DNV AS, Norway

EVALUATION OF VESSEL DISPERSION CONCEPTS IN THE BARENTS SEA

EQUINOR ENERGY AS

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1 EXECUTIVE SUMMARY

Equinor is looking to strengthen the dispersion preparedness for the Barents Sea and have contacted DNV to assist in considering different logistic evaluations of using Offshore Service Vessels to perform dispersion operations offshore.

DNV performed a qualitative workshop 26th of April 2022 with Equinor and relevant stakeholders looking into concepts for improving the logistic operation involved in dispersion preparedness in the Barents Sea. This report summarizes the discussions and main findings from the workshop.

The workshop considered offshore ship-to-ship dispersion transfer operations between offshore vessels, either by hose for bulk tanks transfer or deck tanks containing dispersion liquid. Scenarios for increasing the amount of dispersion liquid on offshore vessels and offshore bases in Norway were also evaluated.

Increasing the amount of dispersion liquid on offshore vessels and offshore bases was evaluated to be scalable solutions that could strengthen the dispersion preparedness both in the Barents Sea and Norwegian Continental Shelf. The concept assumes that several vessels is made ready for a high dispersion volume operation. To be able to increase the amount of dispersion liquid on vessels and offshore bases, it would be required to engage in high level decisions and work with the national dispersion strategy in Equinor and NOFO. According to NOFO standard 2021, the minimum tank capacity on OR vessels for dispersant shall be 100 m³ distributed on minimum four tanks and the stockpile of dispersion liquid on Norwegian offshore bases is currently limited.

To enable more continuous dispersion operation, ship to ship transfer offshore of dispersion liquid was evaluated. ship to ship transfer of dispersion liquid requires more in-depth analysis to support arguments that such transfer will support more continuous dispersion operations.

An analysis of a full operational cycle for a continuous dispersion operation should be performed. Bottlenecks in logistic chain and vessel equipment should be analysed and relevant stakeholders should be involved. The cost element for this solution is not considered in this report.

In addition, the ship-to-ship operation should be risk assessed with relevant stakeholders if found to be feasible solution.

1.1 Recommendations

Before a further evaluation and decision between the concepts are done, the following elements should be considered:

1.	Norwegian Maritime Authority need to be contacted to clarify: 1) Can two offshore vessels transfer dispersion liquid to each other's bulk tanks and then be used in a dispersion operation, without having to consider MARPOL Annex II? 2) Can two offshore vessels transfer deck containers with dispersion liquid and then use this liquid in a dispersion operation. *Øystein Skåra at DNV confirm this can be done.*	Equinor
2.	1. Quantification of full operational cycle should be calculated to allow for a "continual dispersion operation". Consider the following 3 options: • ship to ship transfer to bulk tanks, • ship to ship transfer with deck tanks • Evaluation of how many vessels needed for a "continuous operation" when vessels fill dispersion fluid at base. Different volumes onboard the vessels to be evaluated. Bottlenecks to be identified and relevant stakeholders to be involved to prepare a precise time estimate. Assumption: One of the vessels have crane approved for ship to ship transfer. Decide on: • The quantity of dispersion liquid to be onboard • Number of vessels with this quantity onboard The vessels' location on the Norwegian Continental Shelf 2. Cost analysis for the two scenarios should be evaluated. (bulk operation and tank transfer offshore). 3. Perform risk assessment of ship to ship operation	DNV will prepare proposal for a BAT analysis involving these steps to Equinor

Before going further with decision on the national stockpile of dispersion liquid the following elements should be considered:

1.	Discuss the national dispersion strategy in relevant fora • The supply chain of dispersion liquid in Norway is not made for a high-volume operation today. One bottleneck is to transport the required volume to vessels offshore when collecting dispersion liquid from stock. • Capacity on the NOFO bases. Today standard about 50m3 at the NOFO bases. What is the necessary quantum that should be stored at bases in Norway? Where should they be stored? • Use input from logistic analysis to decide on quantum at bases, vessels and vessel's geographical location • Perform analysis if a larger stock should be placed in Norway • Strategy for dispersion. Subsea, from air, vessels. All elements should be covered before deciding increase of stock	Equinor/NOFO
3.	Prepare decision support towards what solutions is best to ensure a rapid filling of vessels from base. deck tanks, deck tanks or other solution.	DNV

2 INTRODUCTION

Equinor is looking to strengthen the dispersion preparedness for the Barents Sea and have contacted DNV to assist in considering different logistic evaluations of using Offshore Service Vessels to perform dispersion operations offshore.

The challenge with the current offshore vessel capacity is that the typical OR vessel has approximately 50m^3 of dispersion liquid on board to use in the event of an oil spill. To refill, the OR vessel must sail to the nearest NOFO base and refill dispersion liquid, before they can continue dispersing operation offshore. The time used during transit and refill reduces potential time for dispersion operations.

Equinor has asked for assistance to consider whether a PSV or OR vessel can have larger amounts of dispersion liquid on board, which other ships in the field can connect to to transfer dispersion liquid by hose (or other methods) as a ship-to-ship operation.

In this way, a more continuous dispersion operation can be achieved. This report summarizes discussions and findings from a workshop held 26th of April 2022.

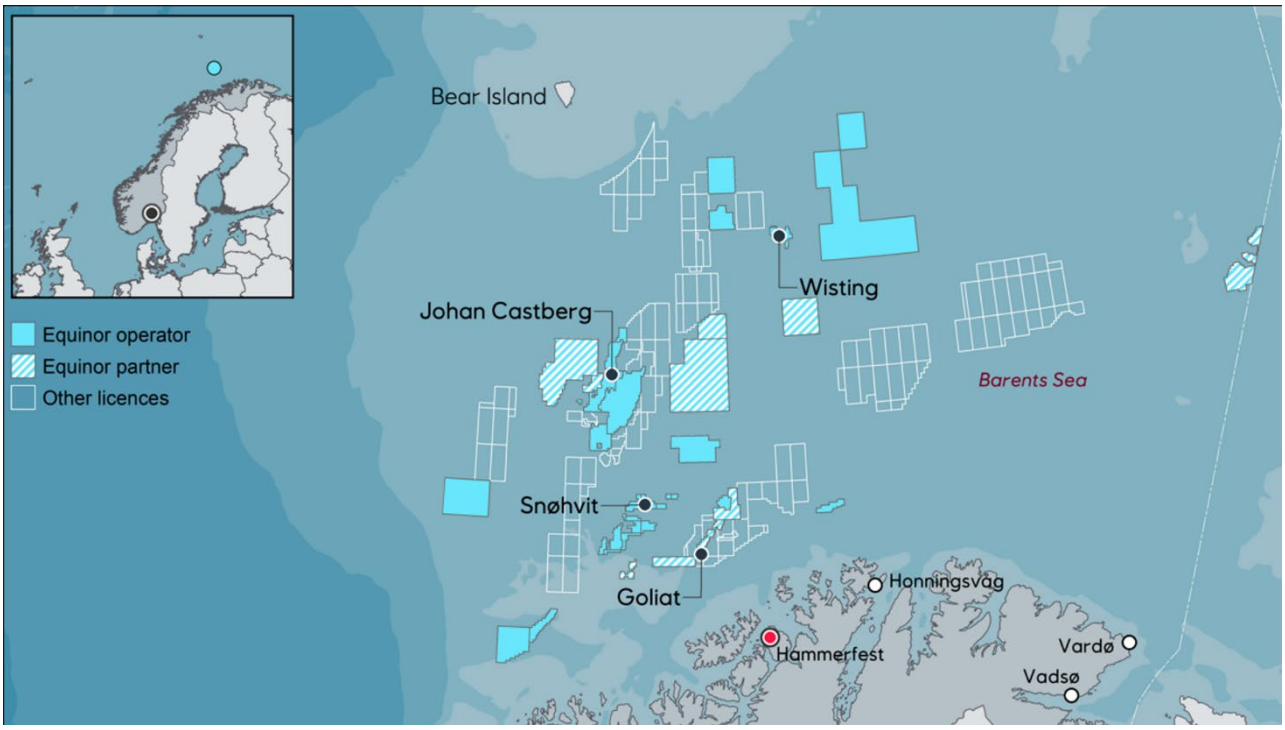


Figure 2-1 The Barents Sea region (reference: www.equinor.com)

