



**ARCTIC
RESPONSE
TECHNOLOGY**
OIL SPILL PREPAREDNESS

CONTINUING TO IMPROVE OIL SPILL RESPONSE IN THE ARCTIC - A JOINT INDUSTRY PROGRAMME

**DR. MATHIJS SMIT - ARCTIC JIP
ENVIRONMENTAL EFFECTS TECHNICAL
WORKING GROUP CHAIR**

August 26, 2015



COLLABORATION AMONG NINE COMPANIES

- International research programme
- Builds upon decades of R&D in arctic oil spill response
- Brings together experts across industry, academia and independent research centres
- Research integrity through technical review and public dissemination of results on the website and at conferences

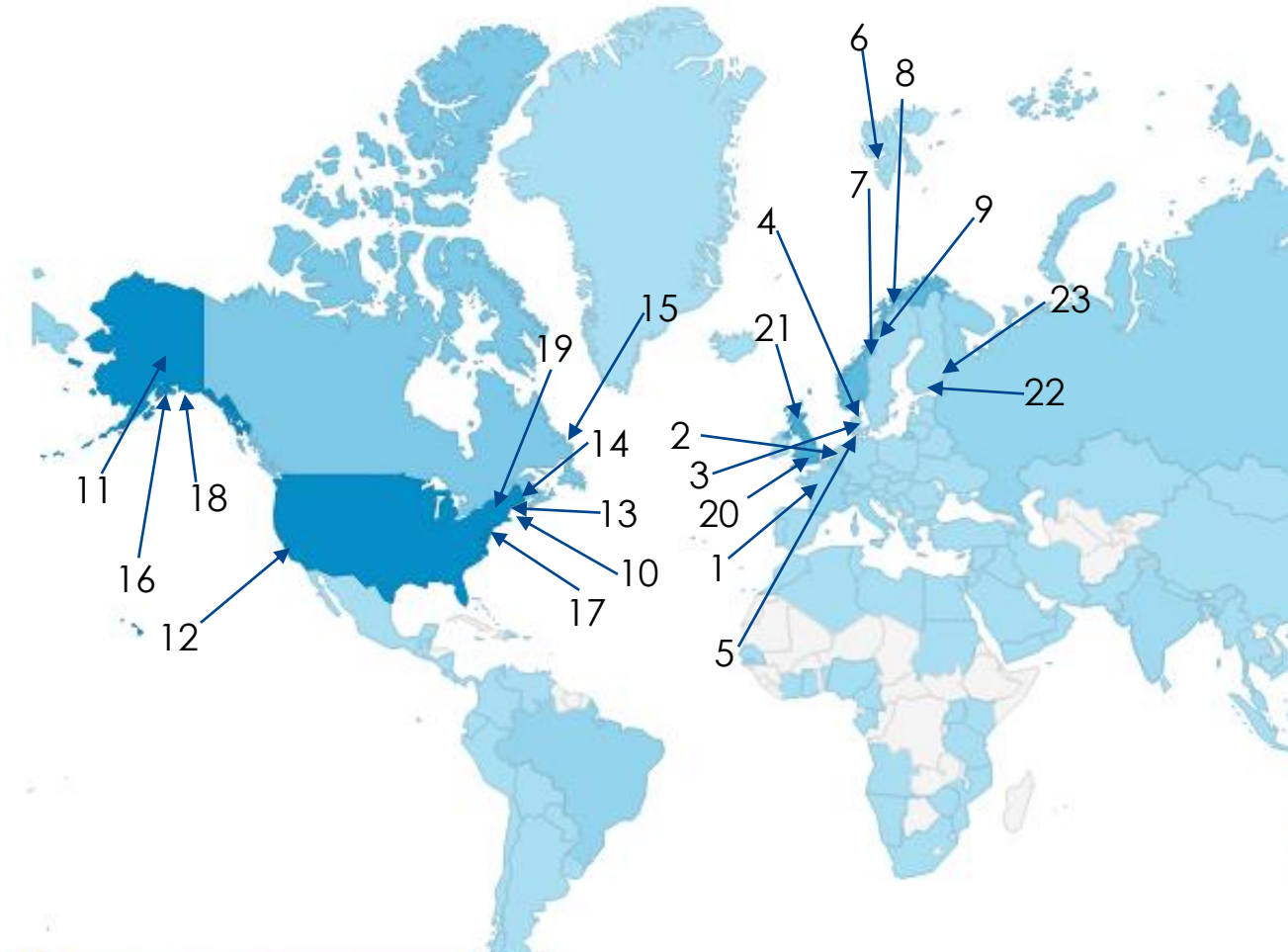
Six areas of research:

