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• Spills

Collision and transboundary pollution in Johore Strait (*APL Denver*, Malaysia)

On 3rd January 2017, in the eastern part of the Johore Strait (off the Pasir Gudang Port, State of Johor, Eastern Malaysia), the container ship *APL Denver* (Gibraltar), at anchor, was struck by the Singapore-registered container ship *Wan Hai 301*, suffering engine failure at the time. One of the starboard tanks of the *APL Denver* was damaged and 300 m^3 of bunker fuel leaked out on the boundary between Singapore and Malaysian waters.

Immediately, the Johor Port Authority deployed 4 spill response vessels, initially to lay containment booms around the *APL DENVER*. Given that the majority of the slicks were drifting towards Singapore, the Singapore Marine Port Authority (MPA) was notified of the incident and took over the coordination of offshore response, mobilising 8 vessels, some of which were equipped with dispersant spraying equipment.

While little detail of response operations is provided in our information sources, MPA reported a medium-sized spill and stated that traffic remained unaffected. However, certain sites were at risk of contamination: (i) the shores of the island of Pulau Ubin where protection equipment (floating containment booms and sorbent booms) was deployed at the edge of the mangroves and mudflats, and (ii) the beaches of north-east Singapore (in particular Changi, Punggol and Pasir Ris). To protect these sites, containment and recovery equipment (such as Current Busters and skimmers) was deployed, although the quantity of oil recovered is not disclosed.

Locally, floating accumulations in harbour areas were recovered manually using sorbents from small workboats.

Shoreline clean-up operations were organised to manually recover the oil that washed up on sandy beaches, along sections a few hundred metres long, in particular around Changi.

The slicks drifting in coastal areas contaminated fishing gear (nets) and several fish farms (which had been issued with sorbents by the authorities and advised to use them to protect their fish stock). According to the Agri-Food and Veterinary Authority (AVA), a dozen farms were affected by the oil, and mortalities were reported in at least 2 of them. AVA decided to implement monitoring of fish flesh contamination and suspended the sale of products from affected facilities (for a 2-month period) as a preventive measure.

Compensation claims were filed by fishermen, with support from AVA, highlighting, according to various press sources, a need for detailed information on the claims process (documentation, evidence, etc.) Meanwhile in Malaysia, the shipowners were ordered to pay the State government 1 million Malaysian Ringgits (approximately €200 k) each to cover the cost of clean-up.

Fuel oil spill in port waters (unspecified oil tanker, Dilovası, Turkey)

A leak, of unspecified type and cause, occurred on 12th January 2017 from an oil tanker docked in the port of Dilovası (Kocaeli Province, Gulf of Izmit, Turkey), resulting in the release of around 100 m^3 of bunker fuel into the port waters.

The response on the water was implemented by the Kocaeli Metropolitan Municipality, in particular by laying containment booms, while a provincial crisis center was activated by the Kocaeli Governor's Office. Although details of the spill response are not provided in our information sources, we know that 350 operators were mobilised to conduct onshore clean-up operations and containment and recovery on the water. TÜBITAK, the Scientific and Technological Research Council of Turkey, was in charge of oil sampling and analysis, and was able to confirm the source of the spill.

Sinking of a cargo vessel carrying magnesium oxide (*Fluvius Tamar*, Channel, United Kingdom)

On 14th January at around 1 am, the cargo ship *Fluvius Tamar* (Barbados-flagged, 90 m long), which had suffered a leak jeopardising its stability, sank in the Channel in British waters, some 30 nautical miles (approximately 55 km) from the coast of England and 40 nautical miles (approximately 70 km) north of Dunkirk, France). The 7 crew members were safely evacuated before the vessel sank to a depth of about 40 metres with its cargo of 3,800 tonnes of magnesium oxide onboard. The contents of its tanks, estimated at around 80 m^3 of marine diesel, leaked out.

The *Fluvius Tamar* was travelling from Eemshaven (Netherlands) to San Sebastian (Spain). The vessel had been inspected in Hamburg in July 2016 and no deficiencies were found. The causes of the incident are not known in our information sources. The French[1], Belgian and Dutch authorities were notified of the incident and the evolution of the situation by the UK authorities.

In the early afternoon, sheen was observed at the surface by a British vessel: these patches of sheen, around 1 km long, did not appear for long, and were naturally dispersed due to metocean conditions (rough sea). Aerial surveys organised by the British authorities quickly reported that no significant or persistent oil slicks remained, an observation that was confirmed onsite by the British buoy-laying vessel *Patricia*. Both British and French drift forecast modelling indicated that there was no risk of oil reaching the coast.

Once the risk of oil pollution had been eliminated, the next step was to assess the risks related to the 3,800 tonnes of magnesium oxide. In France, the Maritime Operations Centre (which comes under the auspices of the Maritime Prefecture for the Channel and North Sea) called upon the expertise of Cedre and the French Navy laboratory, Lasem. The information relating to the product suggests that it should not have acute toxic or chronic effects, and should have a low environmental risk. Upon contact with water, the substance is liable to form magnesium hydroxide, $Mg(OH)_2$, an inorganic, non-toxic product of hydration.

