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REPORT





Oil in Ice - JIP

Report no.: 12

Evaluation of dispersant spray systems and platforms for use on spilled oil in seas with ice present (JIP Project 4, Act. 4.21)

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SINTEF Materials and Chemistry
Marine Environmental Technology

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SINTEF

Preface

SINTEF has in cooperation with SL Ross Environmental Research Ltd and DF Dickins Associates LLC on behalf of the oil companies AGIP KCO, Chevron, ConocoPhillips, Shell, Statoil and Total initiated an extensive R&D program; *Joint industry program on oil spill contingency for Arctic and ice covered waters.* This program was a 3-year program initiated in September 2006 and finalized in December 2009.

The objectives of the program were;

- To improve our ability to protect the Arctic environment against oil spills.
- To provide improved basis for oil spill related decision-making:
- To advance the state-of-the-art in Arctic oil spill response.

The program consisted of the following projects:

- P 1: Fate and Behaviour of Oil Spills in Ice
- P 2: In Situ Burning of Oil Spills in Ice
- P 3: Mechanical Recovery of Oil Spills in Ice
- P 4: Use of Dispersants on Oil Spills in Ice
- P 5: Remote Sensing of Oil Spills in Ice
- P 6: Oil Spill Response Guide
- P 7: Program Administration
- P 8: Field Experiments, Large-Scale Field Experiments in the Barents Sea
- P 9: Oil Distribution and Bioavailability

The program has received additional financial support from the Norwegian Research Council related to technology development (ending December 2010) and financial in kind support from a number of cooperating partners that are presented below. This report presents results from one of the activities under this program.

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Funding Partners

R&D Partners

Cooperating Partners

JIP Oil in ice **REPORT**

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ABSTRACT

This report gives a short overview and evaluations of different dispersant application platforms for use in ice-covered areas.

Based on this evaluation, it is recommended to focus the further work in task 4.2 (*"Improvement of dispersant application technology")* on vessels as application platforms for operations under cold and ice-covered areas.

KEYWORDS	ENGLISH	NORWEGIAN
GROUP 1	Dispersant application	Påføring av dispergeringsmiddel
GROUP 2	Arctic conditions	Arktiske forhold
SELECTED BY AUTHOR	Review / State-of the art	Oversikt / State-of-the-art
	Ice conditions	Isforhold

1 Background

The use of dispersants can have a potential in ice-infested waters, but it has not been sufficiently documented by earlier laboratory testing, nor operationally tested during field experiments.

The most critical parameters for operational use of dispersants under Arctic conditions are:

- Contact between dispersant and oil
- Sufficient energy for the dispersion process
- Oil properties at low temperature – weathering
- Dispersant performance and properties under relevant conditions (salinity, temperature, oil type).

Based on an earlier feasibility study (ONA-project, Daling et al. 1990), the potential for different application methods with different ice coverage was briefly evaluated (see figure 1 below).

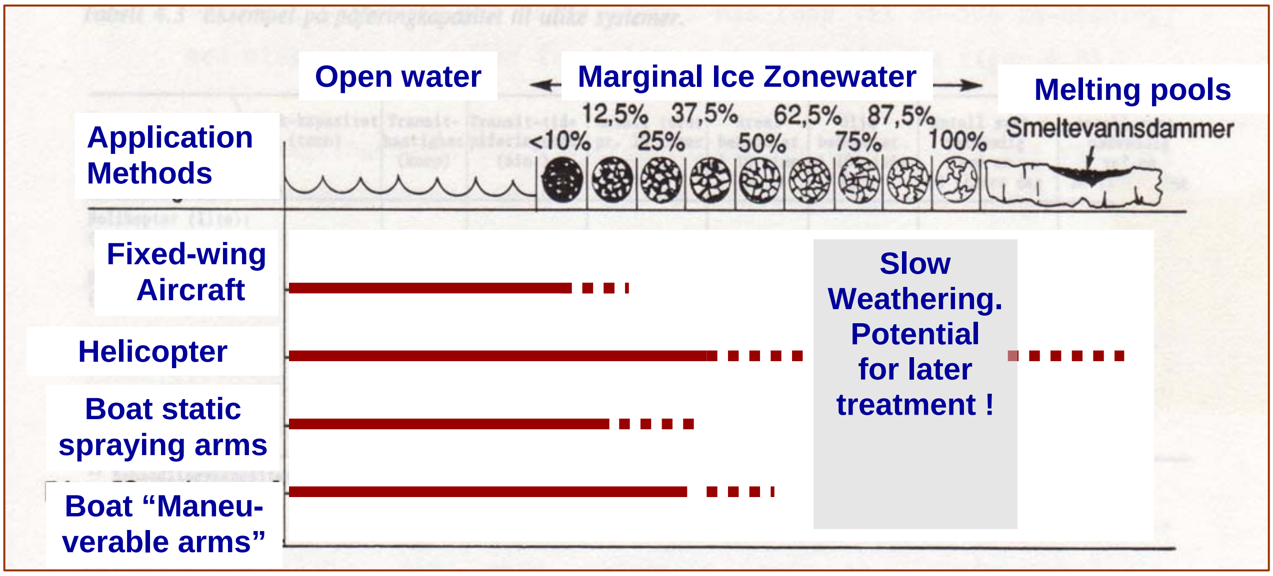

Figure 1. Tentative application area for various methods under different ice- condtions / -coverage (from a feasibility study, ONA, Daling et at 1990)

<u>The purpose with this report :</u>
According to the JIP Oil in Ice proposal, the goal for task 4.2 is to improve and adapt existing helicopter and/or vessel application systems for operations under cold and ice-covered areas.
In order to give a better justification for why these platforms have been recommended for further investigated in the JIP, it was agreed at the reference group meeting within project 4 (November 2006) to make a short report that gives a new / updated overview of the potential of different to days application platforms: proc. et cons. in application in ice-covered areas.