3 BASIS FOR WORK

The following sequence of activities was agreed for the project (Figure 3-1).

Activity		Scope	Output
1	**Kick – off meeting with Equinor/DNV**	Establish possible conceptual solutions, agree on criteria's the concepts will be evaluated against, plan workshop. The meeting will be held digitally.	Minutes of meeting
2	**DNV preparations**	Review existing literature, rules, contact with NMA and planning of workshop.	Workshop preparations
3	**Workshop**	Talk through established concepts. Consider according to agreed criteria's. Define pros and cons with each concept. Important to involve PSV Master, stby Master and NOFO representative.	Minutes of meeting
4	**Further studies (Option)**	DNV may assist in further studies related to emergency preparedness in the Barents Sea. To activate this option, Equinor and DNV must agree on scope and DNV will come back with commercial terms.(Option).	To be agreed
5	**Reporting**	Summarizing report	Report detailing evaluation of alternatives
6	**Project management**	Management of the project and execution of quality assurance activities.	Timely delivery of the project at required quality.

Figure 3-1 Scope of work

4 KICK OFF MEETING

Kick off meeting in project for evaluation of concepts for dispersion operations with offshore vessels in the Barents Sea. The following agenda was discussed:

- Mutual understanding and specification of the concepts that shall be evaluated in the workshop.
- Agree on criteria’s the concepts shall be evaluated against and their data source.
- Plan workshop. (Date and participants)

DNV stressed the importance of being aligned in the understanding of concepts to be considered in the upcoming workshop. Also, that the project shall be of value for the customer by looking at earlier studies and proposing a way forward for the logistic evaluations in vessel dispersion operations.

Criterions for evaluation, participants and dates for the workshop was discussed.

5 DNV PREPARATIONS

DNV prepared workshop by defining concepts to be evaluated. Relevant literature/earlier studies regarding offshore dispersion were collected from Equinor and read as part of preparation for workshop.

6 WORKSHOP

6.1 Objectives

DNV facilitated a workshop to gather the participants view on five different logistic concepts for vessel dispersion in the Barents Sea.

The workshop had three objectives:

1. To do a qualitative assessment of five identified concepts for dispersion operations/logistics in the Barents Sea.
2. To discuss advantages/disadvantages in each concept against specified criteria`s
3. To forward the results from the workshop to Equinor as input for decision support to strengthen vessel dispersion capability in the Barents Sea.

6.2 Participants

The workshop had participants from the following companies:

- Equinor (5 participants)
- NOFO (3 participants)
- Kystverket (1 participant)
- Aker BP (1 participant)
- Master of offshore vessel (1 participant)
- DNV (3 participants)

6.3 Introductory presentations

First DNV and Equinor presented the goals of the workshop. Aker BP shared findings from their internal project on vessel dispersion operations. NOFO presented in detail dispersion operations and NOFO current capacities in this respect.

Scaling up number of dispersion systems (number of vessels) is already possible today. The workshop focused on looking at new concepts and how we can utilize each resource better than today.

Some highlights from NOFO presentation:

- The vessel must have an oil radar and IR camera to be allowed to start dispersion operation. Surveillance from plane, drone or helicopter must also be in place
- Operation window in the Barents Sea
    - At approx. 3.5 m hs on sea, the oil will start to self-dissolve.
- Platform supply vessels have a natural under pressure on aft deck due to accommodation inlets. Dispersion liquid will be sucked towards deck and inlets if you do not follow the natural wind direction during the dispersion operation.
- Application rate will affect the duration of the dispersion operation. At high dose 120 l/per minute, 7m3 per hour. At low dose, 3,5m3 per hour..
- Dispersion is not considered as a continual activity in today`s oil spill preparedness. More as an on-off activity.
- Dispersion bulk tanks on vessels should be standalone and not used to other types of cargo.
- Equinor have access to all the 3 dispersion liquids on the market. Up to 5000 m3. It is some lead time on production of liquid. >10 weeks. If mobilized from e.g. Southampton you may use flight or tank vessel for transport to offshore base in Norway.

Equinor presentation:

Equinor showed simulations of residual oil on the sea surface on Johan Castberg and Grane by modelling different oil spill response alternatives in Oscar. The analyses shows that dispersion by use of offshore vessels will be the most efficient solution, if the access to dispersion liquid is unlimited. It is the small amount of dispersion liquid stored on vessels, the transit time to refill vessels at bases and the limited amount of dispersion liquid on offshore bases that is limiting a continuous dispersion operation.

The workshop was structured as a qualitative assessment of five concepts for vessel dispersion operations. DNV presented the concepts and workshop log briefly and moderated a discussion for each concept during the workshop. All the input from the workshop participants were documented in the workshop log found in appendix 1.

- Concept 1: Ship to ship transfer offshore of dispersion liquid using vessel bulk tanks
- Concept 2: Ship to ship transfer offshore of dispersion liquid by using deck tanks
- Concept 3: Enable vessels to carry higher volumes of dispersion liquid in bulk
- Concept 4: Enable vessels to carry higher volumes of dispersion liquid in deck tanks
- Concept 5: Enable supply bases to hold higher volumes of dispersion liquid at site

The main conclusions from each concept evaluation are presented on the following pages.

6.4 Concept 1 - Ship to ship transfer offshore of dispersion liquid using vessel bulk tanks

Transfer of dispersion liquid offshore between two offshore vessels. Bulk/bulk tank.

1. Vessels alongside for hose transfer
2. Hose transfer. Vessel crane/throwing line, other means?
3. Transfer of dispersion liquid
4. Disconnecting and start/continue dispersion operation

6.4.1 Main findings from concept 1

There are several issues that needs to be solved before a ship-to-ship transfer operation of dispersion liquid offshore can be performed.