Shoreline pollution following tanker vessel collision (*Dawn Kanchipuram*, Chennai, India)

On 28th January 2017 at around 4 am, a few kilometres off the coast of South India, a collision occurred between the *Dawn Kanchipuram*, which was approaching the Kamarajar port in Ennore (neighbourhood in the north of Chennai, capital of the state of Tamil Nadu), and the outbound LPG carrier the *BW Maple Galaxy*. The damage to the oil tanker's fuel tanks immediately caused a spill in the coastal waters. Estimations of the volume of fuel oil spilt were revised numerous times throughout the incident. The crew reported an initial spill of 2 tonnes, while the Indian Coast Guard (ICG) initially estimated a 20-tonne spill, a figure that was gradually increased to reach around 100 tonnes. Meanwhile, the Indian Directorate General of Shipping announced that (i) the tanks contained a total of 584 tonnes at the time of the spill and (ii) some 196 tonnes had been released (estimation 50 days after the incident)[2]. According to ITOPF experts, sent on site during the response, between 250 and 350 tonnes of IFO 180 had been spilt. This volume was confirmed by DG Shipping in November 2017.

The port authorities implemented the initial emergency response measures, immediately deploying booms around the ships involved in the collision to stop the spill from spreading. Around 2 hours later, they notified the ICG and DG Shipping, reporting at this point pollution in the form of sheen that was said to be dissipating naturally. The first surveys were conducted in the port by Tamil Nadu Pollution Control Board (TNPCB) and only one area of oil accumulation (where samples were taken to identify the source) was reported, where the ICG was using skimmers and sorbents to recover the oil. However, it soon became evident that the situation had been underestimated: slicks and patches drifting in the coastal area resulted in large amounts of fuel oil washing up on the shoreline, starting late afternoon, in the port and its infrastructures, as well as neighbouring parts of the coastline, stretching over several kilometres by the following day. While the ICG initially announced (see above) an estimated spill of at least 20 tonnes, the port authority refuted the link with the collision. This point of view was soon proven invalid, explained by the port authority based on (i) the fact that it was dark at the time of the incident and when deploying the booms around the vessels (meaning that no significant slicks could be seen) and (ii) an incorrect appraisal of damages issued by the crew[3].

At the site of the collision, an assessment of the *Dawn Kanchipuram*'s stability and the damage sustained to the structure was carried out (including via the mobilisation of teams of divers in the Port of Kamarajar) jointly by the port authorities, and experts from a classification society and from the DG Shipping, after which the vessel was towed to port for lightering and repairs.

Public agencies were mobilised to attempt to (i) model the trajectory of the oil still at sea (role of the

[1] Via the Marine Rescue Coordination Centre (CROSS) in Jobourg, the marine pollution reference centre for the Channel and North Sea.

[2] Estimation, pending confirmation at the time of writing, made at the end of lightering operations which were postponed due to insufficient on-site storage capacities.

[3] According to the port authority, the crew informed them of a single damaged tank and a leak of a maximum of 1 to 2 tonnes of fuel. Later, the ICG also indicated that a lack of communication by the crew of the *Dawn Kanchipuram* on the volumes potentially spilt had penalised the mobilisation and deployment of sufficient equipment.

Indian National Centre for Ocean Information Services -INCOIS) and (ii) assess the risks of damage to the inshore and shoreline environment. In relation to this second point, the Integrated Coastal and Marine Area Management (ICMAM) Project Directorate launched shoreline surveys, with sampling to monitor the shoreline along a 30-km stretch to either side of the incident location, the area potentially at risk according to modelling results. Modelling suggested that the floating slicks would spread parallel to (and not far from) the coastline, with oil washing up on the shore within a few hours, a forecast which proved true.

Two days after the incident, clean-up operations were organised locally under the coordination of the ICG and TNPCB, using pumping equipment as well as manual methods (e.g. scrapers, scoops, buckets, etc.) apparently suited to the characteristics of the relatively viscous pollutant and the many oiled substrates (boulders/cracks). Clean-up operations were initially carried out by a limited number of local volunteers (a few dozen fishermen, each paid 500 rupees/day, i.e. approximately €7), but as the situation unfolded, resource mobilisation escalated, with additional personnel (some 2,600 participants in early February, increasing to more than 5,700 by mid-February)[4] and equipment for containment, pumping (e.g. pumps, super suckers[5], etc.), skimming, as well as sorbents. At sea, dispersants were applied to certain slicks by helicopter-borne spraying arms.