2 Current dispersant spraying systems

Current dispersant spraying systems, for both ships and aircraft, have been developed for use on spilled oil in open water conditions. The emphasis has been on spraying the dispersant over as wide a spray width as possible and to spray as fast as possible to achieve a high 'encounter rate' (the area of spilled oil sprayed per unit time).

The assumption is that the spilled oil will rapidly spread to cover a very large area of sea surface and that spraying dispersant on this spilled oil as rapidly as possible is the best way to respond for a number of reasons. For example, rapid dispersant spraying is required so that the oil can be dispersed before the time "window of opportunity" for dispersion closes.

It is widely acknowledged that the dispersant cannot be added accurately to the spilled oil at the recommended treatment rate. The oil layer thickness is very variable and varies enormously over very short distances. Localised over- and under-treatment with dispersant is inevitable, even using the best dispersant spraying system available. Nevertheless, there is no easy solution to this fact and a lot of effort (for example, the use of various forms of IR sensing, including FLIR (Forward Looking Infra-Red)) is devoted to treating only the thickest part of the oil slick.

2.1 Ship-based dispersant spray systems

For ship- (or boat-) based dispersant spray systems, the desire to maximise the encounter rate has meant using the longest practical length of spray arms. This has often been a compromise of strength and weight of the spray arms; very long spray arms have to be very strong to resist bending forces and this can cause excessive weight. The spray arms are therefore built of lightweight strong materials. Typical lengths of individual spray arms are 6 to 7 metres.

The spray arms are fitted with a sufficient number of nozzles to ensure an even distribution of dispersant deposited onto the spilled oil. This is a function of the height of the nozzle above the water and the spray angle of the individual nozzles. Eg. Norsk Hydro has recently installed new spraying systems (developed by SINTEF and Jason eng. 2005 – 2006, see figure 2) on their new supply and response vessels (Havila Troll and Havila Runde) in the North Sea. The spraying system is constructed so the deposition area of the dispersant is ahead of the influence of bow-wave of the ship. The system has a high application capacity, with a total swath width of 27-30m.

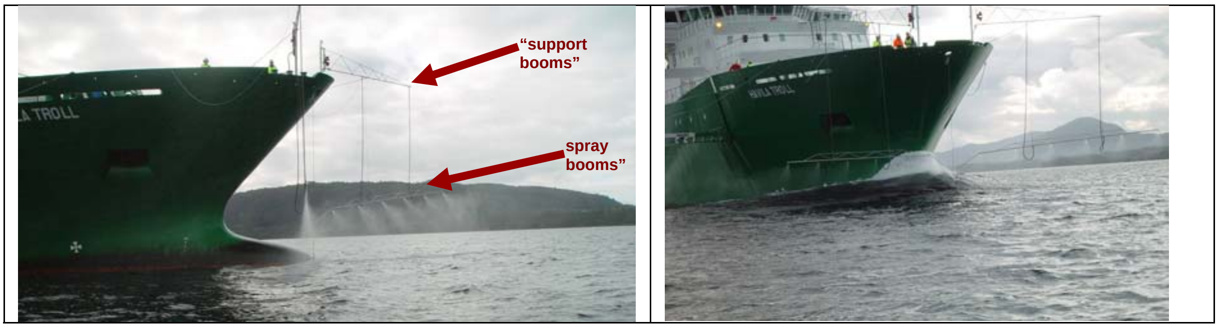

Figure 2. Field testing of the new application system on MV Havila Troll (Norsk Hydro)

The development "process" of this spraying system on new response vessel Havila Troll was approx. 1.5 year: from the idea /concept (in 2005), to construction of dispersant spraying system, installation, functionality testing in the field, nozzle/ spraying arm capacity testing, and calibration of the dispersant system at Havila Troll (application in different speed up to 18 knots with/against wind were tested). The final validation of the system took place during the NOFO oil-on-water exercise in May 2006, where Havila Troll applied dispersant on two experimental oil slicks. The system showed to be very operative, and a high dispersion efficacy were documented both through visual observation on the sea surface and monitoring of dispersed oil concentration and oil droplet size measurement in the water column after treatment.

2.2 Aircraft-mounted dispersant spray systems (fixed-wing and helicopters)

Fixed-wing aircraft are used to spray dispersants because, due to their high transit speed, they can rapidly get to a remote oil spill site and can then spray dispersant. Large fixed-wind aircraft typically spray dispersant at a speed of 100 to 150 knots from an altitude of 30 to 150 feet and can carry relatively large amounts of dispersant, from 5 to 15 tonnes. With a spray swath width of 50 metres they can, in theory, spray large areas of spilled oil quite quickly. However, this apparent advantage can be offset if dealing with fragmented oil slicks. Large fixed-wing aircraft have to climb to a higher altitude before turning and then fly downwind, turn and descend before starting another low-level spraying run. The time spent spraying dispersant onto the spilled oil can be a very small proportion of the time that a large aircraft is in the air over a spill site.

