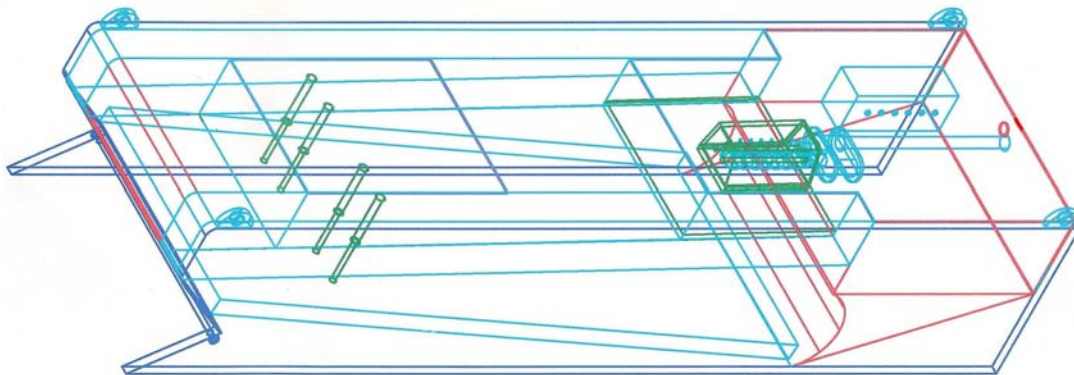


WHITE PAPER FOR PROPOSED FY2004 RESEARCH TO SUPPORT THE  
TECHNOLOGY ASSESSMENT AND RESEARCH PROGRAM CONCERNING THE  
AREA OF OIL SPILL RESPONSE RESEARCH  
MMS Solicitation # 1435-01-04-RP-33212

**DEVELOPMENT OF AN ALL-PURPOSE ARCTIC AND OPEN  
OCEAN OIL SPILL RESPONSE VESSEL AND ASSOCIATED ALL  
PURPOSE SKIMMER**



**Submitted to:**

U.S. Department of the Interior  
Mineral Management Service  
381 Elden Street  
Herndon, Virginia 20170-4817

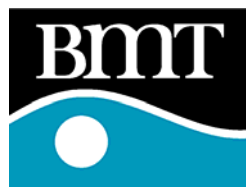
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## **Areas of Interest**

This White Paper, titled “Development of an All-Purpose Arctic and Open Ocean Oil Spill Response Vessel and Associated All-Purpose Skimmer”, has been prepared in response to MMS Solicitation # 1435-01-04-RP-33212 and it addresses three of the proposed objectives of the FY2004 OSRR program; specifically:

1. Innovative Oil Spill Containment and Recovery Technologies for the Open Ocean
2. Innovative Oil Spill Containment and Recovery technologies for Broken Ice Conditions
3. Technology for the Separation of Oil and Ice

## **Understanding of the Problem**

There can be no doubt that the range of physical environments and weather conditions in the Arctic and Subarctic represent the most challenging problems for spill response worldwide. This environment can present extraordinary demands upon responders and their response equipment. Redundant inventories of specialized oil recovery equipment are often necessary to effectively recover oil in different demanding circumstances and conditions. The conditions most problematic to spill response such as ice, high currents, high seas and low visibility will certainly occur seasonally but can often change from one problem to another as a spill migrates from area to area and/or the weather changes from a warm and calm sunny day to a pitch black typhoon with freezing spray. Each of these diverse circumstances could involve concentrations of ice generated by surface freezing or tidewater glaciers and high currents generated by tidal flows through constricted waterways, coastal currents and/or river flow. These problematic conditions can be further compounded by constricted waterways and radically changing bathymetry ranging from extended shallow waters to deep waters that preclude safe anchoring with steep, piercing pinnacles in between.

Traditional consideration of spill response in ice-covered waters has been limited to evaluation of response in the calm sea conditions that typically exist between the edge of an expansive solid ice sheet and an adjacent land mass. These calm sea conditions are becoming much less frequent as the more rapid and extended retraction of the polar icepacks, due to global warming, exposes more “open water” allowing larger waves and current to be generated by winds resulting from higher atmospheric pressure gradients. These “open water” conditions still contain sufficient concentrations of broken ice to substantially impede, if not totally defeat, current spill mitigation measures.

There is therefore a need to develop an affordable method of oil spill response that is versatile enough to be effective in broken ice conditions as well as high sea state conditions on the open ocean.