*02/02/2017: Manually cleaning up slicks of fuel oil washed up on the shoreline (**left**); storing liquid waste in drums on the backshore (**right**) (Source: PTI)*

30/01/2017: Pumping fuel oil slicks near Ennore (Source: PTI)

A dozen days after the incident, more than 200 tonnes of solid waste had been collected and around 100 m^3 of emulsified fuel oil had been pumped. It was at this point that initial clean-up operations, if not the entire clean-up process, were said to be complete. However various press sources reported pollution at several sites after this date.

09/02/2017: Responders (ICG and volunteers) mooring booms to prevent the oil from spreading (Source: B. J. Ramalingam, RR) (**left**); 03/02/17: *Applying chemical dispersants by helicopter (Vikoma TC3 dispersant system) (Source: PTI) (**right**)*

At the request of the Indian Ministry of Petroleum and Natural Gas, it was decided that a specific site for oil treatment by bioremediation would be set up. This involved the creation, close to the port, of a pit 200 m long by 15 m wide, and 30 cm deep. The Indian Oil's R&D Centre was tasked with selecting the treatment process. It appears that the *Oilivorous-S* process, which involves spreading hydrocarbonoclastic bacteria, developed by the Indian company TERI (The Energy and Resources Institute), was the selected technique.

In terms of environmental impacts, various visual observations of crustaceans (crabs) washed up on the shores and oiled turtles were reported from the very first days of the incident; the Integrated Coastal and Marine Area Management Project Directorate (ICMAMPD) was tasked with initiating monitoring of water quality as well as of various biological components of the coastal environment (e.g. plankton), the results and conclusions of which have not been brought to our attention.

From the outset, the response to this incident was hindered due to confusion, notably created by an incorrect assessment of the situation, which increased the response time, restricted the possible operations and techniques (e.g. containment; pumping limited by the emulsification of the oil, etc.)

[4] Responders from various public bodies, including ICG, Tamil Nadu Coastal Security Police, TNPCB, the fire brigade, Chennai Port Trust, etc., and volunteers from universities and NGOs.

[5] High capacity vacuum trucks

and affected their complexity and duration. In this case, various local associations criticised, via the media, the minimisation of the pollution by the port authorities (if not the lack of transparency in the information disclosed). These accusations were backed by the environmental authority of the state of Tamil Nadu, which emphasised how the involvement of the local ICG was thus delayed and less effective (time window exceeded for containing the slicks close to the source of the spill, or even to protect sensitive shores).

This controversy escalated when it was revealed that the ICG, also criticised for a response deemed too slow, had revised its National Oil Spill Disaster Contingency Plan (NOS-DCP) in 2015, in order to "reflect current international norms and best practices", for instance through the development and integration of decision support systems (Online Oil Spill Advisory[6] developed by INCOIS) intended to optimise response times and choices.

According to a report by the Environment Ministry's southern zonal office, the port authority also failed to meet its obligations (with the mention of possible sanctions against it) due, in addition to minimising the extent of the pollution and having an excessively long reaction time (believing that the accident had occurred outside its jurisdiction), to containment measures which were considered ineffective.

At the very least, the available information suggests a lack of clarity in terms of the responsibilities for operations (e.g. supervision, technical implementation, etc.), and inadequate response preparedness. These elements appear to further complicate the situation due to insufficient control of the spill and the fact that many sensitive sites were affected.

The state announced its intention to seek compensation for clean-up costs and damages from Darya Ship Management Private Limited (owner of the tanker).

The 1992 Fund was informed of the pollution from the *Dawn Kanchipuram* and indicated, in its Record of decisions of the April 2017 sessions, that "it appeared from the information provided by the insurer, that the vessel was not carrying persistent oil and that the 1992 Civil Liability and Fund Conventions did not apply to the incident". This point of view was contested by DG Shipping, based on the reports of emulsified fuel oil washing up on the shoreline, and discussions between interested parties were pursued.

In March, the owners of the *Dawn Kanchipuram* and the *BW Maple* are reported to have each paid the Port of Kamarajar the equivalent of $100,000 in compensation for clean-up costs as a result of the collision, regardless of damage and liability estimates. Eight months later, the insurer of the *Dawn Kanchipuram* announced that, at that point, it had paid 100M rupees (*₹10 crore*) to compensate for the costs incurred by the Indian public agencies involved (in particular Chennai Corporation, TNPCB and ICG). Other claims are still pending: (i) by the port authorities and by the provincial government in connection with, respectively, boom deployment and the reimbursement of compensation paid to volunteers; (ii) by local 'fisherfolk'.

Finally, in early November 2017, BG Shipping concluded in an investigation report that the incident was caused by human errors including, in particular, pilot fatigue and negligence on behalf of the bridge teams on both the vessels.

Tank rupture and transboundary coastal pollution (Petrotrin refinery, Trinidad and Tobago)

On 23rd April 2017, at a refinery operated by Petrotrin near Pointe-à-Pierre (Trinidad and Tobago), a ruptured tank resulted in a spill of IFO 380. This spill, initially estimated at 3 m^3 then later revised to just under 50 m^3, affected the estuary of the Guaracara River before flowing into the waters of the Gulf of Paria.

