Main conclusions

- The research program has provided a valuable knowledge base for the planning, implementation and further improvement of oil spill response in ice-covered waters.
- Under the prevailing test conditions each response tool evaluated during the program demonstrated some merit in responding to an oil spill in an Arctic environment.
- The availability of all the response options is considered as key to a successful oil spill response operation under Arctic conditions.
- A systematic way to predict the operational time frame for various response options was identified, thereby demonstrating that efficient spill response may be accomplished, whether the techniques are used individually or in combination.
- Large-scale field experiments proved to be an important verification of results from a number of small- and medium-scale laboratory experiments being performed during the program.
- Laboratory and field experiments have verified that in situ burning and chemical dispersion can be highly effective response methods.
- Findings show that the presence of cold water and ice can enhance response effectiveness by limiting oil spreading and slowing the weathering processes

- The window of opportunity for in situ burning and the use of dispersants operations in ice-covered waters can significantly increase compared to an open water scenario under certain circumstances.

Final comments

The JIP have focused on improvement of oil spill response techniques for Arctic waters and to gather more knowledge about cleanup and the fate and behaviour of oil spills in ice and cold water conditions The main focus has been on existing technologies and their possibilities and limitations and to some extent on further development and improvement of these technologies.

The results and the experience gained during this program will form an important basis for further improvements of technologies as well as of tactics for oil spill response for ice covered waters. The program has not looked at the environmental effect of various response options, but the data that we have gathered will form an important basis for further studies of these aspects

Better protection of marine ecosystems and resources

The "JIP Oil in ice" program has improved our ability to respond to oil spills in Arctic and ice-covered waters

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The joint industry program on:

Oil Spill Contingency for Arctic and Ice Covered Waters

Technology

Windows of opportunity

Knowledge

Laboratory and Field experiments

Being prepared for future challenges

AGIP KCO - Chevron - ConocoPhilips - NFR - Shell - SINTEF - Statoil - Total

JIP on Oil in Ice has uncovered important knowledge and developed new solutions for oil spill response in ice covered waters. From the start in 2006 and to the end in 2009 the program has been carried out as a broad international cooperation where some of the worlds most experienced experts on oil spill R&D has participated. The results of the research program will be used as the basis for oil spill contingency planning, improved spill response operations and the identification of additional applied research opportunities that will ensure the continuous advancement of Arctic oil spill response.

Ice covered waters and Arctic conditions possess other challenges for oil spill response compared to open and more temperate waters; the remoteness of the area, the low temperatures, seasonal darkness and presence of ice. At the same time we have experienced that the ice can aid oil spill response operations; it slows down oil weathering, it dampens the waves, it prevents the oil from spreading over large distances and it gives more time to respond.

Key findings from the projects

Fate and behaviour of oil

The presence of ice will retard the spreading rate of the spilled oil in comparison to ice-free conditions.

Oil will have slower weathering in ice. This can be an advantage and contribute to the enhancement of response effectiveness for certain oil spill scenarios. Still, the window of opportunity is limited and rapid decision making and action are required.

The Oil Weathering Model (OWM) created by SINTEF have been verified by large-scale field experiments and can be used to predict the behaviour of various oil types in ice.

In situ burning

The window of opportunity for the use of in situ burning in Arctic is under some circumstances larger than in the open sea.

In situ burning has been tested and proven to be effective for the elimination of both free floating oil in ice and oil collected in fire resistant booms.

The presence of cold water and ice can enhance in situ burning effectiveness by limiting the spread of oil and slowing weathering processes.

The field experiments verified in situ burning as an efficient technique, with burn efficiency above 90%.

Fire-resistant booms and herders proved to be effective in drift ice.

The operational time window for the in situ burning of oil spills can now be predicted using the OWM.

The “JIP Oil in ice”
has improved our ability to protect the Arctic environment against the impact of oil spills

Chemical dispersion of oil

Laboratory and field experiments have verified that oil spilled in ice-covered waters is dispersible by use of oil spill dispersants.

The weathering process is slowed down when ice is present, enabling a larger window of opportunity for dispersant application than previous anticipated. Some oils spilled in ice remain dispersible over a period of several days.

Reliable predictions on the “operational time window” for the use of chemical dispersants can be given by using the OWM.

A new dispersant spray unit developed through the program opens up the possibility of new strategies for dispersants in high ice coverage (80-90%). Adding extra mixing energy extends the operational possibilities even further.

Mechanical recovery of oil

The efficiency of the available recovery technology may vary depending on the type of ice and its concentration.

Brush drum skimmers represents a good combination of ice processing and oil recovery capabilities. Skimmers with thrusters show improved capability to recover oil in ice.

An existing state-of-the-art skimmer for oil recovery in ice was tested, and two new prototypes were developed.

Oil can be recovered with efficiency similar to that of open water conditions in open leads and pockets between large ice floes while reduced efficiency should be expected in the presence of smaller ice floes and slush ice.

Remote sensing

Trained dogs are able to detect very small oil volumes and map oiled boundaries on solid ice and in sediments on Arctic shorelines under cold conditions.

The most useful remote sensors and systems applicable to Arctic spills are: Side-Looking Airborne Radar (SLAR); Satellite-based Synthetic Aperture Radar (SAR); aircraft and vessel-based Forward Looking Infrared (FLIR); Trained dogs; and Ground Penetrating Radar (GPR) operated from helicopters and/or from the ice surface.

A flexible combination of sensors operating from aircraft, helicopters, vessels, satellites and the ice surface is recommended for future Arctic oil spill emergency preparedness. Existing commercial GPR systems can be used from a low-flying helicopter to detect oil trapped under snow on the ice and to detect oil trapped under solid ice.

Oil distribution and bio availability

When oil is released in an area with ice the oil will be absorbed by snow on the ice edges, it may be trapped in the ice in brine channels and it may be moved underneath the ice. The ice field as such will be under constant transformation driven by wind, currents and temperature. The knowledge derived from the data sampling program under the 2009 field experiment will be used to assess effects of oil spills in Arctic marine environments. These data will also be used as basis for developing models predicting oil distribution in ice and give extended knowledge on the interaction between oil, ice and water as well as of effects of oil spills in Arctic marine environments.

The “JIP Oil in ice” has advanced and build new capability
(tools, skills, and operational experience) for responding to oil spills in ice covered waters