## **Summary of Vessel and Skimmer Concept**

The proposed All-Purpose Arctic and Open Ocean Oil Spill Response Vessel (“AP OSRV”) concept combines an effective high speed, inclined plane open water skimming system with proven ice separation technology and incorporates these technologies into an innovative trimaran hull oil spill response vessel that results in a high spill encounter rate for continuous operation in a broad range of here-to-fore problematic environmental conditions. The overall objectives of this development concept are to develop:

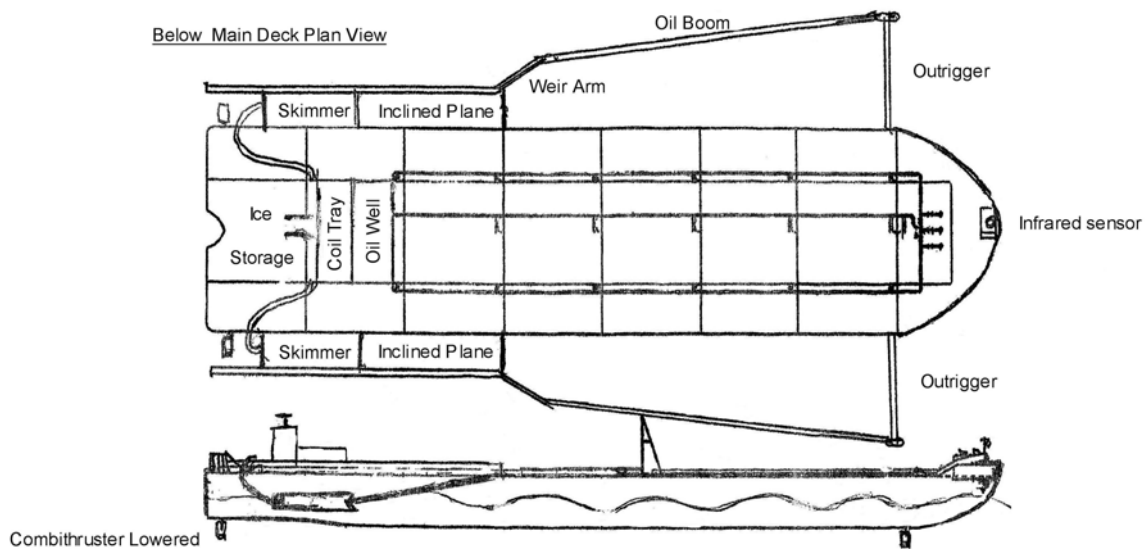
- A versatile vessel and skimmer that can be used in both the deep water of the Gulf of Mexico and in the types of broken ice typically found in the nearshore areas of the Beaufort and Chukchi Seas in Alaska where oil and gas activities are increasing.
- An All-Purpose Skimmer that can be part of a dedicated AP OSRV or can be retrofitted to a “vessel of opportunity”.

In addition to these overall objectives, this development program has identified several goals for the AP OSRV which include:

- Increase the current speed range in which a mechanical skimmer is effective to a range of 0 to 5 knots.
- To operate effectively in concentrated broken ice conditions with diameters up to 15+ ft.
- To operate effectively in wave height conditions up to 18+ ft.
- To operate 24 hours per day in darkness and/or low visibility weather conditions.
- A spill recovery rate of 2,000-4,000 bbl/vessel/hr.
- The ability to process recovered oil for resale.

The proposed AP OSRV utilizes a trimaran hull with a large long barge like center hull with a ship shape bow and two relatively short thin side hulls at the aft end of the vessel. Between each of the side hulls and the center hull, an adaptable modular All-Purpose Skimmer (APS) unit would be fitted. The APS concept employs an inclined plane skimmer principle with current baffles and combines them with a proven ice separation technology and a high capacity rotary lobe pump with a twin auger macerator capable of pumping viscous oil with entrained ice particles. With the APS units mounted between the side and center hull, they are protected from direct wave action and can continue to operate in very high sea states. An illustration of the AP OSRV with two APS units fitted appears below:

### All-Purpose Oil Spill Recovery Vessel



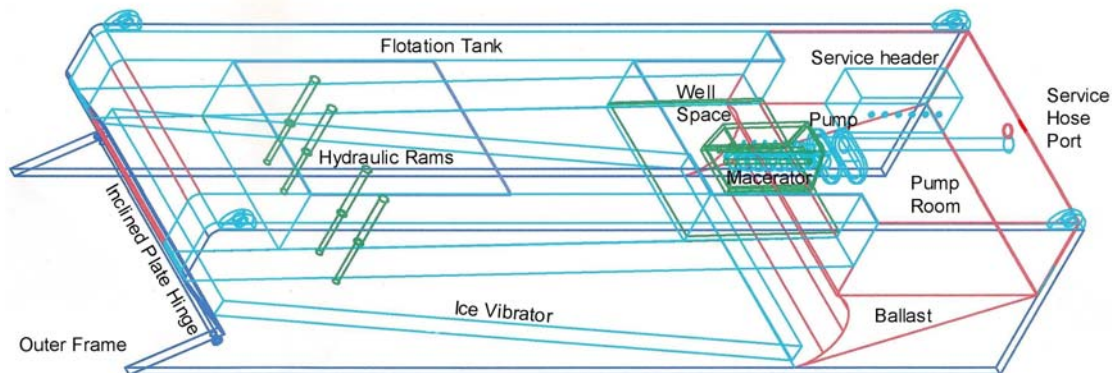
#### Principal Parameters

Length	400 ft.
Beam	144 ft.
Depth	25 ft.
Recovery Rate	3,000 bbl/hr
Current Speed	0 -5+ Knots
Ice Conditions	15 ft. broken ice

#### Profile, Inboard of outer hull

A detailed isometric view of the APS is shown below and illustrates the simple modular approach of the unit:

### **All-Purpose Skimmer – Isometric view without Stratification Baffles**



The modular design of the APS unit would allow its deployment in multiple configurations with or in different vessels including:

- As a stand-alone skimmer positioned in a hole cut through a solid ice surface.
- Being towed behind a vessel or mounted over the side of a “vessel of opportunity”.
- In a dedicated vessel such as the trimaran AP OSRV.
- In a tanker or barge converted to the trimaran configuration.

The trimaran AP OSRV concept that is proposed is the most effective mounting platform for the APS units for several reasons. The tunnel formed between the side and center hulls allows an effective seal between the skimmer and hull to prevent oil escapement around the skimmer while providing an efficient oil/water/ice/debris flow through the skimming system. In severe sea states the trimaran side hull can be used to protect the skimmer by turning broadside to the waves with the forward portion of the main hull concentrating the oil for recovery by the protected skimmer. The tunnels created by the trimaran hull should be at least 36% of the center hull beam to allow for effective high volume ice processing and to provide enough width to catch all of the oil in the bow wake. The trimaran deck and outer hulls extend from the transom forward to about mid-ships, depending on the depth of the vessel, (a greater draft requires a longer inclined plane).

Additional oil concentration is accomplished by adding full depth weir arms hinged to the leading edge of the trimaran side hulls to create a funnel shape at the mouth of the tunnels, (i.e. doors that fold flat against the outer hull when in transit and are winched open with a cable while skimming). This funnel effect can be further augmented in moderate seas or sparse ice concentrations by attaching foam filled ocean booms to the leading edge of the weir arm with “Tide Slides”. The weir arm would then be held at a shallow angle ( $<20^\circ$ ) to the current by 60 ft. outriggers mounted on the forward quarter of the center hull of the vessel. The total encounter width of a 400 ft. X 100 ft. X 25 ft. center barge with outriggers would be 220 ft.

The AP OSRV would be propelled, or dynamically positioned, by three electric Z-drives. Two pre-fabricated aft engine modules would each utilize a 1,500 KW Rolls-Royce CombiThruster that, when in the raised position, could generate thrust forward and aft in the tunnels between the main and outer hulls. The use of the aft thrusters in this

configuration allows the OSRV to perform two essential functions: effective operation in dense broken ice by pulling oil and ice through the tunnels faster than the advancing speed of the vessel; operation of the otherwise advancing inclined plane skimmer in a static skimming mode. In both circumstances the vertically retracting bow Z-drive provides opposite thrust to the aft Z-drives that are generating the optimal flow rate of oil and/or ice past the skimmers in the tunnels irrespective of the advancing speed of the vessel. Without this increased current generated by the CombiThrusters, skimming in dense concentrations of ice would be inefficient if not totally futile. Ice concentrated by the hull and weir arm would tend to block oil flow to the skimmer by development of a bow wake in front of the ice concentrating at the funnel point. The wake at the funnel point is minimized or eliminated because ice doesn't have a chance to build up excessively. Even if ice does occasionally build up in front of the skimmer, the current generated by the Z-drives would still pull oil into the ice pack. No other ice-skimming technology has surmounted this problem of oil diversion around the skimmer due to ice buildup. No other arctic skimmer provides the oil concentration capability, high speed and high recovery rate of this system. Because the aft Z-drives can generate current past the skimmers while dynamically positioned, the inclined plane skimmers on the AP OSRV can maintain acceptable spill recovery efficiencies and high recovery rates in currents from 0 knots up to 5 knots. Skimming can take place at even higher speeds for short durations if the aft Z-drives are used to temporarily retard the current in the tunnels. The Z-drives would otherwise remain in the lowered position if: the OSRV is skimming in advancing mode; severe sea states were encountered or while in transit to, or from, a spill site.