According to Petrotrin, reconnaissance surveys (from aircraft and vessels) showed that the oil was drifting in a west/north-westerly direction, apparently ruling out the risk of it reaching the peninsula's coastline. The firm reportedly deployed offshore response equipment. Although little detail is provided in our information sources, these operations aimed primarily at containing and recovering floating oil, under the supervision of the Trinidad and Tobago authorities (Ministry of Energy & Energy Industries, Environmental Management Authority -EMA, Occupational Safety & Health Agency -OSH, and the Office of Disaster Preparedness & Management -ODPM).

Of the little information gleaned on the incident and its consequences, we note that Venezuela

[6] A system integrating the results of drift modelling, pollutant behaviour modelling, sensitivity atlases, etc.

reported the presence of oil in its coastal waters and on its eastern shores from around 30th April (Isla De Patos). Estimated at around 20 m^3 (300 barrels), this pollution was attributed to the incident which occurred on the Caribbean island and justified the activation of the Trinidad & Tobago/Venezuelan Bilateral Oil Spill Plan through the Republic of Trinidad and Tobago's Ministry of Foreign and Caricom Affairs.

Finally, 1 month after the incident, weathered tarballs washed up on the coasts of Bonaire, Aruba and then Curaçao and were suspected to be related to the tank rupture. We have not identified any information to confirm or disprove this hypothesis.

Mystery spills on the east coast of the United Arab Emirates (Gulf of Oman)

In spring 2017 in the Gulf of Oman, a series of at least three spills of unknown origin hit the coastline of Fujairah, Kalba and Sharjah (United Arab Emirates). All these pollution incidents were thought to be due to illegal discharges from tank rinsing operations onboard oil tankers. In particular, near Dibba Al Fujairah in mid-March, and the beaches of Kalba and Sharjah in early April then in late May, emulsified crude oil sporadically washed up on the coast, locally contaminating port infrastructures, vessel hulls (commercial and fishing vessels), fishing gear (nets, etc.), although there is no evidence (no visual observations) of damage to marine fauna.

Although the volumes of oil involved were not reported, given than these were operational discharges, the quantities were most likely relatively low. Nevertheless, due to the sensitivity of the affected coastlines (port areas, tourist beaches, etc.), clean-up operations were organised and involved various techniques ranging from manual collection to pumping by vacuum trucks, with regard to the varying levels of contamination (heterogeneous distribution of deposits).

In April, for instance, shoreline response operations in the Khor Kalba area were coordinated by the United Arab Emirates Army and the United Arab Emirates Coast Guard, as well as the Sharjah Environment and Protected Areas Authority (EPAA) and the Abu Dhabi Company for Onshore Petroleum Operations Ltd (ADCO)[7].

02/04/2017: Pumping oil from the foot of riprap in Kalba (source: *EPAA*)

While regulations do exist, providing for sanctions against those responsible for such pollution offences, the Sharjah Federal National Council expressed to the Ministry of Climate Change and Environment the need to review the enforcement processes and mechanisms, particularly for the identification of ships responsible for discharges, a difficult tast to achieve a posteriori (e.g. through backtracking) due to heavy oil tanker traffic and the complexity of the currents in this sector, close to the Strait of Hormuz.

• Response preparedness/(inter)national strategies

Belgium accedes to OPRC Convention

In April 2017, Belgium acceded to the International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC), an International Maritime Organization (IMO) treaty that sets out the response measures at national level but also in cooperation with other countries. The country also deposited the instrument of accession for the OPRC-HNS Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, 2000.

Response in the Barents Sea: Russian exercise Arctic 2017

In March 2017, the Russian state oil consortium LUKOIL and the company Gazprom Neft carried out an exercise, dubbed Arctic 2017, to enhance their joint spill response preparedness in the

7 Subsidiary of ADNOC (Abu Dhabi National Oil Company), the main national oil company of the United Arab Emirates.

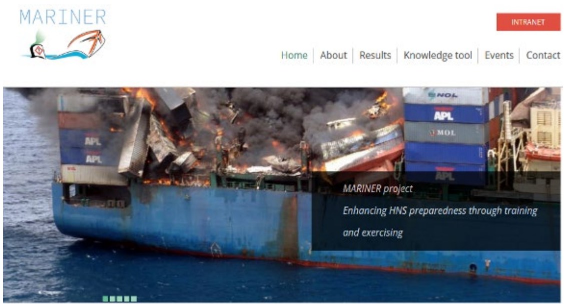
waters of the Pechora Sea (southern Barents Sea), an Arctic region that is covered with ice more than half the year round and is at risk due to its proximity with (i) the Varandey oil terminal[8], whose loading point is about 20 km from the coast, and (ii) the Prirazlomnaya platform[9]. The scenario involved a collision between an oil tanker and a supply vessel. In addition to the human and logistical resources deployed by the two oil operators, the exercise also mobilised the services of the Russian Ministry of Emergency Situations, the Federal Agency for Maritime and River Transport (Sea Rescue Service) and a maritime oil transport company (Sovkomflot). Some fifteen response systems and 2 specialised LUKOIL vessels were deployed as part of the exercise, in order to test the at-sea response and protection capacity sea on the Varandey region's coastline.