1. Several issues have been highlighted in the workshop. The below summarizes the most important ones.

Vessel:

1. It should be decided what amount of dispersion liquid that should be in bulk tanks onboard a vessel offshore.
2. Decide vessel type and number of vessels that should be made ready for ship-to-ship operation offshore.
3. The dispersion liquid should be on dedicated tanks. It is important to have full tanks/nitrogen "carpet" on top to avoid air contact and condensation problems.
4. There are limitations in use of crane onboard a regular PSV for hose transfer between vessels. The chosen vessels must have cranes approved for ship-to-ship operation if hose transfer by crane is the planned solution.
5. To avoid use of crane, one could investigate possibility to trail hose in sea and pick up hose over bow. It is also possible to "shoot" line from ship A to ship B and use capstan or other winches to transfer hose.
6. It may be necessary to rebuild vessels that shall be used in ship to ship transfer to improve loading/discharging rates as the time needed to pump and receive dispersion liquid on existing vessels is a real challenge. The specifications or cost of such rebuilding is not addressed in the workshop.

Administrative issues:

1. The most updated standard, NOFO Standard 2021 Requirements for oil recovery vessels on the Norwegian Continental Shelf, requires that any new vessels to the NOFO pool to be able to carry minimum100m3 of dispersion liquid. If a higher volume of dispersion liquid should be required on vessels, this needs to be addressed at the appropriate decision level

2. A quantitative or qualitative risk assessment of the Ship-to-Ship transfer operation should be performed.

3. Standard operating procedures should be developed for the ship to ship operation. Ownership of procedure development should be decided. Drills and exercises program should be implemented if ship-to-ship transfers are implemented.

4. Course in ship to ship operation should be considered for seafarers before start of a ship-to-ship operation.

5. A quantitative assessment of the operational cycle for a vessel dispersion operation should be carried out.

    - A graphical presentation of result. How many vessels do we need? How much dispersion liquid would that mean? Quantification.
    - Volumes and loading time with today's equipment vs a future solution with dedicated vessels and dedicated piping, pumps
    - Consider if concept shall cover SSDI, topside/surface dispersion or both?
    - Analyse how many vessels that will need to be ready for higher volumes in bulk to give an increased emergency preparedness effect in the Barents Sea.
    - How many vessels/systems will operate/disperse in parallel?
    - Should one have several dispersion teams of vessels together? More robust if several vessels are involved in dispersion
    - What can be done to take away bottlenecks for vessel loading operations. What is required to reduce filling time?
    - Sailing time from offshore to base
    - Number of hours with ship to ship operation vs sail to offshore base for refilling
    - What can be done to remove bottlenecks/capacity issues?

6.5 Concept 2 – Ship-to-ship transfer offshore of dispersion liquid - Deck tanks

Transfer of dispersion liquid offshore between two offshore vessels. Transfer of deck tanks.

1. Vessels alongside for tank transfer
2. One vessel transfer deck tank containing dispersion liquid to the other via vessel crane
3. Receiving vessel either pumps dispersion liquid to own bulk tanks or have system for directly connecting dispersion booms to deck tanks

6.5.1 Main findings from concept 2

Pros:

- It may be an advantage to not be connected to another vessel by use of hose. With deck tanks you also save the time for filling on bulk tanks. Since PSV may have issues preventing it using the crane for transfer, one of the vessels involved in the ship to ship operation must have a crane fit for this purpose. May be a construction vessel or other type of vessel transferring the deck tanks to the PSV.
- Deck tanks can be connected directly to supply the dispersant vessel Cons:
- Deck tanks must be lifted via rig if vessels do not have approved cranes. Increases operations time. Not a robust solution to go via rig.
- Pumping from deck tanks to own bulk tanks, may take long time.
- Need many containers to get high volumes with present solution.
- Dispersion liquid is stored on IBC tanks (1 m3), the units have small quanta. Alternatives may be deck tanks with higher capacity.
- The operation may be more challenging since the deck tanks are more exposed to the elements and two vessels will create container movements that may be challenging for the deck crew when connecting/disconnecting containers.

6.6 Concept 3 - Enable vessels to carry higher volumes of dispersion liquid in bulk

Bulk tanks:

- Dedicate vessels to apply for up to 800 m3 of dispersion liquid in bulk tanks to Norwegian Maritime Authority
- The vessels do not have to hold this volume in bulk at all times, but vessel certificates to be ready for this.
- The vessels will need to perform tank wash and fill up dispersion liquid at offshore base before ready for dispersion operation.

6.6.1 Main findings from concept 3

Pros:

- From an emergency preparedness capacity view, it may be wise to increase the capacity for dispersion liquid in bulk tanks for dedicated offshore vessels (e.g 500-600 m3). Dispersion liquid will then be closer to the area of application and save transit time for vessels involved in dispersion.
- Dispersion liquid in tanks may be durable many years if stored in a proper way.
- If some vessels on the shelf have higher volumes of dispersion liquid onboard, it may increase the emergency preparedness for the whole Norwegian continental shelf.
- Benefit as you prolong dispersion operation/cycle if you have available more liquid on board.
- Can be scaled to include all parts of Norwegian Continental Shelf. If vessels are also equipped with dispersion booms, they can actively participate in oil spill response.

Cons:

- Reloading vessels at base 600-800 m3 may take long time today's equipment. Precise estimates should be found
- To be an effective alternative, dedicated vessels would have to be rebuilt (piping, pumps, valves) to avoid many days at base for loading dispersion liquid due to low rates and capacities on pumps, valves and piping system.

To be considered:

1. Decision on what volume should be stored onboard vessels Define vessels in pool. Where should the increased amount of dispersion be stored along the coast?

2. Operational cycle should be calculated.

6.7 Concept 4 - Enable vessels to carry higher volumes of dispersion liquid in deck tanks

Deck tanks with dispersion liquid on aft deck

- Deck Tanks to be loaded at offshore supply base on aft deck
- Deck space needed?
- Options:
    - Transfer dispersion liquid to vessel own bulk tanks during transit
    - Connect deck tanks to vessels own dispersion booms
    - Transfer deck tanks to other vessels offshore via ship to ship operation

6.7.1 Main findings from concept 4

Pros:

- Takes less time to load onboard containers than loading bulk tanks with present capacity on vessels and offshore base.
- Flexible solution. May transfer dispersion liquid from deck tanks to vessel own bulk tanks during transit, connect deck tanks to vessels own dispersion booms, if fitted or transfer deck tanks to other vessels offshore via ship to ship operation.
- Enables higher volumes onboard as you may have dispersion liquid in bulk tanks and have deck tanks in addition.
- If deck tanks are connected to vessels own dispersion booms, it is considered an effective solution and increases the vessels dispersion capability
- Assumed to be lower risk than ship to ship operation

Cons:

- Pumping from deck tanks to own bulk tanks, may take long time.
- Need many containers to get high volumes with present solution.
- Storage area need at base with many “small” containers
- Costs unknown

To be considered:

1. Should aim for good mobilizable solutions (dispersion booms, new solutions for vessel dispersion, to keep costs down. If vessels need to be rebuilt it is a more expensive solution.

6.8 Concept 5 - Enable supply bases to hold higher volumes of dispersion liquid

If vessels are equipped for higher volumes of dispersion liquid onboard, the amount of dispersion liquid should be higher at the bases to gain a higher emergency preparedness effect.

The quay at Hammerfest base has sufficient space for several loading operation simultaneously. (Source Johan Castberg utredning 2020)

1. Discuss possibilities to store high-capacity deck tanks with dispersion liquid to place on vessel deck.
    - Vessel transfer dispersion liquid to dedicated bulk tank(s) during transit or have system connecting tanks directly to dispersion booms.
    - Total volume needed at base?