Helicopters have the advantage of greater manoeuvrability than larger fixed-wing aircrafts, but the disadvantage of a smaller dispersant payload. The largest helicopters in routine operation in offshore oil operations, such as the Eurocopter Puma, have a maximum dispersant payload of 3 tonnes and this severely restricts their operating range. Smaller helicopters have a maximum dispersant load of less than 1 tonne.

The dispersant spray system is similar to that used on a ship; tanks, pumps, and spray arms. Higher capacity pumps are used to achieve similar dispersant deposition rates on the spilled oil as that achieved by ships, because the aircraft sprays at a much higher speed. The dispersant spray is deposited into the air as a long, linear cloud of dispersant spray that then settles onto the oil under the effect of gravity.

2.3 Comparison of ship and aircraft dispersant spraying systems

Many comparisons of the relative merits of ships and aircraft as dispersant spraying platforms have been made.

Ships have been the traditional platform for spraying dispersants. The main advantage of a ship, compared to an aircraft, is the ability to carry a very large quantity, (e.g. typically 20 - 100 tonnes of dispersant onboard many response vessels in the North Sea). A ship can remain on station day and night for a prolonged period, whilst an aircraft has to operate from an airfield on land and must return there frequently to re-fuel.

The claimed disadvantages of ships, when compared to aircraft, include the relatively slow spraying speed, typically 5 to 15 knots. However, a consideration of the operational aspects of spraying dispersants from fixed-wing aircraft shows that for much of the time that they are in the air, the aircraft are not spraying dispersant. An aircraft has to spend time transiting between its airfield and the spill site. Even when over the spill site, the aircraft may spend the majority of time (90%+) manoeuvring to line up on a suitable area of oil to be sprayed, climbing to turn, turning, returning downwind, descending in preparation for spraying etc. It is true that once an aircraft is spraying, it can spray an area of spilled oil with dispersant quite rapidly, but all the other factors must be taken into account.

Another, often-quoted disadvantage of ships as dispersant spraying platforms is their relatively slow speed in sailing to an oil spill site. This would be true if the ships are in harbour, many miles from the spill site, but would not be an important factor if the ships are supply vessels already operating close to the potential oil spill site.

Compared to conventional fixed-wing aircraft, helicopters are much more complex, more expensive to buy and operate, relatively slow, have shorter range and restricted payload. The compensating advantage is maneuverability: helicopters can hover in place, reverse, and above all take off and land vertically. Subject only to refueling facilities and load/altitude limitations, a helicopter can travel to any location, and land anywhere with enough space (approximately twice the area of the rotor disk). General operational limitations in use of helicopters in connection to dispersant underslung bucket application (John Birger Erstad, CHC-Helicopter Service) require visual flying rules (daylight VFR-conditions): i.e.: 5 km horisontal visibility and 1000' ceiling. CHC have evaluated a wind speed of 30 knots during application as a limit for obtaining a good deposition of the dispersant. Furthermore, there are limitations for operations of "moveable" helidecks that are vessel specific (dependent on vessel size, instrumentation for measuring vessel movement etc.).

Appendix 1 gives some more information concerning operative limits in cold /arctic conditions (Ian Denness, personal communications).

The figure below show the Response 3000 underslung Helibucket (which is apart of the Norwegian offshore industry oil spill contingency) and the Simplex Spray system where the tank is hooked to the helicopter body (not restricted as undeslung flying certifications). The recently developed Simplex Spray system has not yet been adapted for dispersant use).

Figure 3. A: Response 3000 underslung Helibucket (a part of the Norwegian offshore industry oil spill contingency) and B: the Simplex Spray system where the tank is hooked to the helicopter body

3 Spilled oil in ice

The presence of ice on the sea surface will influence the spraying of dispersant onto spilled oil in two ways, compared to ice-free conditions:

(i) The ice will alter the distribution of the spilled oil on the sea surface.

(ii) The presence of ice will set limits on the operation of any vessel spraying dispersants.

3.1 Distribution of spilled oil on the sea surface

The basic problem for oil spill response in ice conditions is that ice floats on the sea surface and so does also spilled oil. The presence and form of ice on the sea surface will modify the spreading behaviour and distribution of the spilled oil by a degree that depends on ice coverage (Figure 4).