This large-scale exercise, initiated by the Russian Ministry of Natural Resources and Environment, as part of the national "Year of the Environment", is said to have demonstrated the effectiveness of the response mechanism and thereby the minimisation of environmental risks in an ecologically sensitive region.

Also in March, the 4th International Arctic Forum held in Arkhangelsk saw the signing of an agreement laying down the principles of cooperation between Rosneft and Lamor, a Finnish spill response equipment manufacturer. It is geared towards developing response equipment production sites to meet the needs of Rosneft and other interested parties in the Russian Arctic.

HNS: the European project MARINER

Funded by the European Union Civil Protection mechanism (DG ECHO), the MARINER project (Enhancing HNS preparedness through training and exercising) started on 1st January 2016 for a duration of 2 years, under the coordination of CETMAR (*Centro Tecnológico del Mar*, Spain). It involved the Spanish partners INTECMAR (*Instituto tecnológico para el control del medio mariño de Galicia*) and the University of Vigo, the Portuguese partners Action Modulers and CIIMAR (*Centro Interdisciplinar de Investigação Marinha e Ambiental*), and the English partner PHE (Public Health England), and Cedre for France.



Home page of the MARINER website

The objective of the MARINER project is to enhance preparedness to respond to HNS spills. The main actions include:

- A literature review covering the institutes and research projects that have produced accessible data on chemical spills. Some 40 projects (out of more than 100 examined) and some 40 institutes were selected, for which the public documents produced were classified by type (report, manual, scientific publication, training document, video, etc.) and field (contingency planning, response, impact, regulations, case studies, etc.). A search tool available on the project website was then developed to facilitate access to and use of more than 300 documents.
- A study of response protocols and equipment for chemical spills on land or at sea. This action took the form of meetings with a dozen response stakeholders as well as participation in various exercises. This action made it possible to collect useful information and images in particular for the preparation of training materials.
- Development of a set of training materials (presentations, interactive tools, online exercises, videos, etc.) dealing in particular with the regulatory context of chemical pollution, the transport of these products and their impacts, modelling, health aspects, protection measures and response strategies. These English-language training materials are available for download on the project website.
- Modelling of the behaviour of spilled substances and their impact on the environment. This project also resulted in the improvement of the model developed by Action Modulers which is also coupled to the CIIMAR database providing information on the environmental impact

[8] Operated by LUKOIL, mainly for the export of the crude oil produced in the Timan-Pechora Basin.
[9] First offshore oil exploitation in the Russian Arctic, operated by Gazprom.

of certain substances. These tools can be accessed via the project website.

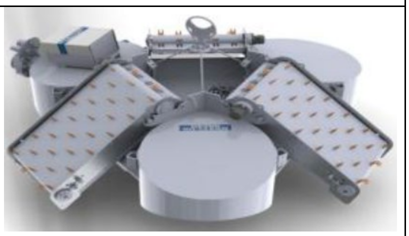
For further information:
http://mariner-project.eu/

- **Recovery at sea**

High-rate mechanical recovery of viscous substances: belt system for the Giant Octopus skimmer (DESMI)

To recover slicks of highly viscous heavy oil, the manufacturer DESMI has been marketing its BELT Skimmer for around fifteen years[10]. This mechanical skimmer's studded belt pulls the oil into the collection unit, from which it is pumped to a transfer tank with a DOP DUAL 250 pump.

Developed for use alone or in conjunction with the Terminator weir skimmer (125 m^3/h flow rate), the BELT Skimmer is now available as a modular element that can be fitted on top of the Giant Octopus, a high capacity (250 m^3/h via two DOP DUAL 250 pumps) offshore skimmer, replacing the linear oleophilic brushes usually fitted to the Giant Octopus (based on the principle of combining weirs and oleophilic modules, in this case the Terminator and the rotary brushes of the Helix).



(Source: DESMI)

Three belts can thus be fitted between each of the floats fitted to the weir to form a high capacity device designed to provide a large contact area with the slick and optimise the recovery of extremely viscous oil slicks.

For further information:
https://www.desmi.com

Skimming accessories: DESMI ZUH sleeve for floating hoses

Source: Cedre

The use of recovery devices at sea requires the necessary hoses and hydraulic circuits to be deployed in order to operate and control the various elements involved: pumps, skimmer components (brushes, discs, etc.), propulsion system for self-propelled models, etc.