2. Transfer of dispersion liquid from base to bulk tanks

6.8.1 Main findings from concept 5

Pros:

Proximity of dispersion liquid to offshore fields increases efficiency.

Takes down waiting time for dispersion liquid stored elsewhere in the world

Cons:

At present dispersion liquid is stored several places in the world. During an offshore oil spill operation, the dispersion liquid will come in pieces from different locations.

Will increase costs. Purchasing of higher volumes, storing of higher volumes, costs for modifications at offshore base.

Long transfer time from base tanks to vessels bulk tanks

To be considered:

- Capacity on bases. Today standard about 50m3 at bases. What is the necessary quantum that should be stored at bases in Norway. Where should they be stored?
- Perform analysis if a higher stock should be placed in Norway
- Operation cycle calculations should be performed
- Strategy for dispersion. Subsea, from air, vessels. All elements should be covered before deciding increase of stock

7 APPENDIX 1 – WORKSHOP LOG

Concept 1

Criteria	Conclusions from workshop participants
Advantages/how to reach goal	**Advantages:** The solution with Ship-to-ship transfer of dispersion liquid offshore will ensure quick access to dispersants (also from global stockpile). Enables continuity in dispersion process. **Vessel:** 1. It is important to decide which type of vessels that should have attention for enabling them to be efficient for a Ship-to-ship transfer. Area emergency preparedness vessels may not have special product tanks like a Platform Supply Vessel. Named vessel should be identified. 2. The dispersion liquid should be on dedicated tanks. It is important to have full tanks/nitrogen "carpet" on top to avoid air contact and condensation problems, as this will affect lifespan for chemicals and gaskets on dispersion liquid that is not taken into use immediately. 3. Special product tanks or 2-4 of the cargo tanks of the vessel that is isolated for dispersion liquid was discussed. In the vessel discussed int workshop, 350m3 could be stored on Special Product tanks. The capacity in total for a normal platform supply vessel is up to 1800m3 for all cargo tanks. 4. There are limitations in use of crane onboard a regular PSV for hose transfer between vessels. This is an important element to check out when considering this solution. Other types of vessels such as tankers and construction vessels will have approved cranes for this purpose. 5. To avoid use of crane, one could investigate possibility to trail hose in sea and pick up over bow. It is also possible to "shoot" line from ship A to ship B and use capstan or other winches to transfer hose. 6. It may be necessary to rebuild vessels that shall be used in ship to ship transfer to improve loading rates. The cost of such rebuild is not addressed in the workshop. **Administrative issues:**

	1. The most updated standard, NOFO Standard 2021 Requirements for oil recovery vessels on the Norwegian Continental Shelf, requires vessels to carry 100m3 of dispersion liquid. For newbuilds, future specifications may be changed to allow higher quantities. 2. A quantitative or qualitative risk assessment of the Ship-to-Ship transfer operation should be performed. 3. Standard operating procedures must be developed for the ship to ship operation. Ownership of procedure development to be decided. 4. Course in ship to ship operation should be considered for seafarers before start of a ship-to-ship operation.
Disadvantages	It was discussed that it may be a safer solution to increase vessel`s bulk tank capacity for dispersion liquid, instead of transferring the liquid via hose in a ship-to-ship operation. NOFO address that it may be a better solution to have deck tanks transported to Lakselv/Banak via airfreight and transfer the dispersion fluid offshore from there. The dispersion operation will in any case have downtime during the offshore ship-to-ship transfer operation. (Vessels positioning alongside, hose transfer, pumping operation, etc) Due to low capacity in cargo piping and pumps, loading ship to ship takes a long time. One example was that unloading of 25m3 of dispersion liquid from the vessel addressed in the workshop took 12 hours to complete. NOFO addressed that transfer time offshore is a challenge when taking large quanta of dispersion liquid to Norway. For instance, the volumes in Southampton and France are stored in deck containers. They would have to be transferred to a tank vessel or other means before suitable to transfer ship-ship via hose to an offshore vessel.
Costs	Will need modifications on piping and pumps on offshore vessels intended for ship-to-ship transfer to allow for higher speed in transfer of fluids and efficient operation. The costs and scope for such modification is out of scope for this workshop If cranes are intended to be used for hose transfer, they must be approved for use offshore.

	NOFO: Current cost is 60 kr/litre for dispersion liquid. 9 MNOK to refill 150 m3.
Emergency preparedness effect	Larger quanta of dispersion liquid on Special Product tanks or deck tanks may improve the emergency preparedness effect in the Barents Sea, but new logistical calculations would have to be completed. Uncertainty if a Ship-to-ship transfer would improve emergency preparedness effect in the Barents Sea. The operational cycle would need to be calculated.
Operability	There are limitations for ship to ship operations due to weather window. The actual ship to ship operation will represent down-time during transfer between vessels. It would be necessary to describe operation in procedures. Using DP? Both vessels making way? Potential use of Transrec hose (if clean)? Possible to transfer hose? Vessels are not rigged for an efficient ship to ship transfer today. (small diameter piping, pump capacity, cranes etc). Will probably need modification. NOFO: Why this approach? Alternative deck-tanks on RORO vessel from Southampton to Stavanger/Bergen.
Performance requirements	Clean tanks must be ready for taking onboard dispersion liquid. If an ship to ship operation should be performed, it must be a part of procedures for drills and exercises.
Continuity in dispersion operation	Necessary to do a more specific study of operational cycle. Operation vs. transit time. Net effects to be calculated.
Scaling possibilities	Ship to ship transfer operation may be considered to be generalized as a standard operation after risk assessment, procedures, training and commercial decisions have been completed
Safety (Personnel/Environment/Assets)	Several potential safety issues in ship to ship operations.

	Such operations would require shipowner/operator to perform risk assessments, have standard operating procedure and train crew in ship to ship operation. Potential hazards mentioned in workshop: • Two vessels alongside with ship specific movements • Offshore crane in movement • Crew using capstans • Manual handling
Action	1. Rules that must be checked: Transfer of chemicals between vessels & transport of chemicals that shall be used by others (Certificate of transportation). Is internal transfer of liquid between tanks on own vessel an issue? *Feedback from Øyvind Skåra in DNV 01.06.2022: Do not see any problems with internal transfer.* 2. Uncertainty if a Ship-to-ship transfer would improve emergency preparedness effect in the Barents Sea. NOFO have many potential vessels to send for an oil spill. Can that take away the need for a ship to ship transfer? Is the time for ship to ship operation part of Castberg analysis? Is delivery time from global stock (deck tanks) and transfer offshore taken into account? The operational cycle for this scenario would need to be calculated. *DNV to prepare proposal.* 3. NOFO have received a letter from NMA that the freight of dispersion liquid onboard offshore vessels would not require to follow MARPOL Annex II. Equinor to gather this letter from NOFO. Important to check if this exemption can be used for all vessels, or only for vessels in certain categories. *Equinor* 4. Consider performing a formal quantitative or qualitative risk assessment of an offshore ship-to ship transfer operation. Include personnel with experience in ship to ship. *Equinor*