The basic inclined plane skimming system can be protected from intruding ice larger than 1" in diameter by the utilization a self-cleaning grill such as the Lamor Oil and Ice Separator. This self-cleaning grill would also be effective for excluding ordinary debris/flotsam and may be desirable in all conditions, but baffles used to stratify currents in the skimmer well may prove sufficient in areas with little floating debris. Many high-capacity positive displacement pumps available on the market can easily pass ice pieces/debris in the range of 1" diameter, particularly if fitted with chopping blades, a macerator or grinder. Pump selection is also dependent upon the viscosity of the oils that would be encountered in the area.

### **The Concept Development Team**

The originator of the AP OSRV and APS concepts is Mr. Tom Lakosh. Mr. Lakosh has been involved in spill response issues since the Exxon Valdez severely impacted Prince William Sound. In the past year-and-a-half he has intensively investigated the problems and solutions for effective spill mitigation in Arctic/Subarctic conditions that necessarily include response when ice is present. He has found that even though separate technologies have been developed that substantially improve response capability for each of the problematic conditions mentioned above, the oil industry and governments that rely on oil revenues will not invest in the specialized equipment due to the high cost of redundant response inventories. Equipment that was designed to address one or two problematic conditions couldn't respond effectively in another essential mode of operation, thereby necessitating another expensive response device in the inventory to fill the gap. It was this that led to the idea of the All-Purpose OSRV and APS. Mr. Lakosh will act as an advisor on this program and will be actively involved in helping the team bring his ideas to technical reality.

Mr. John Avis, B.A.Sc., M.A.Sc., P. Eng. will be the project manager. Mr. Avis has over 14 years experience in the naval architecture and marine engineering industry most recently as President of Kvaerner Masa Marine, a known leader in vessel design. Mr. Avis now is the Principle Consultant of Avis Marine Consulting. Mr. Avis will lead and manage the project.

Since 1953, BMT Designers and Planners, Inc. has been offering technical support to government agencies and commercial clients in the fields of Naval Architecture; Marine Engineering; Environmental, Safety and Health Services and Information Systems Development. In 1989, D&P joined the BMT Group of companies, one of the world's leading maritime and engineering consulting organizations. BMT has a well deserved reputation as a leader in maritime research. Included in the BMT Group is Fleet Technology, Ltd. in Ottawa Canada which has specific expertise in ice related research and has carried out earlier work for MMS TA&R in project 353 "The Use of Ice Booms for the Recovery of Oil Spills from Ice Infested Waters".

### **Research Scope and Level of Effort**

It is proposed that this project be carried out in three phases. Phase 1 would be carried out with FY2004 funds with Phase 2 and Phase 3 to follow. It is expected that Phase 1 would require approximately one man-year of effort. The scope of work for each project phase would be as follows:

#### **Phase 1 – Feasibility Study and Concept Design**

1. Perform a patent search and establish proprietary rights to component technologies to allow for cooperative development of the AP OSRV and APS concepts.
2. Carry out preliminary engineering calculations for design of the APS structure, component interface and oil recovery system sizing.
3. Prepare complete concept design drawings (in AutoCad 2000) of the APS for both a 2,000 bbl/hr ice capable unit and 3,000 bbl/hr Gulf of Mexico unit.
4. Develop arrangement drawings for the AP OSRV trimaran.
5. Carry out naval architecture and engineering calculations for a concept design of the AP OSRV including midship section, stability, resistance and powering etc.
6. Carry out numerical modeling of the AP OSRV with APS units to generally assess vessel performance and skimming capability.

#### **Phase 2 Preliminary Design and Scale Model Testing**

1. Preliminary design of AP OSRV and APS including structural calculations and drawings, oil recovery systems design and schematics, lines plan, intact and damaged stability etc.
2. Build scale models of APS and AP OSRV for testing at Ohmsett Test Facility.
3. Develop model test plan for APS unit on its own and for complete AP OSRV system with two APS units deployed.
4. Carry out tests in various wave heights and current conditions at Ohmsett.
5. Carry out tests in oil and ice and waves at Ohmsett or other suitable testing facility.

#### **Phase 3 Prototype APS Construction and Testing**

1. Develop detailed construction drawings of APS.
2. Build full-scale prototype APS unit.
3. Carry out controlled tests at Ohmsett Test Facility
4. Carry out full-scale open water tests.