To facilitate this organisation and improve floatation and protection, DESMI recently launched a zipped sleeve for floating hoses: the Zipper Umbilical Hose or ZUH. This 20- or 30-metre long sleeve is designed to accommodate commonly used diameter discharge hoses (4, 5, 6 inches) and a number of hydraulic cables, each of which is secured with fasteners along the inner skin of the sleeve.

The idea is also to facilitate the cleaning of the pipes and connectors, after unzipping the sleeve. The latter consists of a polyurethane textile, of different weights according to the models and uses, with HF welded seams.

For further information:
https://www.desmi.com

[10] This model was developed, and initially implemented, during the offshore response to the Prestige spill.

Floating Oil Recovery Unit (FORU), a high capacity skimmer for rough water

After several years of development then testing, first at Ohmsett in late 2014, then, following modifications, at the Norwegian Coastal Administration's test centre in Horten (in 2015 and 2016), the Dutch manufacturer Foru Solution BV is now marketing an offshore skimmer, with high flow rates and designed to operate in rough sea conditions, thanks in particular to its robustness, stability and selectivity, which is often lower in rough conditions in the case of weir skimmers.

The FORU (Floating Oil Recovery Unit) can be used in static and potentially in dynamic mode.

Testing the FORU prototype in the tanks of the NCA test centre (Horten, June 2016) (Source: Kystverket/NCA)

Overview of the FORU (Source: Foru Solution BV)

This unit comprises a weir, a system to regulate the flow of incoming liquids at the weir edge, and a vacuum device. According to the manufacturer, it can reach recovery rates of more than 300 m^3/hour and a recovery ratio of around 75%[11].

In addition to its apparently high performance, the device's dimensions (2.4 m high, with a 1.8 m draught) mean that it can be stored and transported in a standard 20-foot container. Its deployment reportedly requires 2 operators.

For further information: http://foru-solution.nl/

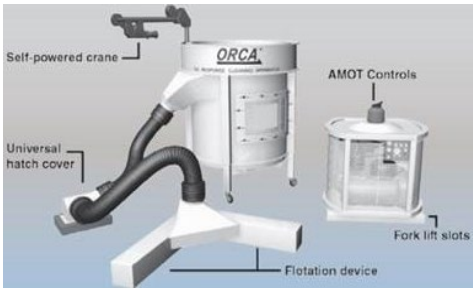
ORCA system: suction recovery system

The Dutch company ORCA markets a suction system dubbed the Oil & Refuse Cleaning Apparatus (ORCA). Set up on the deck of a vessel, this system recovers floating products (or objects) by suction and transfers them to an onboard storage capacity. With an air flow creating a tornado effect in the suction head, the ORCA can lift material over 30 m according to the manufacturer.

In the case of oil pollution, the advantages put forward for this technology (as compared to conventional skimming/pumping systems generally speaking) are:

- the system's low sensitivity to debris in the fluids collected (i.e. virtually clog-proof, given that there are no pumps or other elements between the suction head and the receiving tank).
- a high recovery ratio, with selective suction of the elements (objects or liquids) floating at the water surface.
- an apparently high flow rate: a performance of at least 80 m^3/hour for oil (up to around 200 m^3/hour depending on the type of oil and sea conditions) according to the manufacturer.

The device is powered by a diesel-driven hydraulic power pack (116 hp); the assembly includes a universal hatch cover to fit the suction hose (equipped with a floating head) to the standard dimensions of the deck or storage tank openings.



Left:

Illustration of the different components of the ORCA (source: http://orcaclean.com/)

The materials of which the ORCA is made (aircraft grade aluminium; weight of less than 600 kg) and its dimensions (approximately 2 m high x 2 m wide) are intended to make it a rapidly transportable system that can be adapted to spatial constraints (configuration/size) on the deck of vessels (barges, supply vessels, etc.), or even on land vehicles (for application on the shoreline or riverbanks).

The concept is reported to have been successfully implemented on a real spill (by the Singapore Oil Spill Response Centre, following a 29,000 tonne-spill of heavy fuel oil during the *Evoikos* incident in the Singapore Strait in 1997). Although not a new system, the ORCA is little known and has therefore recently been the focus of broader communication by the manufacturer, in particular with

[11] As an indication, the tests at the NCA facilities were carried out in 1/2 knot currents and 50 cm high waves.

the creation of a dedicated website. Its scope of application is not limited to oil pollution, but also includes floating refuse (e.g. in port areas) or on beaches.

For further information:
http://orcaclean.com/

• Sorbents

Development of a sorbent material for oil plumes: the Oleo Sponge (Argonne National Laboratory)

The Argonne National Laboratory (ANL) of the U.S. Department of Energy (DOE) has recently developed a new sorbent material, the Oleo Sponge, whose specifications not only aim to ensure an effective product but also allow for its reuse, as well as its deployment in the water column (and not only at the surface) to recover upwellings of oil (project developed following the Macondo well blow-out).