Concept 2

Criteria	Conclusions from WS participants
Advantages	It may be an advantage to not be connected to another vessel by use of hose. With deck tanks you also save the time for filling on bulk tanks. Side-by side transfer of deck tanks are standard procedure (for other goods). Possible for dispersants? Can be dedicated "transport-vessel" with offshore crane. Alternative approach is to alternate systems in a cycle (operation/reload).
Disadvantages	Dispersion liquid is not stored on large deck tanks, the units have small quanta. Since PSV may have issues preventing it using the crane for transfer, one of the vessels involved in the ship to ship must have a crane fit for this purpose. May be a construction vessel or other type of vessel transferring the deck tanksto the PSV.
Costs	*Nothing raised in workshop*
Emergency preparedness effect	*Nothing raised in workshop*
Operability	More complicated with hose from other ship than to move deck tanks between vessels Assumed strict weather criteria and sight before dispersion strategy in an oil spill is decided. Multiple factors will decide 4-5 m max wave height (or lower). Deck tanks must be lifted via rig if vessels do not have approved cranes. Increases operations time. Not robust solution to go via rig. The operation may be more challenging since the deck tanks are more exposed to the elements
Performance requirements	Transport tanks can be delivered with heating systems (avoid freezing)
Continuity in dispersion operation	*Nothing raised in workshop*

Scaling possibilities	*Nothing raised in workshop*
Safety (Personnel/Environment/Assets)	Vessel and container movements
Action	1. Can deck tanks be used directly to supply the dispersant system if the vessel is equipped with dispersant system? Or does it have to go by vessel internal dispersant tank. *Feedback from Øyvind Skåra in DNV 01.06.2022: Should not be a problem to use deck tanks* 2. Limitations in certificates for volumes of chemicals in deck tanks on deck?. *Feedback from Øyvind Skåra in DNV 01.06.2022: Still 800m3 allowable chemicals onboard.* 3. NOFO currently not "rigged" for continues dispersant operation. Needs to be lifted to higher level in NOFO. Action: Equinor

Concept 3

Criteria	Conclusions from WS participants
Advantages	From an emergency preparedness capacity view, it may be wise to increase the capacity for dispersion liquid in bulk tanks for dedicated offshore vessels (e.g 500-600 m3). You then provide dispersion liquid closer to the area of application and save transit time. Dispersion liquid in tanks may be durable many years if stored in a proper way. If some vessels on the shelf have higher volumes of dispersion liquid onboard, it may increase the emergency preparedness for the whole Norwegian continental shelf. Benefit as you prolong dispersion operation/cycle if you have available 6-800 m3 on board. Use of special product-tanks. Normally these are interconnected, but use must be checked with owner. An option is to have 50-100m3 as "tier 1" capacity onboard, but with capability to reload with higher

	volume ("tier 2" capacity) for prolonged dispersion operations (for instance blow-out). On a typical oil and gas field, there is only 2-3 vessels available. Should 1 of these be dedicated for having a high capacity in bulk tanks?
Disadvantages	NOFO: Reload of 6-800 m3 will take up to a week with today's equipment. To be an effective alternative, dedicated vessels would have to be rebuilt (piping, pumps, valves) to avoid many days at base for loading dispersion liquid due to low rates and capacities on pumps, valves and piping system.
Costs	60 kr/l for dispersion liquid. Unknown scope and cost for vessel rebuilding.
Emergency preparedness effect	Several vessels with increased bulk tank capacity will have higher efficiency than one/few vessels with high volume. You may look at having one vessel in Halten, Tampen and one further south with higher bulk capacity. By that you would strengthen the emergency preparedness on the whole Norwegian Continental Shelf.
Operability	Important to have full tanks/nitrogen "carpet" to avoid air contact. Affects lifespan for chemicals.
Performance requirements	Consider to combine Ship to ship transfer capability as well as application from vessel with higher volumes of dispersion liquid onboard.
Continuity in dispersion operation	Increased due to higher volumes in field.
Scaling possibilities	Can be scaled to include all parts of Norwegian Continental Shelf.
Safety (Personnel/Environment/Assets)	No arguments from workshop
Action	1. Increase of bulk capacity in NOFO fleet would need to be lifted to a higher administrative level in Equinor and NOFO for decision. Today the NOFO standard

	specifies that a vessel should have onboard 100m3 dispersion liquid. *Action: Equinor* 2. A quantitative assessment of the operational cycle for a vessel dispersion operation should be carried out. • A graphical presentation of result. How many vessels do we need? How much dispersion liquid would that mean? Quantification. • Volumes and loading time with todays equipment vs a future solution with dedicated vessels and dedicated piping, pumps • Consider if concept shall cover SSDI, topside/surface dispersion or both? • Analyse how many vessels that will need to be ready for higher volumes in bulk to give an increased emergency preparedness effect in the Barents Sea. • How many vessels/systems will operate/disperse in parallel? • Should one have several dispersion teams of vessels together? More robust if several vessels are involved in dispersion • What can be done to take away bottlenecks for vessel loading operations. What is required to reduce filling time? • Sailing time from offshore to base • Number of hours with ship to ship operation vs sail to offshore base for refilling *Action: Equinor* 3. Consider combining Ship to ship transfer capability as well as application from vessel with higher volumes of dispersion liquid onboard. *Action: Equinor* 4. Decide where higher volumes of dispersion should be stored to allow for higher volumes on vessels. At

	offshore bases? In other areas of the world as today? Problem with parallel import? *Action: Equinor*

Concept 4

Criteria	Conclusions from WS participants
Advantages	Takes less time to load onboard containers than loading bulk tanks with present capacity on vessels and offshore base. Flexible solution. May transfer dispersion liquid from deck tanks to vessel own bulk tanks during transit, connect deck tanks to vessels own dispersion booms, if fitted or transfer deck tanks to other vessels offshore via ship to ship operation. Enables higher volumes onboard as you may have dispersion liquid in bulk tanks and have deck tanks in addition.
Disadvantages	Need many containers to get high volumes with present solution. Storage area need at base with many “small” containers
Costs	Relatively low (for each vessel) Unknown costs for NOFO, offshore base. Should aim for good mobilizable solutions (dispersion booms, new solutions for vessel dispersion, to keep costs down. If vessels need to be rebuilt it a more expensive solution.
Emergency preparedness effect	If deck tanks are connected to vessels own dispersion booms, it is considered an effective solution and increases the vessels dispersion capability Pumping from deck tanks to own bulk tanks, may take long time.