- Dispersants
- Environmental Effects
- Trajectory Modelling
- Mechanical Recovery
- Remote Sensing
- In Situ Burning (ISB)



GLOBAL EXPERTISE - CONTRACTORS

1. Cedre Brest, France
2. IMARES, The Netherlands
3. COWI, Denmark
4. DTU Byg – Department of Civil Engineering, Technical University of Denmark, Denmark
5. DCE - Danish Centre for Environment and Energy, Aarhus University, Denmark
6. University Centre in Svalbard, Norway
7. SINTEF, Trondheim, Norway
8. Akvaplan-niva, Tromsø, Norway
9. The Nansen Environmental and Remote Sensing Centre (NERSC), Bergen, Norway
10. RPS-ASA, Rhode Island, USA
11. University of Alaska, Fairbanks, Fairbanks, USA
12. RAMBOLL/ENVIRONS, Emeryville, California, USA
13. US Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL), New Hampshire, USA
14. Bigelow Laboratories, Maine, USA
15. C-CORE, St. Johns, Newfoundland, Canada
16. Alaska Clean Seas, Anchorage, US
17. Woods Hole Oceanographic Institute, Massachusetts, USA
18. The Prince William Sound - Oil Spill Recovery Institute (OSRI), Cordova, Alaska, USA
19. SL Ross Environmental Research Ltd., Ottawa, Canada
20. Hill and Knowlton Strategies, London, UK
21. Polar Ocean Service, Taynuit, UK
22. Aker Arctic, Helsinki, Finland
23. LAMOR, Porvoo, Finland



RESEARCH: REPORTS

11 reports completed so far:

In Situ Burning (ISB)

- **State of Knowledge**
- **Technology Summary and Lessons from Key Experiments**
- **Status of Regulation in arctic and sub-arctic Countries**
- **Research summary: Herding surfactants to contract and thicken oil spills for ISB in arctic waters**

Dispersants

- **Fate of Dispersed Oil Under Ice**
- **State of Knowledge of Dispersant Testing Under Realistic Conditions**
- **Status of Regulations and Outreach Opportunities**
- **Inter-Basin Calibration**

Remote Sensing

- **Surface Remote Sensing**
- **Subsea Remote Sensing**

Mechanical Recovery

- **Recovery of Oil in Ice Feasibility Report**



April 2015
SL Ross Environmental Research Ltd.
Danish Centre for Energy and the Environment

RESEARCH SUMMARY: HERDING SURFACTANTS TO
CONTRACT AND THICKEN OIL SPILLS FOR IN-SITU
BURNING IN ARCTIC WATERS



CURRENT RESULT STATUS

- Results to-date demonstrate the potential viability of multiple oil spill response technologies in arctic conditions beyond mechanical recovery – although limitations exist with each of them and more research needs to be done
- The release of eleven reports to date continues to build a comprehensive picture of arctic oil spill response technologies
- JIP has commenced laboratory, basin, and permitted field experiments of specific technologies



Photos: Transport Canada; DF Dickins, SINTEF

CURRENT UNDERSTANDING – REMOTE SENSING

REMOTE SENSING

WHAT IS REMOTE SENSING?

Remote sensing is the detection, monitoring and tracking of oil on the water surface, under the ice, within the ice sheet, or on top of the ice by using sensors mounted on a variety of platforms: satellites, aircraft, helicopters, autonomous underwater vehicles, etc.

ABOUT THE PROJECT:

The Joint Industry Programme (JIP) is conducting a rigorous test programme that systematically compares the different sensors under controlled conditions, with the aim of identifying the most effective combinations of sensors that can locate oil, as well as identify oil spreading and thickness.