This project was funded by the U.S. Coast Guard (USCG) and the Bureau of Safety and Environmental Enforcement (BSEE).

Broadly speaking, the design of this oleophilic sponge is based on the use of a flexible polymer foam (polyurethane or polyimide), a material whose cavity structure provides a large contact surface area with the liquid to be absorbed, the idea being to "line" it with an extremely thin layer of an oleophilic agent. To do so, Argonne adapted a process[12] previously developed by its Center for Nanoscale Materials to infuse hard metal oxide atoms within complex nanostructures. This layer of metal oxide acts as a primer, on which a layer of oleophilic molecules is then deposited.

The resulting product—currently a prototype and therefore not available on the market—resembles a block of foam with a high absorption and retention capacity (30 to 90 times its weight, depending on the polymer used), and is reusable after recovery of (pure) oil by wringing out or compression.

In 2017, meso-scale tests were carried out in the Ohmsett tanks to assess the absorption performance of this new material, in the form of panels attached to a metal frame, on submerged plumes of crude oil (Hoops and Alaska North Slope) and diesel of known flow rate.

Oil extraction tests using the wringer system (Source: Argonne National Laboratory)

Mesoscale testing in the Ohmsett tanks (Source: BSEE)

Estimates of plume size and concentration (by video imagery and LISST—Laser In-Situ Scattering and Transmissometery) and the quantities of oil recovered by the foam panels (extracted by wringing out or compression) appear to have confirmed the Oleo Sponge's potential. We note too that, according to ANL, further testing also showed that the foam has good mechanical resistance.

ANL is currently continuing to develop this technology and is seeking production and marketing opportunities for the Oleo Sponge, which is believed to also offer promise for applications in the field of chronic pollution, for instance in port areas.

For further information:
http://pubs.rsc.org/en/content/articlelanding/2017/ta/c6ta09014a#!divAbstract (preliminary results published in the Journal of Materials Chemistry)

[12] known as sequential infiltration synthesis or SIS

• Conferences

International Oil Spill Conference 2017

The 2017 International Oil Spill Conference (IOSC) was held in Long Beach (California, USA) from 15th to 18th May. This triennial event, generally attended by some 2,000 participants, comprises numerous conferences, an exhibition that this year featured around a hundred stands run by equipment suppliers and/or distributors, oil spill response organisations (OSROs), representatives of the oil industry and public bodies involved in spill response (mainly from the US), R&D organisations, etc. Additionally, a number of meetings between experts from various organisations were held on the sidelines of the IOSC programme[13].

CONFERENCES

Forty-five thematic sessions, each comprising 4 presentations. Cedre had the opportunity to discuss the recent or ongoing experimental equipment development projects for assessing (i) the behaviour of chemicals (chemistry test bench)[14], and (ii) the efficiency of bioremediation agents[15].

Among these 180 presentations held at 5 platforms run in parallel (in between the opening and closing plenaries), we would like to highlight the following points[16]:

- Many of these presentations focused on **spill response planning and preparedness** (often in a specifically North American context). One point to remember[17] is the use of the RETOS tool (version 2.0), launched in 2014 at the previous edition of the IOSC (with the new version of the ARPEL Oil Spill Response Planning and Readiness Assessment Manual[18]), and designed to enable the user—industry, government, etc.—to assess its level of spill response planning and readiness. In early 2017, more than 30 countries and 20 private companies were reportedly using this software to assess their response capacity, with results generally indicating a readiness rating ranging from 20% to 99%, based on the RETOS criteria. By repeating the assessment using this tool, it would appear possible to determine the progress made in the various aspects of preparation. Its use is being encouraged with the publication of English, Spanish, Portuguese and French versions (available for download free of charge from the ARPEL website www.arpel.org). A presentation by the World Maritime University in Malmö[19] focused on the comparative assessment of the Swedish level of preparedness using this RETOS tool, which places it at a level roughly equivalent to that of the countries bordering the Baltic Sea (but lower than that of neighbouring Norway), despite the absence of a national contingency plan and an Incident Management System for major accidental oil spills. Among the other main focuses, there was also emphasis on spill response preparedness/planning in Arctic environments and in inland waters. On this second point, the presentations focused in particular on the recent publication of an API guide[20] and the issues specific to response in rivers (limited access, vulnerability of banks and bottom sediments, etc.). Several conferences on training and exercises were also given: in particular, there was a presentation on guidelines also recently published by API[21] (*API Selection and Training Guidelines for In Situ Burning Personnel*), designed to guide users in terms of training qualifications and requirements for those working in the specific field of In Situ Burning (ISB).

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[13] For instance, meetings of the thematic working groups coordinated by the Coastal Response Research Center (USA) (Cedre attended some of these, notably that of the Dispersants Working Group).