Operability	At offshorebase – Good operability Loading from deck tanks to vessel own bulk tanks – Slow pumping rates Ship-to-ship transfer of deck tanks offshore. Weather dependent.
Performance requirements	No arguments from workshop
Continuity in dispersion operation	Considered to be good. Enables higher volumes onboard as you may have dispersion liquid in bulk tanks and have deck tanks in addition.
Scaling possibilities	Good scaling potential
Safety (Personnel/Environment/Assets)	Assumed lower risk for this concept than ship to ship operations.
Action	1. DNV: Check requirements/regulations for combining external tanks /pipes with internal tanks. • Application process to NMA? Deck space needed? • examine what kind of standard-transportation tanks that should be used *Feedback from Øyvind Skåra in DNV 01.06.2022:* *IMDG tanks on deck are allowed to be used. They are also allowed to be connected to vessel's own piping system.* 2. Proposal from Master of T. Pollux in workshop. Build a dispersion system that is mobilizable. 5 containers on a row with dispersion liquid connected to a branching system to dispersion booms. This will increase the dispersion capacity immediately without having to load liquid to bulk tanks. *Action: Equinor*

Concept 5

Criteria	Conclusions from WS participants
Advantages	Proximity of dispersion liquid to offshore fields increases efficiency. Takes down waiting time for dispersion liquid stored elsewhere in the world
Disadvantages	At present dispersion liquid is stored several places in the world. During an offshore oil spill operation, the dispersion liquid will come in pieces from different locations. Costs
Costs	Will increase costs. Purchasing of higher volumes, storing of higher volumes, costs for modifications at offshore base.
Emergency preparedness effect	Proximity of dispersion liquid to offshore fields increases efficiency. Today dispersion liquid has to be collected where it is before it can be transferred to the oil spill operation
Operability	Operability would be good if more liquid is stored at offshore bases
Performance requirements	No arguments from workshop
Continuity in dispersion operation	Proximity increases continuity
Scaling possibilities	Several bases on the Norwegian Continentinal Shelf could be made ready for having stored more dispersion liquid
Safety (Personnel/Environment/Assets)	No arguments from workshop
Action	1. High level decision. • Capacity on bases. Today standard about 50m3 at bases. What is the necessary quantum that should be stored at bases in Norway. Where should they be stored?

	• Perform analysis if a higher stock should be placed in Norway • Operation cycle calculations should be performed • Strategy for dispersion. Subsea, from air, vessels. All elements should be covered before deciding increase of stock *Action: Equinor*

8 APPENDIX 2 - WORKSHOP PRESENTATION

9 REFERENCES

/1/ Utredninger for Johan Castberg 2020 –Kjemisk dispergering, responstid for full barriere på åpent hav og mellomlagring av oljeemulsjon. Equinor 18.01.2021.

/2/ Miljørisiko- (MRA) og Oljevernberedskapsanalyse (BA) for Wisting-feltet i Barentshavet. DNV 2022-01-31

/3/ Guide for transfer operations between OR vessels and tankers. NOFO 2019

/4/ NOFO standard 2021 krav til OR-fartøy på Norsk sokkel

About DNV

DNV is the independent expert in risk management and assurance, operating in more than 100 countries. Through its broad experience and deep expertise DNV advances safety and sustainable performance, sets industry benchmarks, and inspires and invents solutions.

Whether assessing a new ship design, optimizing the performance of a wind farm, analyzing sensor data from a gas pipeline or certifying a food company's supply chain, DNV enables its customers and their stakeholders to make critical decisions with confidence.

Driven by its purpose, to safeguard life, property, and the environment, DNV helps tackle the challenges and global transformations facing its customers and the world today and is a trusted voice for many of the world's most successful and forward-thinking companies.

WHEN TRUST MATTERS

Workshop – Evaluation of vessel dispersion concepts in the Barents Sea

26. April 2022

DNV Maritime Advisory

Agenda

Time	Topic	Presenter
09.00	Welcome and introduction of participants, agenda, workshop “rules”, etc.	DNV
09.15 - 0930	Workshop goals and concepts	DNV
09.30-10.30	Presentation of vessel dispersion in the Barents Sea ▪ Equinor 15 min (Experiences vessel dispersion modelling) ▪ Aker BP 15 min (Project findings dispersion) ▪ NOFO 15 min (Dispersion preparedness Barents Sea)	As agreed
10.30-10.45	Break	All
10.45-11.15	Evaluation of concept 1 Ship to ship transfer offshore – Bulk transfer	All
11.15-11.45	Evaluation of concept 2 – Ship to ship transfer offshore – Deck tank transfer	All
11.45-12.30	Lunch	All
12.30-13.00	Evaluation of concept 3/4 - Enable vessels to carry higher volumes of dispersion liquid in bulk or in deck tanks	
13.00-13.30	Evaluation of concept 5 – Enable supply bases to hold higher volumes of dispersion liquid	All
14.00-14.15	Break	All
14.15-15.30	Further discussion in relevant concepts against criteria's	All
15.30-15.45	Summon up and way forward	DNV

Participants

Welcome!

Please inform your:

- Name, position and company

Workshop “rules”

- **Care!** The content of the workshop will come from you.
- **Share!** Share from our own knowledge and experience.
- **Dare!** Challenge how things are done, dare to ask questions.

- **Online rules**
  - Video on
  - Mute your microphone when not speaking
  - Detailed problem solving is to be done outside this workshop
  - Stay focused on topic at hand

WE CARE

WE DARE

WE SHARE

DNV

Workshop objectives

Qualitative assessment of five (5) identified concepts for vessel dispersion operations in the Barents Sea

Advantages/disadvantages in each concept to be discussed against specified criteria`s

Results from workshop will be used as input for decision support to strengthen vessel dispersion capability in the Barents Sea

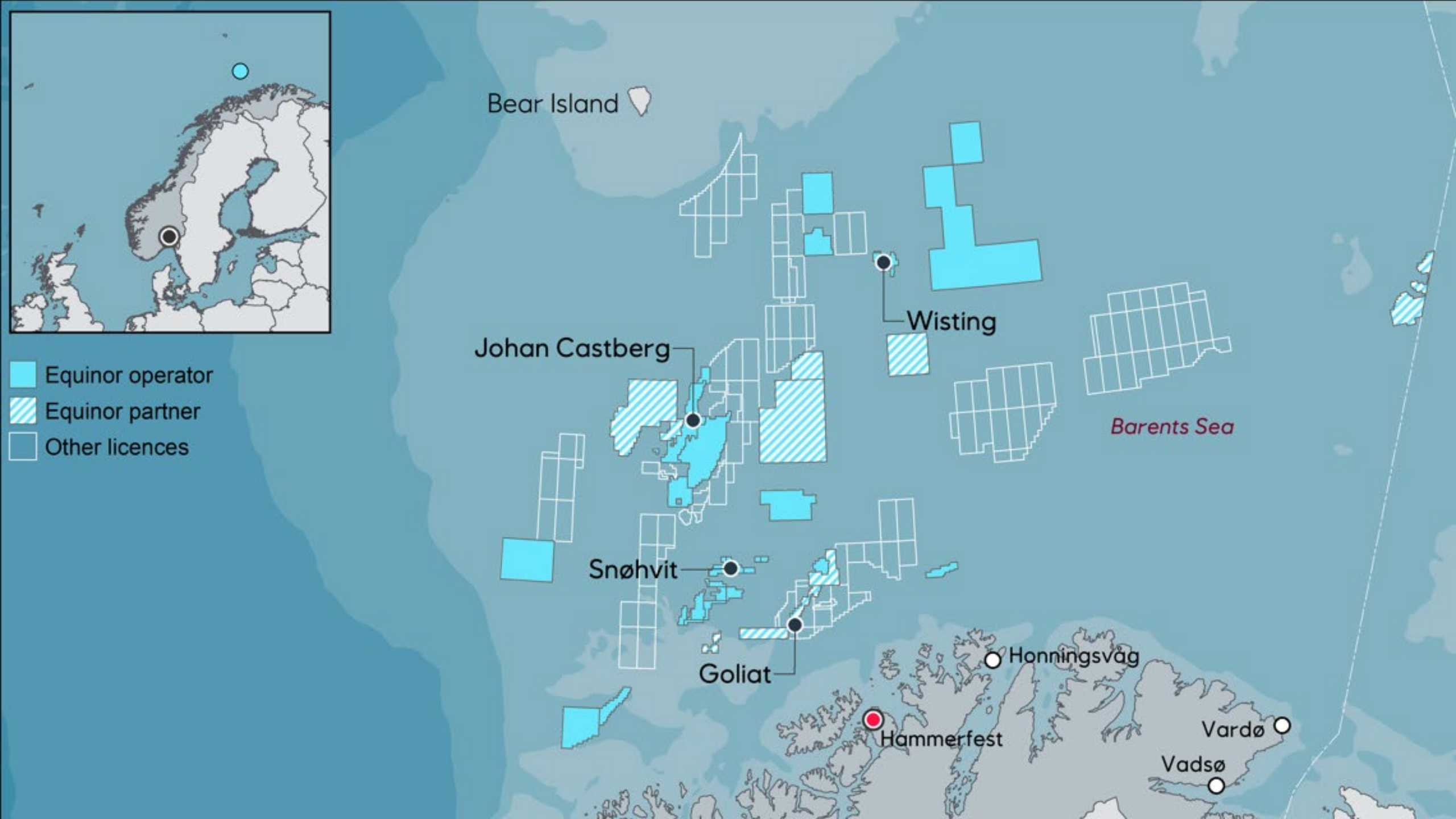
Why offshore transfer of dispersion liquid?