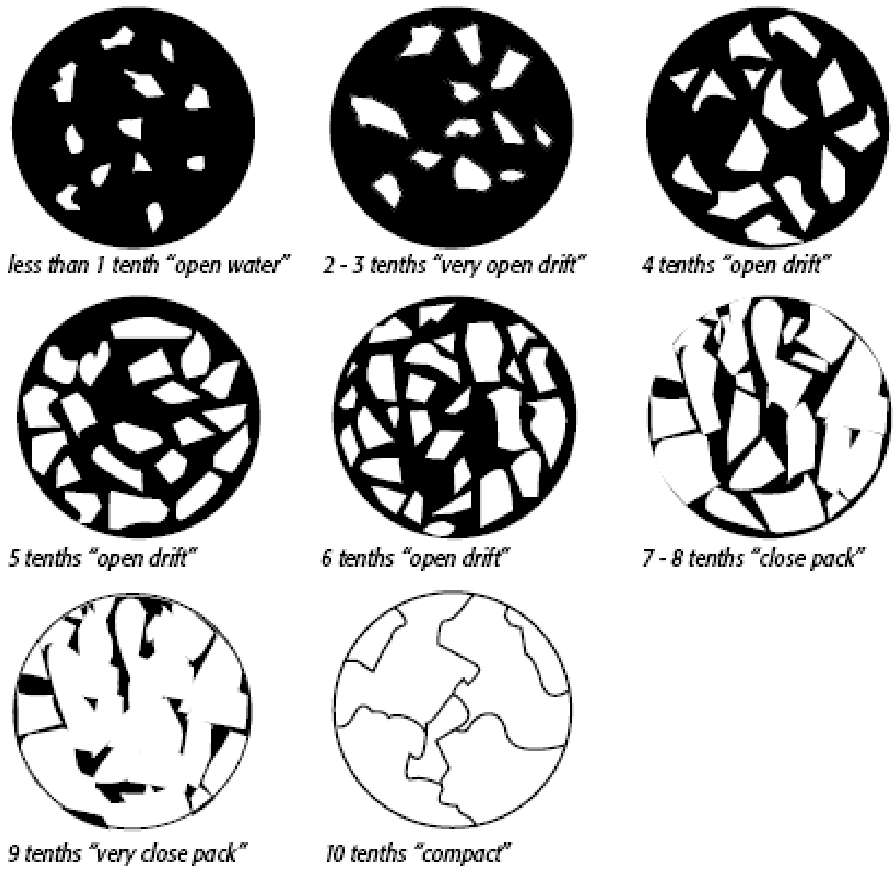

Figure 4. Ice coverage (from NOAA Observers Guide to Sea Ice)

If the ice is present as broken pieces, the spilled oil will spread on the water surface in-between the pieces of ice. The spilled oil will not be in the form of a discrete oil slick (albeit of highly variable thickness), the thicker parts of which would be the obvious target for a dispersant spraying operation. Instead, there will be a proportion of sea surface covered by ice with oil on the remaining sea surface.

At high ice concentrations (7 – 8 tenths), the spreading of spilled oil is limited by the presence of the ice.

If the ice is present as a near-continuous layer, such as consolidated pack ice, the location of the spilled oil will depend on where and how it was spilled:

- Spilled oil trapped below the ice layer from a sub-sea blow-out:
- Spilled oil on top of the ice layer if caused by an above water level oil release

In near-continuous ice cover conditions the oil may be spilled into ice / water conditions that were created by the activities that resulted in the oil spill incident. For example, if the oil spill results from damage to an ice-strengthened tanker, the oil may spill into the broken brash ice on water in the wake of the ship or of the escorting ice-breaking vessels.

3.2 Thickness and form of the ice

Seasonal ice develops through various stages of increasing thickness (Table 1).

Table 1. Stages of development of ice (from NOAA Observers Guide to Sea Ice)

Stage of development	Thickness	Sub-group	
New ice	<10 cm	Nilas; Ice rind	0-10 cm
Young ice	10 – 30 cm	Grey ice	10-15 cm
		Grey-white ice	15 – 30 cm
Thin first year ice	30 – 70 cm	Thin FYI, first stage	30 – 50 cm
		Thin FYI, second stage	50 – 70 cm
Medium first year ice	70 - 120 cm		
Thick first year ice	> 120 cm		
Old ice			
Second year ice			
Multi-year ice			
Ice of land origin			
Unknown			

The type or form of ice (Table 2), and therefore the relative dimensions of the pieces of ice and of the patches of open water between the pieces of ice, is also an important factor in the spreading of spilled oil and its subsequent distribution on the sea surface.

Table 2. Sea ice forms (from NOAA Observers Guide to Sea Ice)

Type of ice	Description
New	Small, thin, newly formed, dinner plate-sized pieces
Brash	Broken pieces less than 2 m across
Pancake	Rounded floes 30 cm - 3 m across with ridged rims
Ice Cake	Level piece 3 - 20 m across
Small Floe	Level piece 20 - 100 m across
Medium Floe	Level, continuous piece 100 - 500 m across
Big Floe	Level, continuous piece 500 m - 2 km across
Vast Floe	Level, continuous piece 2 - 10 km across
Giant Floe	Level, continuous piece greater than 10 km across
Belt	A linear accumulation of sea ice from 1 km to over 100 km wide
Strip	A linear accumulation of sea ice less than 1 km wide
Beach Ice or Stamukhas	Irregular, sediment-laden blocks that are grounded on tidelands, repeatedly submerged, and floated free by spring tides
Fast Ice	Ice formed and remaining attached to shore

One form of ice may predominate or several different ice forms can co-exist.

- Leads opening up in close ice pack can produce long, thin areas of open water.
- At break-up in relatively calm conditions with low water current speeds, medium or big floes can exist at various levels of ice coverage with minimal presence of other forms of ice.
- In more dynamic conditions (caused by high tidal range and high velocity water currents) there can be substantial interaction between the pieces of ice, leading to smaller pieces of ice being created.

High concentrations of small pieces of ice (frazil and brash ice), regardless of the presence of larger ice forms, stops the oil spreading. Field experience has shown that it is the small ice pieces (i.e., the brash and frazil, or slush, ice) that will accumulate with the oil against the edges of larger ice features (floes) and control the concentration (i.e., thickness) of oil in a given area, and the rate at which the oil subsequently thins and spreads (S L Ross and D F Dickins, 1987).