Experimental Sensors

Several University-led and industry-sponsored development projects are under way to adapt new technologies to further advance detection of oil in ice. One of these programmes recently (2012) led to the development of a Frequency Modulated Continuous Wave radar designed to fly at low altitude to detect oil trapped in or under ice. Another initiative aims to use the known principles of Nuclear Magnetic Resonance to achieve a similar goal of detecting oil in ice with a specialized antenna mounted on a helicopter. JIP supports ongoing research efforts to test both of these technologies in a realistic setting, using crude oil and an artificially grown ice sheet.

Satellite Platforms

Sensors may include high-resolution optical imagers and synthetic aperture radar. Advantages of using satellites include wide area coverage, and in the case of radar imagery, independence from cloud cover, fog or darkness. Satellite detection of spills is most efficient in water with lower ice concentrations, making this technology most useful in conditions of partial ice cover.

Surface Systems

Surface remote sensing systems can be deployed from a bridge on a support vessel to detect oil on the water in light ice cover. Other surface systems include Ground Penetrating Radar that can be towed on the ice surface to detect oil buried under snow or trapped within ice. Another highly effective remote sensing system employs trained dogs on the ice to detect and find oil buried under snow or in the top surface of the ice.

Subsea Platforms

Sensors mounted on unmanned underwater vehicles, especially the latest generation of rapidly evolving autonomous underwater vehicles (AUVs), hold the potential to overcome some of the challenges associated with airborne systems (low visibility, difficulty in penetrating sea ice). AUVs carrying a range of sensors, such as cameras and sonar, could provide a direct view of oil under the ice and possibly of oil that is encapsulated by a layer of new ice growing beneath the oil. Preliminary tank tests have demonstrated positive results using upward looking sonar that can show not only where the oil is but also its thickness.

Airborne Platforms

A number of Arctic nations and other countries where shipping is routinely conducted through ice employ sophisticated pollution surveillance aircraft to search for oil spills. These aircraft normally carry a suite of sensors that complement one another to differentiate thin from thick slicks, identify oil type and operate in conditions of low visibility. Current efforts are focusing on how best to fuse the data from these different sensors into a useful operational product that response teams can use in real time.

ABOUT THE JIP

To further build on existing research and improve the technologies and methodologies for Arctic oil spill response, nine oil and gas companies established the Arctic Oil Spill Response Technology Joint Industry Programme (JIP). The goal of the JIP is to advance Arctic oil spill response strategies and equipment as well as to increase understanding of potential impacts of oil on the Arctic marine environment.

The Arctic Oil Spill Response Technology JIP is sponsored by nine oil and gas companies:



<http://www.arcticresponsetechnology.org>

Joseph Mullin, Programme Manager – Joseph.mullin@arcticresponsetechnology.org
MEDIA ENQUIRIES: press@arcticresponsetechnology.org • tel. +44 (0)20 7413 3070

The industry has a range of airborne and surface imaging systems utilised from helicopters, fixed-wing aircraft, vessels and drilling platforms that can be used for ice conditions

CURRENT UNDERSTANDING - DISPERSANTS

DISPERSANT USE IN ARCTIC CONDITIONS

WHAT ARE DISPERSANTS?

Dispersants are an oil-spill response tool that facilitates removal of oil from the environment by enhancing the process of natural biodegradation. They consist of solutions of biodegradable compounds dissolved in low-toxicity solvents.

ABOUT THE PROJECTS:

Fate of Dispersed Oil Under Ice

Industry subject matter experts have defined a research project that will measure the mixing energy under ice in the Arctic and then use this information to run models that predict when or if dispersed oil will resurface. The model results will help determine under what conditions dispersed oil will remain dispersed.

Dispersant Testing Under Realistic Conditions

Industry subject matter experts have defined a large set of wave-basin tests that will study important parameters that control dispersant effectiveness in ice conditions. These tests will more fully define the operational boundaries for dispersant use in ice and can help to develop comprehensive rules for deployment in the Arctic.

How dispersants work

Dispersants work in the same way that soaps work to remove oil and grease from clothing. That is, they break down the oil slick into tiny droplets. These droplets become essentially neutrally buoyant in the water column. Breaking down the oil into tiny droplets causes the formation of clouds of dispersed oil that rapidly dilute. This facilitates natural biodegradation by increasing the amount of oil surface area available for microbial consumption. It also allows the oil to dilute to concentrations low enough to avoid exhausting available oxygen and nutrients needed for aerobic biodegradation.