When performing calculations of emergency preparedness effect, chemical dispersion is not at the same level as mechanical collection of oil spill. This is mainly caused by the fact that the vessels with todays solution, have to sail back to supply base to refill dispersion tanks.

Simulations show that the best solution to reduce refilling time and increase the effectiveness to combat emulsion, is to have more dispersion liquid in bulk tanks on the field and transfer the liquid between vessels as a Ship to Ship operation.

As of today, there exist no procedures in NOFO for this operation

From report Johan Castberg 2020 (Equinor)


Bear Island
Wisting
Johan Castberg
Barents Sea
Snøhvit
Goliat
Honningsvåg
Hammerfest
Vardø
Vadsø
Equinor operator
Equinor partner
Other licences

Concepts that will be evaluated in workshop

- Concept 1: Ship to ship transfer offshore of dispersion liquid – Bulk tanks
- Concept 2: Ship to ship transfer offshore of dispersion liquid - Deck tanks
- Concept 3: Enable vessels to carry higher volumes of dispersion liquid in bulk
- Concept 4: Enable vessels to carry higher volumes of dispersion liquid in deck tanks
- Concept 5: Enable supply bases to hold higher volumes of dispersion liquid at site
  - **Store ISO tanks with dispersion liquid to place on vessel deck. (Total volume to be discussed).**
  - **Transfer of dispersion liquid from base to vessel bulk tanks**

Workshop log

ID	Expected advantages of concept	Expected disadvantages of concept	Costs	Emergency preparedness effect	Operability	Performance requirements	Continuity in dispersion operation	Scaling possibilities	Safety (P, E, A)	Action	Responsible	Due date
Concept 1: Ship to ship transfer offshore of dispersion liquid – Bulk tanks												
			Positive/negative	Positive/negative	Comments from WS participants	Get feedback from WS participants Winterisation of equipment? Number of hours for STS operation?	To what degree you are able to utilize possibilty for vessel dispersion (Positive/negative)	(Positive/negative) Possible to make universal solution? How easy is the solution to implement for other vessels, bases, sea areas?	(Positive/negative)			
Concept 2: Ship to ship transfer offshore of dispersion liquid – Deck tanks												
Concept 3: Enable vessels to carry higher volumes of dispersion liquid in bulk												

Presentations

- Equinor
- Aker BP
- NOFO

Concept 1 - Ship to ship transfer offshore of dispersion liquid – Bulk tanks

STS transfer of oil emulsion. Ref. NOFO Guide for transfer operations between OR vessels and tankers (2019)

<u>Transfer of dispersion liquid offshore between two offshore vessels. Bulk/bulk tank.</u>

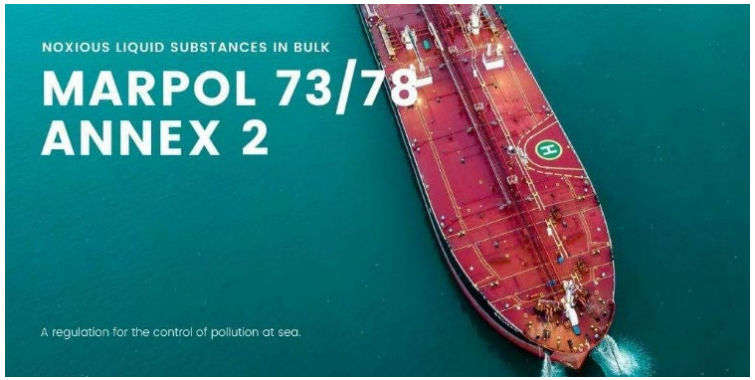
1. Vessels alongside for hose transfer
2. Hose transfer. Vessel crane/throwing line, other means?
3. Transfer of dispersion liquid
4. Disconnecting and start/continue dispersion operation

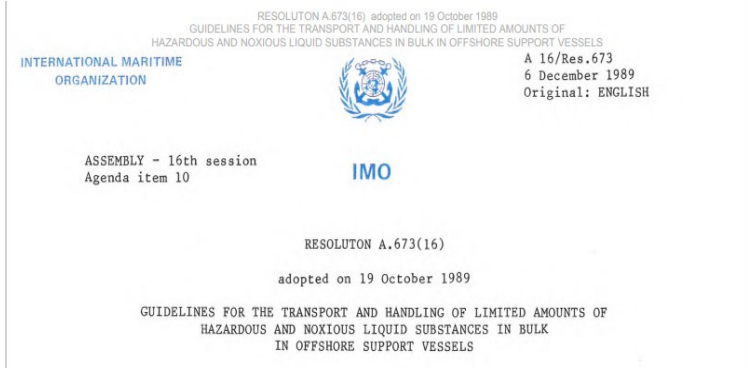
Concept 2 - Ship to ship transfer offshore of dispersion liquid - Deck tanks

Transfer of dispersion liquid offshore between two offshore vessels. Transfer of deck tanks.