Shore fast ice may act as a natural barrier to spilled oil, preventing it from contaminating the shore and limiting the spread of the oil.

4 Dispersant spraying from aircraft onto spilled oil in ice

Any aircraft will have to be within the operational limits for flying under the prevailing conditions. These will include visibility limits and ambient temperatures with due regard to icing conditions.

Spraying dispersant from an aircraft onto spilled oil in ice will be the same as spraying spilled oil in ice-free conditions, except that the distribution of spilled oil on the sea will be altered by the presence of ice.

Dispersant spraying from aircraft onto spilled oil in ice may be feasible in low ice coverage conditions, even though the dispersant deposited onto the ice would be effectively 'lost'. The areas of spilled oil between the pieces of ice could probably be accurately targeted up to 2-3/10 ice cover by fixed-wing aircraft spraying dispersant.

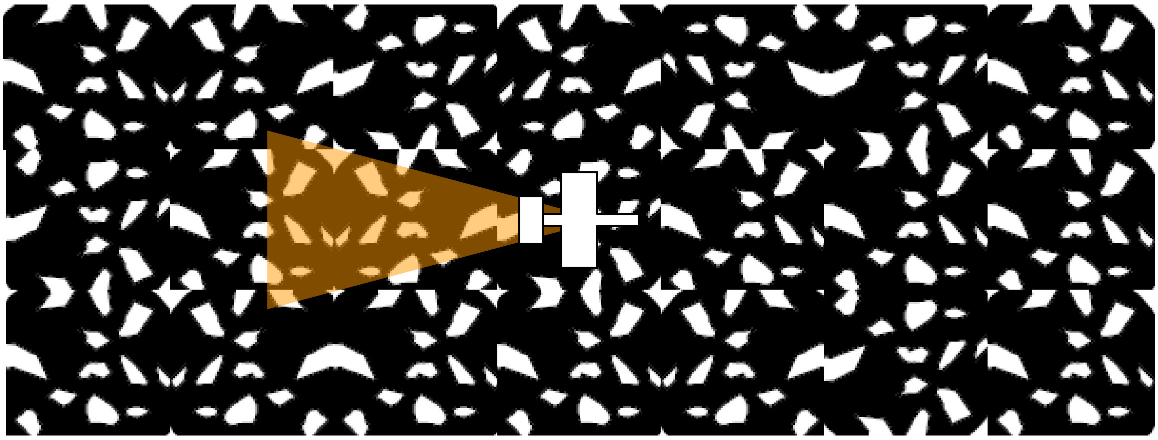

Figure 5 Schematics of aircraft spraying dispersant onto spilled oil in 2 – 3 / 10 ice cover.

Helicopters spraying dispersant could conceivably operate in higher ice coverage conditions, being slower and more manoeuvrable than fixed-wing aircraft. Helicopters could be particularly useful if the spilled oil were concentrated in long, linear leads or on the open water between medium or big floes. It might be feasible to conduct dispersant spraying from helicopters up to 5/10 ice cover and possibly higher, if flying conditions were good.

5 Dispersant spraying from ships onto spilled oil in ice

5.1 Operation of ice class ships

In common with practice in ice-free waters, it is anticipated that spraying of oil spill dispersants could be undertaken from ships associated with oil E&P activities, such as supply ships. The operation of any ship in waters with ice present needs to be considered for dispersant spraying duties. Firstly, the ship must be suitably designed and classified (‘ice class’) to operate in waters where ice is present; this normally involves extra strengthening of the hull and changes to the propulsion system.

An example of such a vessel is the combined AHTS (Anchor Handling, Tug and Supply) / Icebreaker *Vidar Viking* (Figure 6) and the sister ships *Tor Viking II* and *Balder Viking* that are owned by the Norwegian company Trans Viking Icebreaking & Offshore AS, Kristiansand, or the *Oden* (Figure 7).

Figure 6. Example of ice class ships: Vidar Viking

The three Viking ships were built at Kvaerner Leirvik AS, in 2000 and 2001, and are 83.7 meters long and 18 meters wide. The above deck equipment is designed for offshore support and the hulls and engines are adapted for icebreaking. The maximum icebreaking capacity is approximately 1.2 meters of level ice, and the ships can move at a speed of 10.5 knots in 0.7 meters of level ice, although this is dependent on ice conditions. Slower speeds are required in thicker ice.

Figure 7.. Example of ice class ships: Oden

The *Oden* is capable of breaking 1.9-metre-thick, flat ice cruising at 3 knots.

The maximum speed of a vessel in ice is a function of ice thickness and ice concentration.

In icebreaker escort operations, the speed of an escorted ship is ordered by the icebreaker. In open ice a speed of 6-7 knots can be expected to be maintained, but only if it is certain that the ship will not collide with the floes. A useful rule of thumb is that 8 knots can be maintained in an ice concentration of 4/10 and that the speed will be reduced by 1 knot for each additional 1/10 of concentration, down to only 2 or 3 knots in 10/10 ice. However, thickness and hardness of the ice, snow cover and ice under pressure may need to be taken into consideration in addition to the ice concentration. In close ice, when the escorting distance is reduced, a speed of no more than 5 knots should be attempted.

