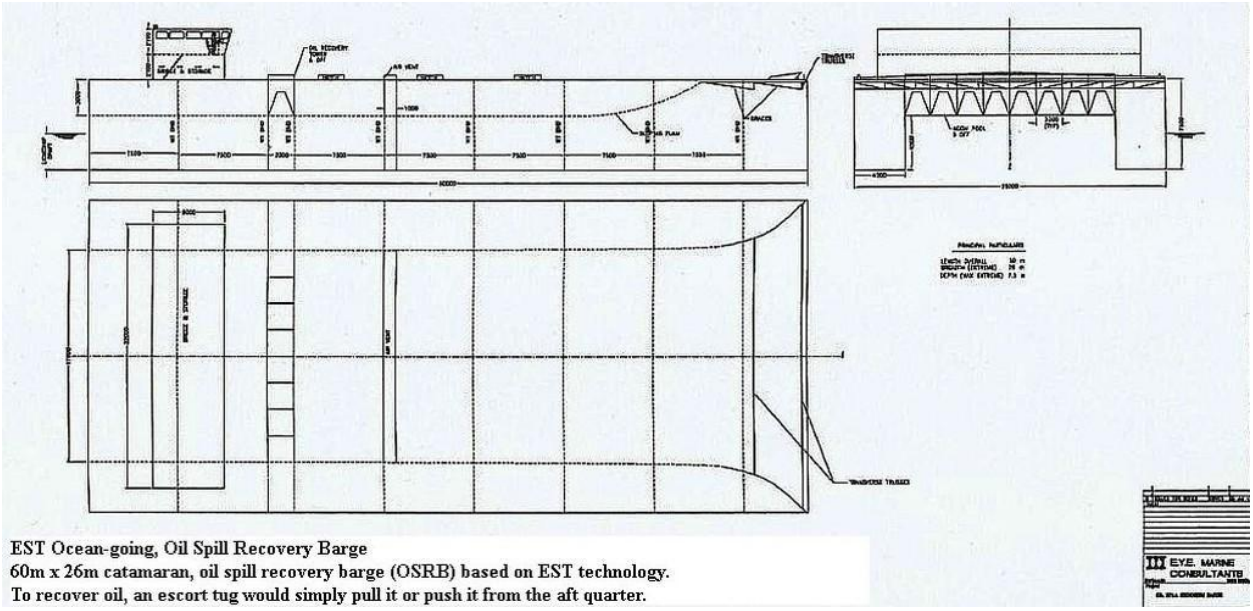
EST Polar Class 5, 70-metre OSRV

The Canadian Coast Guard acquired the EST vessel which was tested at OHMSETT, and in 2014 described it as "an essential piece of response equipment that we maintain in Atlantic Canada".

EST holds a global patent related to its unique technology.

EST Skimmer testing at OHMSETT

Recovered oil blobs rising in EST tower



3) Addressing the BSEE Identified Factors

a) Remote Operation

Because the EST technology does not require the manual interventions associated with conventional skimmers (e.g., deploying and collecting boom; adjusting the oil 'slicing' depth; deploying, operating and recovering crane-mounted small DBD skimmers) and is already highly automated, it lends itself to remote operation using automated vision, telemetry, sensor monitoring, control (pumps, valves, ballasting, steering, etc.) and recording/reporting systems. Existing redundancy measures would be enhanced for operations in Arctic conditions. The EST barge system is already designed to permit unmanned operation (other than for recovered oil transfer at sea operations, where coupling and uncoupling are performed manually).