1. Vessels alongside for tank transfer
2. One vessel transfer deck tank containing dispersion liquid to the other via vessel crane
3. Receiving vessel either pumps dispersion liquid to own bulk tanks or have system for directly connecting dispersion booms to deck tanks

Concept 3 - Enable vessels to carry higher volumes of dispersion liquid in bulk




RESOLUTON A.673(16) adopted on 19 October 1989
GUIDELINES FOR THE TRANSPORT AND HANDLING OF LIMITED AMOUNTS OF
HAZARDOUS AND NOXIOUS LIQUID SUBSTANCES IN BULK IN OFFSHORE SUPPORT VESSELS

INTERNATIONAL MARITIME ORGANIZATION

A 16/Res.673
6 December 1989
Original: ENGLISH

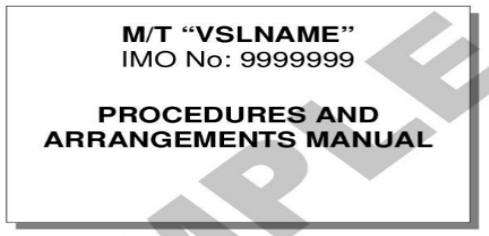
ASSEMBLY - 16th session
Agenda item 10

IMO

RESOLUTON A.673(16)

adopted on 19 October 1989

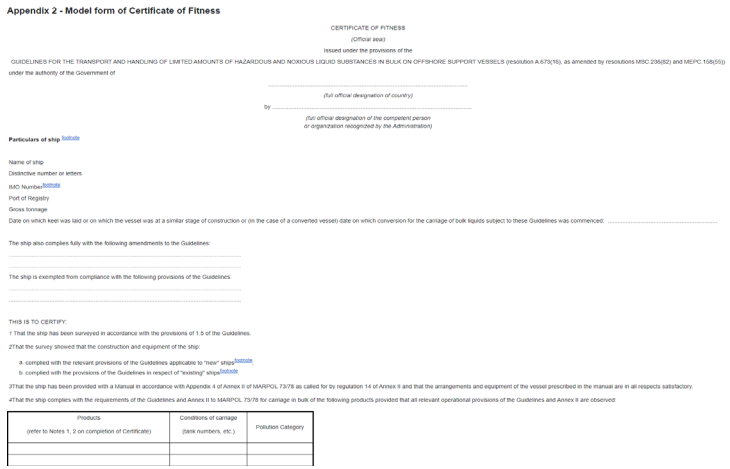
GUIDELINES FOR THE TRANSPORT AND HANDLING OF LIMITED AMOUNTS OF
HAZARDOUS AND NOXIOUS LIQUID SUBSTANCES IN BULK
IN OFFSHORE SUPPORT VESSELS



SAMPLE

To meet the requirements of

Annex II of MAPROL 73/78
as amended by IMO Res. MEPC.118(52)


Appendix 2 - Model form of Certificate of Fitness

CERTIFICATE OF FITNESS

(Official seal)

issued under the provisions of the

GUIDELINES FOR THE TRANSPORT AND HANDLING OF LIMITED AMOUNTS OF HAZARDOUS AND NOXIOUS LIQUID SUBSTANCES IN BULK ON OFFSHORE SUPPORT VESSELS (resolution A.673(16), as amended by resolutions MSC.235(82) and MEPC.158(55))

under the authority of the Government of

(full official designation of country)

by

(full official designation of the competent person or organization recognized by the Administration)

Particulars of ship footnote

Name of ship

Distinctive number or letters

IMO Number footnote

Port of Registry

Gross tonnage

Date on which keel was laid or on which the vessel was at a similar stage of construction or (in the case of a converted vessel) date on which conversion for the carriage of bulk liquids subject to these Guidelines was commenced:

The ship also complies fully with the following amendments to the Guidelines:

The ship is exempted from compliance with the following provisions of the Guidelines:

THIS IS TO CERTIFY:

1 That the ship has been surveyed in accordance with the provisions of 1.5 of the Guidelines.

2 That the survey showed that the construction and equipment of the ship:

a. complied with the relevant provisions of the Guidelines applicable to "new" ships footnote

b. complied with the provisions of the Guidelines in respect of "existing" ships footnote

3 That the ship has been provided with a Manual in accordance with Appendix 4 of Annex II of MARPOL 73/78 as called for by regulation 14 of Annex II and that the arrangements and equipment of the vessel prescribed in the manual are in all respects satisfactory.

4 That the ship complies with the requirements of the Guidelines and Annex II to MARPOL 73/78 for carriage in bulk of the following products provided that all relevant operational provisions of the Guidelines and Annex II are observed:

Products (refer to Notes 1, 2 on completion of Certificate)	Conditions of carriage (tank numbers, etc.)	Pollution Category

Bulk tanks:

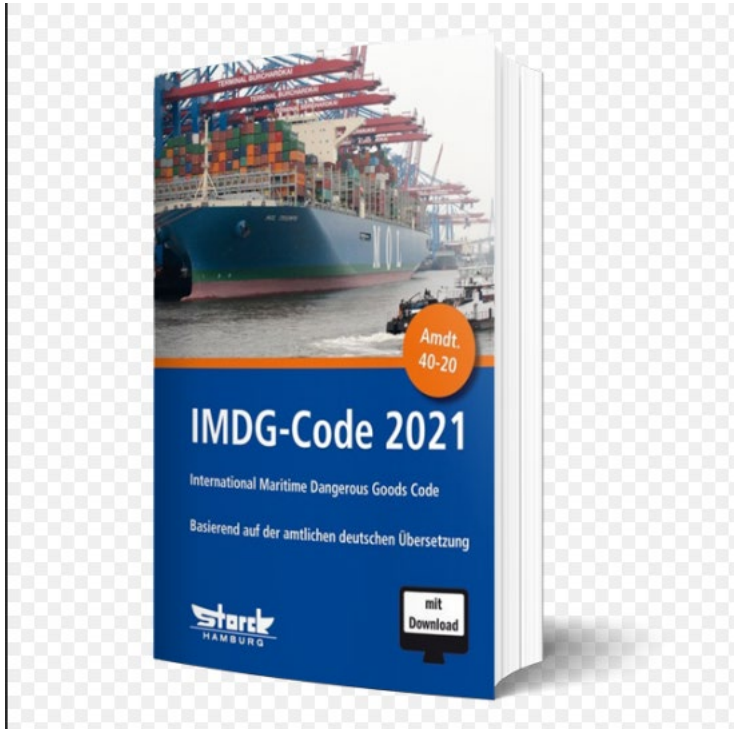
Dedicate vessels to apply for up to 800 m3 of dispersion liquid in bulk tanks to Norwegian Maritime Authority

The vessels do not have to hold this volume in bulk at all times, but vessel certificates to be ready for this.

The vessels will need to perform tank wash and fill up dispersion liquid at offshore base before ready for dispersion operation.

Other vessels may refill dispersion liquid offshore via hose and STS operation

Concept 4 - Enable vessels to carry higher volumes of dispersion liquid in deck tanks



ISO tanks with dispersion liquid on aft deck

- Tanks to be loaded at offshore supply base on aft deck
- Application process to NMA?
- Deck space needed?
- Options:
  - Transfer dispersion liquid to vessel own bulk tanks during transit
  - Connect deck tanks to vessels own dispersion booms
  - Transfer ISO tanks to other vessels offshore via STS operation

Concept 5 - Enable supply bases to hold higher volumes of dispersion liquid

https://norseagroup.com/en/bases/norsea-polarbase

If vessels are equipped for higher volumes of dispersion liquid onboard, the amount of dispersion liquid should be higher at the bases to gain a higher emergency preparedness effect.

The quay at Hammerfest base have sufficient space for several loading operation simultaneously. (Source Johan Castberg utredning 2020)

1. **Discuss possibilities to store high-capacity ISO tanks with dispersion liquid to place on vessel deck.**
   - Vessel transfer dispersion liquid to dedicated bulk tank(s) during transit or have system connecting tanks directly to dispersion booms.
   - Total volume needed at base?

2. Transfer of dispersion liquid from base to bulk tanks

https://www.nofo.no/planverk/ressurser-og-kapasiteter/nofos-egne-ressurser/disepergeringsvaske/

Safety, Risk & Reliability

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