The most powerful icebreakers in the world, for example the nuclear-powered Russian icebreaker *Yamal*, are capable of continuously breaking 2 - 3 metre thick ice at 3 knots. The US has the conventionally-powered icebreakers *Polar Star* and *Polar Sea*. *Polar Star* is able to ram her way through ice ridges up to 21 feet (6.4 meters) thick and steam continuously through 1.8 meters of ice at 3 knots.

5.1.1 The localised ice conditions created by the passage of vessel

The localised ice conditions that a vessel creates as it moves through ice will depend on the prevailing ice conditions.

When an icebreaker is breaking a channel through large heavy floes at slow speed (3 to 5 knots), the channel will be about 30-40 per cent wider than the beam of the icebreaker. If, however, the ice is of a type and thickness that can be broken by the stern wave of the icebreaker proceeding at higher speed (up to 8 knots or more), the width of the channel may be as much as three times the icebreaker's beam. In the channel there may be pieces of ice and small floes which the icebreaker has broken off the floes at the sides of the channel.

5.2 Dispersant spraying from ships

The feasibility of spraying dispersant onto spilled oil in ice from a vessel will depend on the ice conditions and the circumstances of the oil spill.

5.2.1 Low ice coverage

Spraying dispersant onto spilled oil from a ship in low ice coverage conditions, less than 1/10 “open water” or 2 – 3/10 “very open drift”, will be similar to spraying dispersant in ice-free conditions.

The thickness and form of the ice will be an important factor. Localised areas of “new ice”, less than 10 cm thick, or “young ice” of 10 to 30 cm thick will not present a high degree of hazard, but thicker first-year ice (“thin”, 30 – 70 cm thick; “medium”, 70 – 120 cm thick; or “thick”, over 120 cm thick) will present an increasing hazard. The presence of pieces of multi-year ice is particularly hazardous because of its much greater hardness, compared to first year ice.

The main difference in dispersant spraying in these conditions will be for safety reasons; there will be a need to reduce vessel speed and to avoid collisions with the ice. The usual practice of spraying directly into the wind, or with the wind, will not be possible and a lot more manoeuvring of the vessel will be required, compared to ice-free conditions. The advantage of very long spray arms becomes less apparent when ice is present than when the spraying in ice free conditions can be done in long, continuous strips.

5.2.2 Medium ice coverage

Spraying dispersant onto spilled oil from a ship in medium ice coverage conditions, 4/10 to 6/10 “open drift”, will be a lot more difficult than spraying dispersant in ice-free conditions. The spilled oil will be present on the 40% to 60% of the water surface not covered by ice. The thickness and form of the ice will determine whether dispersant spraying is possible.

If the ice is in the early stages of development it will not severely interfere with vessel operations or hinder the spreading of the spilled oil, but if the ice is more developed and thicker then it might prevent dispersant spraying.

5.2.3 High ice coverage

Spraying dispersant onto spilled oil in 7- 8/10, “close pack” or 9/10, “very close pack” ice will be more difficult (Figure 8).

Figure 8. Icebreaker going through close pack ice

The maximum speed of the vessel will have to be reduced if the ice is thick.

Spraying dispersant onto the ice is potentially wasteful, but if the dispersant were formulated to be of particularly low viscosity, it might flow off the ice and onto the oil where it would soak into the oil. The subsequent turbulence created in the ship's wake may cause adequate dispersion

If there is a continuous 10/10 ice cover of relatively thick ice (Figure 9), any ice class ship will be limited in the speed at which it can travel. A maximum of 3 knots in thick ice (up to 1.5 metres thick) to a maximum of 10 knots in thinner ice (0.5 metres thick or less) seems a reasonable assumption.

The location of the spilled oil will depend on whether the oil was released under the ice sheet (from a sub-sea blowout or pipeline leak, for example), or from above the water line into the broken ice created by the vessel passage.

Figure 9. Ice class LNG tanker in ice off Sakhalin

If the vessel in Figure 6 were an ice-strengthened oil tanker (and not the LNG tanker pictured), and sustained damage to the hull, an oil spill might result. If the damage was relatively minor, some of the spilled oil would then flow into the brash ice trail created by the vessel's passage. The spreading of the spilled oil would be limited to the extent of the channel in the ice created by the vessel.

A supply vessel equipped with dispersant spraying gear could then move in to the brash ice trail and spray dispersant onto the broken ice / spilled oil mixture.

In considering whether the dispersant is likely to be effective, there are two contradictory factors:

- The potential problem would be that the dispersant does not soak into the spilled oil, but was lost to the water in the ice / spilled oil mixture. If the dispersant fails to contact the spilled oil the dispersant is likely to be ineffective.

- However, the turbulence created by the propellers and wake of the dispersant-spraying vessel would be a massive input of mixing energy into the upper layers of the water column that could be entirely absent in the presence of near-continuous ice cover in calm conditions.

A possible strategy might therefore be to spray dispersant onto the broken ice / spilled oil at a very low vessel speed and then wait for some time before carrying out a higher speed 'mixing run'.

6 Recommendations

The main aim with JIP-project 4, task 4.2 is to evaluate existing application equipment and suggest improvement and adaptation ("winterization") for use in cold conditions and in presence of ice. The goal is that such upgraded equipment will be verified in the field trials during the JIP (MIZ Barents Sea, spring 2009). It is therefore important to identify a cooperative partner (end user) for supporting the construction / adaptation of a dispersants application prototype for that planned field trial.

