Oil Spill Contingency Planning for Use of Dispersants

SINTEF has established an approach for development of oil spill contingency plans, consisting of the following steps:

- Risk based definition of oil release scenarios (surface vs. subsea, release rates, duration etc.).
- Oil weathering and chemical dispersibility studies of the relevant oil types.
- Simulation of underwater blowout with the DeepBlow model (ref.: News No.3 – 1998).
- Stochastic surface drift simulations by the STATMAP model.
- Oil spill response analysis by the OSCAR 2000 model (ref.: News No.3 – 1997).

This approach has been used to create background information for development of oil spill contingency plans for oil fields in the North Sea, using chemical dispersants as part of the initial response. This work has been performed in co-operation with Forus Beredskap AS.

Oil Spill Response Analyses

Based on the release scenarios defined (from risk-based analysis), weathering and dispersibility studies of the oils, simulation of subsea blowout and surface drift simulations, oil spill response analyses were performed with the OSCAR 2000 model system. Both effects of different initial response options (mechanical recovery and/or dispersant application; see Mass Balance curves on last page), effects of various numbers of larger mechanical recovery systems and coast and shoreline countermeasures were assessed. Concentrations and exposure to total hydrocarbons (THC) and water soluble oil components (WAF) in the water column have also been simulated, for the different response options, with the newly developed 3D multi-component plume model in the OSCAR 2000 system.

To be continued on the last page.
SINTEF initiated in 1995 the R&D program “Mechanical Oil Recovery in Ice Infested Waters” (MORICE) to develop technologies for more effective recovery of oil spills in ice. MORICE is a multinational effort that has involved Norwegian, Canadian, American and German researchers. Financial contributions from oil companies, private as well as governmental oil spill responders, governmental agencies and research funds have secured the funding.

Each phase of the program has been organized as a separate project with its own objective:

Phase 1 started with an extensive literature review to identify available information from previous efforts to develop oil-in-ice recovery equipment. Following this, a series of brainstorming sessions and technical discussions were held to evaluate past ideas and generate new ideas for potential solutions to the problem. As a result, ten concepts were suggested and discussed in detail by a Technical Committee.

Phase 2 of the program involved qualitative laboratory testing of most of the concepts suggested in Phase 1. The lab tests in Phase 2 were carried out in a test tank where oil in ice-infested water conditions could be prepared. This phase of the study provided important insight and reduced the number of concepts that warranted further evaluation and development.

Phase 3 focused on continued development of two concepts that were selected from Phase 2, the lifting grated belt (ice processing/deflection) and the brush-drum system (oil recovery). Detailed quantitative testing was conducted on these concepts at a larger scale in the Hamburg Ship Model Basin (HSVA) in Hamburg, Germany.

In Phase 4 a complete full-scale harbour-sized prototype was designed and constructed, comprising oil recovery and ice processing units as well as the support vessel. The prototype was tested in the Alaskan Beaufort Sea during freeze-up in October 1999 where ice up to 37 cm in thickness was processed without problems. Oil was not introduced during these tests.

At present Phase 5 is planned to take place in 2000 and will probably be the final phase of the MORICE program. Following more extensive component testing of oil recovery in ice under controlled conditions, further ice testing will be carried out in the Alaskan Beaufort Sea before the complete prototype is tested in oil and ice, probably at the OHMSETT test facility in New Jersey, US.

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The funders of MORICE Phase 4:
- Alaska Clean Seas
- Minerals Management Service
- Saga Petroleum
- Norsk Hydro
- Oil Spill Recovery Institute
- Canadian Coast Guard

Funders of previous phases also include:
- Statoil
- Norwegian Pollution Control Authority
- Exxon Production Research Company
- Environment Canada
- Hamburg Ship Model Basin
A research consortium is planning a controlled release of crude oil treated with dispersant in a shallow bay. The purpose would be to measure actual exposures and effects to biota. SINTEF has been contracted to perform a pre-spill simulation of the experimental spill scenario. Hypothetical spill conditions are:

- 400 gallons fresh Arabian Medium Crude
- instantaneous release
- initial thickness 10 mm
- 3 m constant water depth
- scenarios with constant winds at 5, 7, and 10 m/s from the Northeast
- 5 m/s simulated without dispersant for reference case
- 5, 7, and 10 m/s simulated with dispersant action at start time
- dispersant treatment ratio 1:20.

OSCAR 2000 was used to evaluate the maximum total hydrocarbon concentrations (THC) in the water column over space and time under different wind speeds. This information will prove useful in establishing weather windows for the field trial, as well as eventual details of experimental plans.

The oil component profile used to simulate the crude oil is given in Fig. 1. In OSCAR 2000, each component or pseudo-component (total 25 components/groups) is assigned individual physical-chemical and toxicological properties. Results for the 5 and 10 m/s scenarios are reproduced in brief here: With no dispersant and a 5 m/s wind, very little natural dispersion takes place, resulting in maximum total hydrocarbon concentrations (THC) near 1 ppm (Fig. 2). With dispersant used, maximum THC is about 50 ppm after 1 hour (Fig. 3), reducing to 10 ppm after 3 hours (Fig. 4).

Dispersant application in 10 m/s wind gives more rapid dispersion than in 5 m/s wind. Lower THC values in the higher wind speed are also due to increased hydrocarbons entering the sediments.

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Strategy for use of dispersants

The “window-of-opportunity” for use of dispersants on the oils being produced indicate that dispersants can be effectively used as part of the initial response. There are, however, differences in the “window-of-opportunity” based on oil types. The initial response vessels are equipped with mechanical recovery systems as well as equipment for dispersant application and adequate amounts of dispersant. The spraying capabilities of the dispersant application systems have been tested and calibrated (see photo on the front page).

Based on a Net Environmental Benefit Analysis (NEBA) of the spill scenarios and the presence of vulnerable natural resources in the influence area close to the release point, strategy and action plans for use of dispersants have been worked out. During the fish spawning season priority should be given to use of mechanical recovery, to minimise the amounts of dispersed oil and dissolved oil components in the water column. Use of dispersants should be given priority when the sea bird activity is high in the area, in order to reduce the spreading of oil on the sea surface. Dispersants should also be used when the sea conditions prevent effective mechanical recovery.

Monitoring assistance

SINTEF has established a methodology for monitoring services to optimise dispersant actions and to secure documentation of the effects when using dispersants, according to the new “Regulations for composition and use of dispersants in Norway”. Effectiveness of mechanical recovery actions and mass balance can also be recorded. SINTEF monitoring assistance contains:

- Monitoring, sampling and analysis on the spill site to:
  - Characterise the surface oil/emulsion properties.
  - Monitor the concentrations of hydrocarbons in the water column.
- Guidance to the landbased action management based on real-time modelling to:
  - Forecast the oil behaviour on the sea surface.
  - Evaluate potential harmful effects from the oil release.

SINTEF has recently signed an assistance agreement with an oil company operating in the North Sea.

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