How dispersants are applied?

Dispersants can be applied in several ways depending on the type of spill and the ambient conditions. For a well-control event where oil could be released from a point-source, dispersants can be applied directly at the source. For large oil slicks in low concentrations of ice or no ice, dispersants

can be applied from large, specially outfitted planes. For oil slicks in higher ice concentrations, dispersants can be more precisely applied to the oil without overspraying onto the ice using boat or helicopter delivery systems.

Dispersants and the Arctic

Dispersants have a key advantage over other oil spill response options because currently they are the only option that can be applied by aircraft. This allows dispersants to be rapidly put into operation and treat large areas. Although the JIP is continuing to study dispersant use in the Arctic, much research has already been completed. This work has shown that the Arctic contains petroleum-degrading microbes that can efficiently biodegrade oil. Also, research has shown that dispersants are effective under cold, icy conditions. There is enough existing information on dispersant use and its use in the Arctic to guide operations. Thus, dispersants should be a key component of an Arctic oil spill response strategy.

ABOUT THE JIP

Nine oil and gas companies have established the Arctic Oil Spill Response Technology Joint Industry Programme (JIP) to further build on more than 40 years of existing research into technologies and methodologies for Arctic oil spill response. The goal of the JIP is to advance response strategies and equipment and to increase understanding of potential impacts of oil on the Arctic marine environment.

The Arctic Oil Spill Response Technology JIP is sponsored by nine oil and gas companies:



<http://www.arcticresponsetechnology.org>

Joseph Mullin, Programme Manager – Joseph.mullin@arcticresponsetechnology.org
MEDIA ENQUIRIES: press@arcticresponsetechnology.org • tel. +44 (0)20 7413 3070

Dispersants can work in the Arctic and will, under certain conditions, be more effective in the presence of ice than in open water

The presence of ice can increase the time window within which dispersants can be used effectively

There is need for a discussion around potential obstacles to achieve permission to conduct dispersant operation in ice-prone regions

CURRENT UNDERSTANDING – IN SITU BURN (ISB)

IN SITU BURNING IN BROKEN ICE

WHAT IS IN SITU BURN (ISB)?
The burning of oil "in situ" (meaning "in place") can be conducted on land, on water, on ice or on any surface upon which the oil can reside with adequate thickness (typically a few millimetres or more), has sufficient volatility to burn, and can be exposed to conditions necessary to ignite and sustain combustion.

Fire Resistant Booms
Fire resistant booms can be towed in open water and in light ice concentrations to thicken oil and provide sustained combustion. With as little as 150 metres of fire boom, 50 to 100 cubic metres of oil could be eliminated in less than an hour or two with an efficiency of 90 to 98 percent.

Natural Containment
Ice can aid in response by acting as a natural containment system, providing oil thicknesses of several centimetres or more and allowing for the rapid and efficient elimination of oil. Such burning, whether enhanced by wind or chemical-herding of the oil, can be conducted safely over large areas with little-to-no surface support personnel.

Chemical Herders
Oil slicks can be thickened to several millimetres with chemical herders thereby significantly enhancing the effectiveness of skimming and controlled burning. When heavy ice concentrations preclude the use of booms, oil layers can be concentrated and thickened by wind and/or chemical herders against large ice floes or in cracks between them.

Aerial Ignition Systems
The ignition of oil contained by fire boom or other natural barriers, such as ice, has been demonstrated hundreds of times during controlled experiments, field trials and during actual spill events over the past 30 years. Such ignition can be conducted with hand-held igniters from boats, and from the air with helicopters using a Hell-torch. Field research has been conducted and further efforts are underway to develop fixed-wing ignition systems as well.

ABOUT THE PROJECT:
State of Knowledge Review
Objective: prepare a state of knowledge report summarising the role, function, benefits and limitations of ISB as a response option in Arctic offshore environments, and to develop educational and outreach materials for non-technical audiences.

Aerial Ignition Systems
Objective: develop improved ignition systems to facilitate the use of ISB in offshore Arctic environments when the presence of sea ice restricts use of vessels as a platform for this response option.

Chemical Herders
Objective: evaluate the effectiveness of herders to enable ISB in open water and among broken ice and to develop an application system for herder deployment from either boats or aircraft in cold conditions.