Based on the limited budget of task 4.2., it is suggested to focus such testing on only one test system, and that we through this evaluation of different application platforms see the largest potential in going further with boat application systems.

A very preliminary approach to further development /improvements is to develop a very flexible spray system that might be applicable for use both in open water and in ice-covered areas (see illustration below). The idea is based on a very flexible and manoeuvrable spray system with hydraulic arms with replaceable nozzle systems that are possible to be steered (remotely from the bridge, see figure 10 below) analogue to the de-icer system used at airports. Such a manoeuvrability of the spray nozzle will make it possible to optimize the dispersant treatment on the oil between the ice –floes, and minimize deposition of dispersant on the ice.

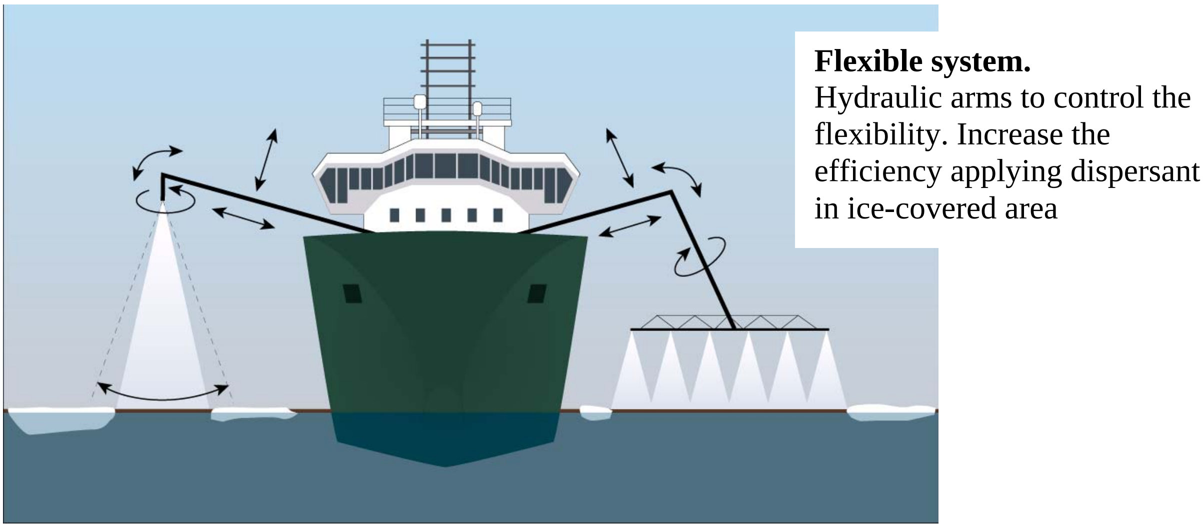

Figure 10: Suggestion to (preliminary thoughts) approach for further development a very flexible spray system, that might be for applicable for use both in open water and in ice-covered areas.

Other critera:

- Freezing / icing : - can be problematic and may block the nozzle (in start/ stop –situations).
- The system should be flushed when finished to avoid this problem: "start – stop" system. "Back-flush system" with defrosting liquid after use.
- The equipment must be tested for winterization (- 20 ºC in SINTEF oil-ice basin).
- The spraying arms should be protected against freezing / icing conditions by being stored in a special designed (heated) container on the front deck, that are "opened" only when used for spraying.
- No pipes should be on the deck. Standardized system suggested being coupled on the boom.

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Appendix 1:

Aircraft limits under Arctic operations

Ian Denness , ConocoPhillips

Helicopters
Cold weather limits:
Canadian Helicopters Ltd.cold weather operating limit is -40C
Some aircraft models may have cold weather operating limits higher than -40C i.e. (B212 is certified to -54C)
Some aircraft models may have cold weather operating limits higher than -40C when operating with specific fuels i.e. (Jet A) has a lower freeze /gel pt. than Jet B so you could possibly operate this aircraft at a lower temp without freeze up……….but not likely though.

There are no fixed limits for wind speed, however excess wind may restrict visibility in blowing snow, produce unacceptable wind chill factors for crews working in the field and gusty conditions may restrict both internal and external load operations.

Heli. Flight Visibility Ceilings and Routes :

Day VFR
Requires a 1000' ceiling and visibility of 3 miles.
In uncontrolled airspace a helicopter can fly with visibility **not less than** 1/2 mile provided that is operated clear of cloud and with visual reference to the surface at all times. While it may be possible to fly with 1/2 mile visibility in summer conditions, snow covered featureless terrain with low light levels may preclude these low visibility operations. Two instrument rated pilots, flying an instrument capable helicopter with a "plan" will be better equipped to deal with reduced visibility operations.

Night VFR:

Flights must be conducted along pre approved routes that maintain 1000 foot obstacle clearance above the highest obstacle 3 miles either side of the centre line of the route. There must be a minimum of 3 miles visibility and the helicopter must remain 500' clear of cloud. There must be adequate lighting at both the takeoff and landing location. For night operations the helicopter must have two engines, have additional flight instruments and be flown by two instrument rated pilots.