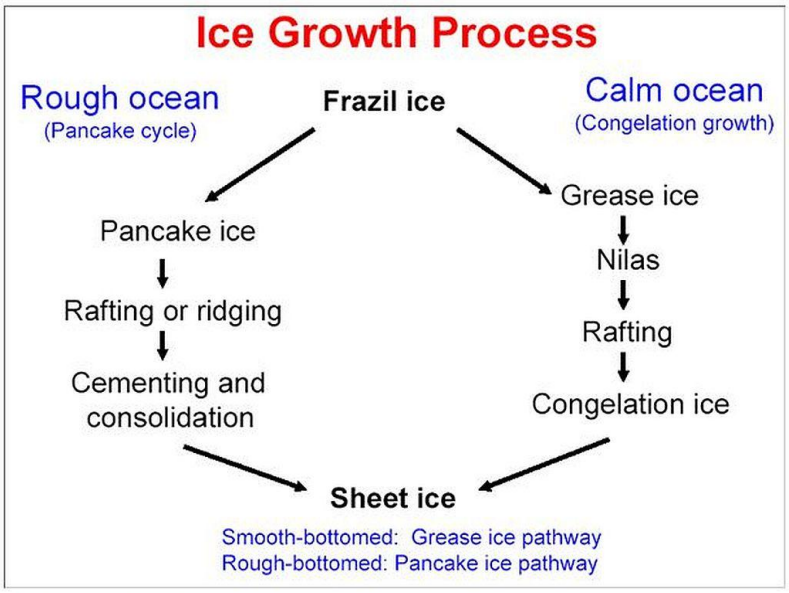
b) Temperature

For operation in ice-infested waters, EST expects to fit the vessels with heating systems to improve separation of oil from ice surfaces to improve the quantity of recovered oil. The very small number of moving parts (pumps, valves, possibly drive system) in the EST vessel greatly reduces the number of potential points of failure, especially as there are no moving parts exposed to the outside air, which is where ice is likely to collect and affect operation.

c) Vessel Heavy Weather Capability

The EST design eliminates free-surface effect. At the oil collection point beneath the vessel, there are no waves so sea state is effectively removed as a variable. The 60-metre barge version of the EST vessel will operate in conditions up to and including Force 7 gales (Beaufort scale). The Polar Class 5 Oil Spill Recovery Vessel (OSRV) concept is intended for Arctic operation and use in iced waters.

Different operating approaches to oiled ice will be employed depending on the type of ice - ranging from thick, solid multi-year ice to thinner sheet ice to drift ice to dispersed ice, vs. surface oil in cold water with occasional or no ice present.



Ice Formation: Sea state affects the way ice is formed.
Source: NSIDC

4) Research Proposal

With sufficient BSEE funding, RESTCo proposes to carry out the following research work based on the EST technology.

i. Build a new 1/10 scale model of the 60-metre EST oil spill recovery barge which can fit in the OHMSETT test tank, including refinements developed since 2012, sufficiently functional to fulfill the research work (i.e., prove capabilities regarding: collection of oils of varying viscosity; operation in a range of ambient temperatures; operating effectively in waves; reduce collection-related emulsification relative to sea-going skimmer technology currently in use; passive ice-shedding materials and shapes; active ice-shedding; and, the ability to store recovered oil on-board and transfer to storage bladders or other containment).

ii. Develop and test refinements to deal with iced waters including heating of the oil collection tower interior and cleaning large pieces of ice. (Solid oiled ice will be broken by the EST OSRV or a companion vessel so it can be pushed below the vessel. Larger

pieces will not enter the tower, but be gated past the tower bottom opening. Ice chips and slush will float into the tower being small and lighter than water. However, the slush will be melted in the tower, turning to water, and thus separating below the oil.)

iii. Research, develop, test and refine additional remote operation capabilities for the vessel, such as remote operational control, vision system image transmission, radar screen image transmission, telemetry for monitoring sensors and recording and reporting equipment, stronger redundancy in control systems, ice shedding; and oil detection. (UAVs or drones for aerial oil detection will be operated separately.)

iv. Full model vessel and systems testing and demonstration in cold-weather climate areas (including freshwater and saltwater areas in Canada which can provide outdoor testing conditions up to full water freeze-up).

5) RESTCo Contact Information

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