ABOUT THE JIP
To further build on existing research and improve the technologies and methodologies for Arctic oil spill response, nine oil and gas companies established the Arctic Oil Spill Response Technology Joint Industry Programme (JIP). The goal of the JIP is to advance Arctic oil spill response strategies and equipment as well as to increase understanding of potential impacts of oil on the Arctic marine environment.

The Arctic Oil Spill Response Technology JIP is sponsored by nine oil and gas companies:

bp Chevron ConocoPhillips eni ExxonMobil NCOC Shell Statoil TOTAL

<http://www.arcticresponsetechnology.org>

Joseph Mullin, Programme Manager – Joseph.mullin@arcticresponsetechnology.org
MEDIA ENQUIRIES: press@arcticresponsetechnology.org • tel. +44 (0)20 7413 3070

Technology exists to conduct controlled ISB of oil spilled in a wide variety of ice conditions

ISB is one of the response techniques with the highest potential for oil spill removal in arctic conditions and the industry should consider regulation that will support its use

Most of the perceived risks associated with burning oil are able to be mitigated

A CLOSER LOOK AT THE PROJECTS

Environmental impacts

AIM: To improve the knowledge base for conducting arctic Net Environmental Benefit Analysis (NEBA)

- The comprehensive Phase 1 review is complete and shows there is an extensive existing science base for Arctic NEBAs
- NEBA Tool - Information resource that collects the available research results and information required for NEBA in one place.
- It is a fully searchable report and literature database that contains 960 citations
- The tool is hosted on a dedicated microsite, accessible from the Arctic JIP website and openly available to all other audiences.

<http://neba.arcticresponsetechnology.org/>



Photo: Caspian International Seal Survey



Photo: Aker Arctic

CURRENT UNDERSTANDING - ENVIRONMENTAL EFFECTS

- **There is an extensive existing science base for Arctic NEBAs.**
- **Arctic species are not more sensitive to dispersed oil than non-arctic species and that they react to dispersed oil exposure in the same way as temperate species do.**
- **Certified dispersants and oils treated with dispersants are not more toxic than the oil itself.**
- **Biodegradation of oil in the Arctic does occur and that certified dispersants do not reduce the ability of microbes to degrade oil.**



Photo: ENVIRON



Photo: Akvaplan-niva

A CLOSER LOOK AT THE PROJECTS

Environmental impacts

AIM: To improve the knowledge base for conducting arctic Net Environmental Benefit Analysis (NEBA)

- Phase 2 is conducting research activities to improve and advance Arctic NEBA's
- Four research projects underway
- Two projects involve field work using crude oil, dispersants and in situ burn residue
- The JIP received permit from Governor of Svalbard to conduct oil in ice experiments at Svea, Norway
- Experiments are in progress



Photo: ENVIRON



Photo: ENVIRON

In Situ Mesocosms



Mesocosms to be Employed in the Svea, Norway Field Campaign. Length: 3 m, Diameter: 1.6 m, Weight: 325Kg



Mesocosm Buoyancy Testing at Cedre



Four Conical Shape Floats Held Together by a Protective Metal Framework Keep the Mesocosm at the Surface as the Ice Forms