IFR:

Flights must be conducted along pre-approved routes that maintain 2000 foot obstacle clearance above the highest obstacle 10 miles either side of the centre line of the route. Generally the helicopter must land at a location with an approved instrument landing procedure in place. Visibilities and ceilings at landing sites will depend on the site location and the particular approach used at the site. Generic offshore rig approach allows landings with ceilings down to 150' and visibilities of 1/2 mile provided the rig is located more than 7 nautical miles from shore. Onshore GPS approaches typically allow approaches in the 500' to 250' range although the proximity of high terrain, communication towers, flair stacks etc will drive these limits higher.

External Slung Loads:
May be conducted under day and night VFR conditions and under day VFR conditions with reduced visibility. At this time there is no approval for IFR external load operations..

Fixed wing
Ice runways for Hercules aircraft were always built with 53" freshwater ice and 63" sea ice. Runways were 5000 feet long and 150 feet wide with a 400' x 400' loading ramp.
These specs were suitable for the 737 but 6000 feet was needed for the 727.

There are a variety of answers to the temperature limits question, however, next page provides the best one. "The ambient temp. cannot be less than 3 degrees C above the freezing temp. of the aircraft fuel" . If you pick - 50 C for Jet B then the temp. limit would be -47 C.

Practically speaking……….. most charter operators do not work their crews below -40C.

Aircraft	**Length Fresh**	**Thickness Salt**	**Thickness Range**	**Range (SM)**	**Wheels**	**Skis**
DHC6	1400’	14”	20”	900	Yes	Yes
BT67	3500’	20”	28”	2400	Yes	Yes
Dash 7	2000’	24”	32”	1200	Yes	
Dash 8	4000’	28”	40”	1500	Yes	
ATR	3822’	28”	40”	3400	Yes	
C-130	5000’	40”	45”	2360	Yes	

The visibility for day VFR is 1 mile and 500’ ceiling and for night VFR (runway lights required) 2 miles and 1,000’ ceiling.

SRP

DC3-TP67 FLIGHT MANUAL

CHAPTER 2
OPERATING LIMITATIONS

B. Accumulation of ice on the upper surface of the wing aft of the protected area.

C. Accumulation of ice on the engine nacelles and propeller spinners farther aft than normally observed.

2. Since the autopilot, when installed and operating, may mask tactile cues that indicate adverse changes in handling characteristics, use of the autopilot is prohibited when any of the visual cues specified above exist, or when unusual lateral trim requirements or autopilot trim warnings are encountered while the airplane is in icing conditions.

3. All wing icing inspection lights must be operative prior to flight into known or forecast icing conditions at night. [NOTE: This supersedes any relief provided by the Master Minimum Equipment List (MMEL).]

CABIN LOADING

No cargo or passenger interior configuration has been approved as part of this STC

TAKEOFF AND LANDING

Takeoffs and landings are limited to pressure altitudes between -1,000 feet and +10,000 feet and temperatures between -54°C (-65°F) minimum to ISA + 35°C (ISA + 63°F) maximum. **Minimum Takeoff and Landing temperatures may not be less than 3°C (5°F) above the below listed fuel Freeze Point temperature for the fuel being used.**

Note: If pressure altitude is below sea level, use performance data scheduled for sea level.

MAXIMUM OPERATING ALTITUDE AND ENROUTE TEMPERATURE LIMIT

The maximum operating pressure altitude is 25,000 feet. En-route temperature limits are -54°C (-65°F) minimum to ISA + 35°C (ISA + 63°F) maximum. **Minimum En-route temperature may not be less than 3°C (5°F) above the below listed fuel Freeze Point temperature for the fuel being used.**

FUEL FREEZE POINT TEMPERATURE

Fuel	Specification	Freeze point
Jet A	ASTM D1655	-40C -40F
Jet A-1	ASTM D1655	-47C -53F
Jet A-2	ASTM D1655	-40C -40F
Jet B	ASTM D1655	-50C -58F
JP-4	MIL-T-5624	-58C -72F
JP-5	MIL-T-5624	-46C -51F
JP-8	MIL-T-83133	-50 C -58F

ENGINE ICE PROTECTION

Engine inlet and propeller icing protection must be on whenever the outside air temperature is at or below +5°C (+40°F) and visible moisture is present.

MANEUVERING FLIGHT LOAD FACTOR

Flaps Up.. + 2.5 G
Flaps Down.................................... + 2.0 G
Negative.. - 1.0 G

Appendix 2:

Helicopter limits under Arctic operations

Jon Birger Erstad CHC - Helikopter Service, Norway

Subject: Helikopter begrensninger

Når det gjelder operasjonsbegrensninger for helikopter så har vi kun sagt at det skal foregå under Visuell flyforhold (VFR). D.v.s. sikt 5km og vertikal avstand til skyer 1000'.
Vi har vurdert en vindstyrke på 30kt. til å gi lite effekt for påføring av dispergeringsmiddel.
Lasteflyging med underhengende last skal normalt foregå i dagslys under VFR forhold.
Skal man dispergere i lav høyde ville bruk av Nattbriller (NVG) kunne muliggjøre en slik operasjon.
Dette har så vidt jeg vet ikke vært prøvd. Kunne vært interessant å teste ut.
Redningshelikoptret i Longyearbyen er utstyrt med NVG.

Vi har også begrensninger for operasjon på beveglige helidekk. Dette varierer avhengig av fartøyets/innretningens størrelse og utstyr til å måle bevegelsene.

Håper dette kan være til hjelp.

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