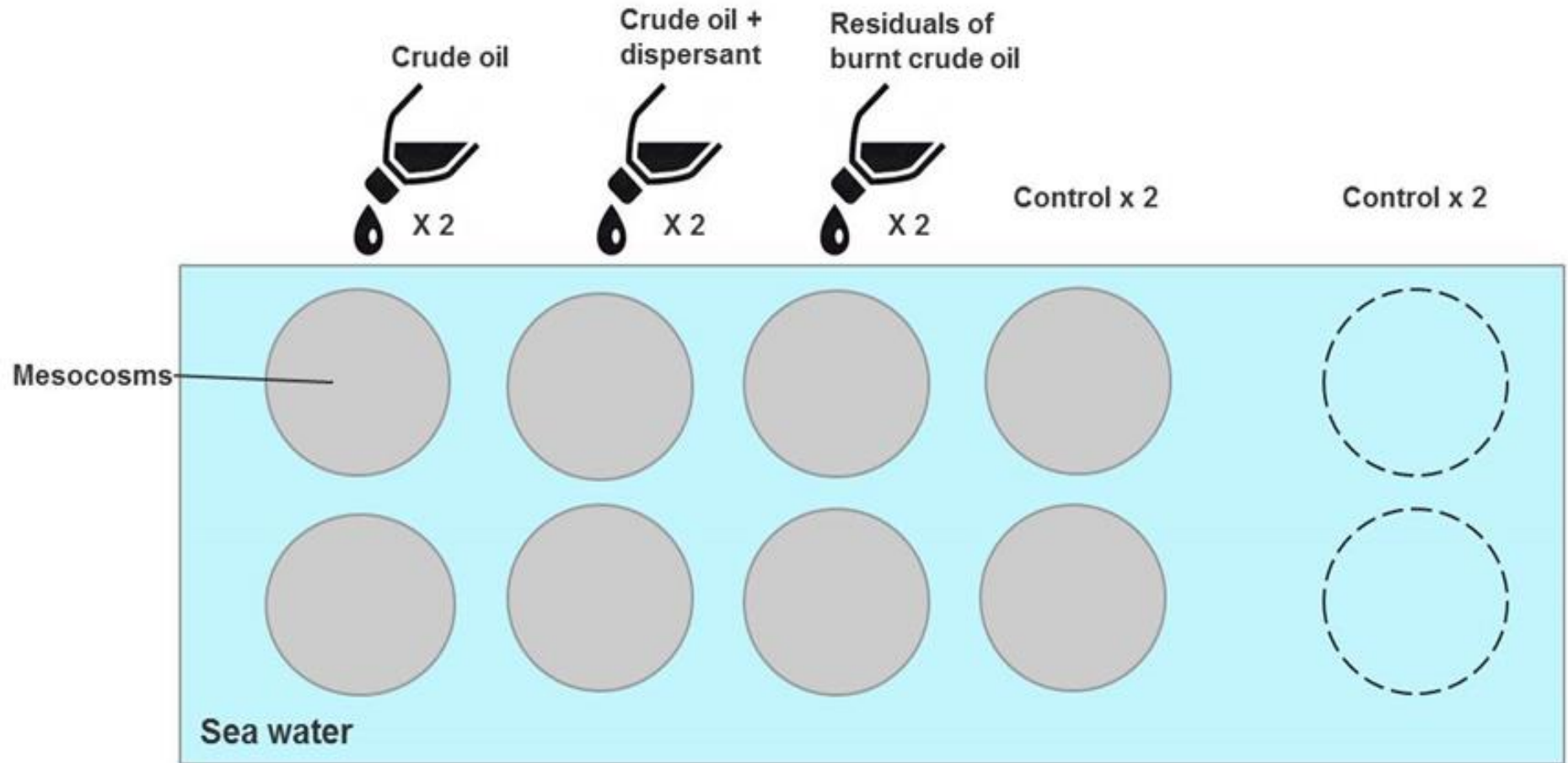








TREATMENTS



Final Sampling - July 2015



A: Oil



B: Oil



C: Oil + Dispersant



D: Oil + Dispersant



E: In Situ Burn Residue

Final Sampling - July 2015



Towing back at Svea harbor



Retrieval for cleaning and decommissioning

SUMMARY

- **Results to-date demonstrate the potential viability of multiple oil spill response technologies in arctic conditions beyond mechanical recovery**
- **Over the coming year dispersant effectiveness experiments will be conducted using**
 - **Natural mixing energy**
 - **Mixing energy from the propeller wash of ice breaker**
 - **After oil or oil-dispersant mixtures have been frozen in ice**
- **Flume tank studies in the UK and field research experiments at Svea, Norway in 2016 will provide data for dispersant modelling project**
- **Development an integrated herder delivery and ignition system for in situ burn (ISB) operations**
- **Development of an aerial ignition system to facilitate the use of ISB in offshore Arctic environments, including situations when severe ice conditions and/or safety concerns may preclude the use of vessels as a nearby base for helicopter operations**

JIP CONTACT INFORMATION

- **Joseph Mullin – Programme Manager**
joseph.mullin@arcticresponsetechnology.org
- **John Campbell – JIP Administrator**
jac@iogp.org.uk
- **James Hall – JIP Executive Committee Chair**
james.hall@arcticresponsetechnology.org

Visit the programme website at: www.arcticresponsetechnology.org