[14] **Giraud W., Thomas A., Richard P., Chataing S., & Le Floch S. (2017).** An innovative experimental device to assess the behavior of a chemical under controlled environmental parameters. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1287-1303.

[15] **Jézéquel R., Duboscq K. & Le Floch G. (2017).** Assessment of Bioremediation Agent Efficiency: Development of a Test Protocol. Preliminary result. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1718-1736.

[16] N.B.: the selection of bibliographical references below can be accessed on the IOSC proceedings website.

[17] **Taylor E., Moyano M, & Miranda-Rodríguez D. (2017)** RETOS™: USE OF AN INTERNATIONAL TOOL FOR ASSESSING OIL SPILL PLANNING AND PREPAREDNESS. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1-20.

[18] Association gathering oil, gas and biofuels sector companies and institutions in Latin America and the Caribbean.Association.

[19] **Pålsson J., Hildebrand L., & Lindén O. (2017)** COMPARING SWEDISH OIL SPILL PREPAREDNESS TO REGIONAL COUNTRIES USING THE RETOS™ EVALUATION TOOL. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 21-36.

[20] **Michel J. & Ploen M. (2017)** Options for Minimizing Environmental Impacts of Inland Spill Response: New Guide From the American Petroleum Institute. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1770-1783.

[21] **O'Brien J.P. & McCaffrey P.S. (2017)** Development of API Selection and Training Guidelines for in situ Burning Personnel. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 403-418.

- In terms of response strategies, once again **chemical dispersion** was unquestionably the focus of the majority of the presentations:

- In particular, Subsea Dispersant Injection (SSDI) in the event of a blowout (following post-Deepwater Horizon research) was addressed through various presentations. We note in particular, the use of a modelling approach to evaluate the benefits of subsea dispersant injection compared to no injection at the source[22]. The results would appear to confirm the view that oil upwellings are very significantly reduced by SSDI. While this technique generates temporary contamination of deep waters, their ecological sensitivity is considered lower than at the surface and/or on the shoreline. This modelling work is part of a broader project devoted to knowledge on the fate and degradation of oil, dispersed oil and gas from subsea blowouts, considered as key considerations in the choice of response techniques and in particular dispersion. In addition, 2 studies were also presented[23] and supported by the American Petroleum Institute (API), on the current state-of-the-science in terms of (i) the **biodegradation** of dispersed oils and (ii) the **sedimentation** processes in the context of well blowouts and SSDI (a phenomenon known as "marine snow", referred to in particular in relation to the Macondo blowout using the term "oily snow", but whose significance is subject to debate). Also noteworthy is an experimental study, co-funded by the U.S. EPA, showing the biodegradation kinetics of dispersants (or more precisely of Dioctyl Sodium Sulfosuccinate, or DOSS, used here as a degradation indicator) at concentrations in principle representative of those encountered in the environment, a recurrent question in recent years in relation to the SSDI strategy[24]. Finally, the API proposed a 5-year overview[25] of research funded under the Joint Industry Task Force Subsea Dispersant Injection Project, aimed at enhancing knowledge of the effectiveness of SSDI, the fate and impacts of dispersed oil, and the monitoring and modelling of subsea plumes. According to API, laboratory studies have demonstrated the strategy's benefits, but further work is required on the biodegradation potential and toxicity of a subsea plume in deep water. A presentation was also given by SINTEF on the improvement of numerical models for predicting the fate of subsea plumes[26].
- In terms of **dispersant use** in general, we can cite a presentation[27] on a joint project between IPIECA and API, aimed at highlighting a certain number of perception issues, owed to a lack of familiarity within the scientific community with the dispersion strategy, in its widest sense[28], based on a review of dispersant studies published by the scientific community (in particular through the GoMRI[29]). In particular, it was suggested (and regretted) that certain studies overlook the operational realities of dispersant use, meaning that they are unlikely to produce constructive results for spill response. This work is designed to provide the groundwork for broad, supported discussions between the scientific community and industry, with a view to encouraging the emergence of lessons relevant to response.

- **Controlled offshore in-situ burning (ISB)** was discussed during a specific session, as well as during sessions on cold environments, which are clearly foreseen as conducive to the application of this technique, as shown by recent and ongoing developments in its implementation:

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22 **French-McCay D., Crowley D., & Rowe J. (2017)** Evaluation of Oil Fate and Exposure from a Deep Water Blowout With and Without Subsea Dispersant Injection Treatment as Well as Traditional Response Activities. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 362-382.

23 **Broje V. (2017)** Recent Studies on Fate and Degradation of Hydrocarbons Dispersed Subsea. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 271-290.

24 **Zhang Y., Zhuang M., Campo P., Deshpande R.S., Sundaravadivelu D., Conmy R.N., & Santo Domingo J.W. (2017)** Comparative Study to Determine the Biodegradability of Dispersants at Environmentally Relevant Concentrations. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 331-346.

25 **Nedwed T. (2017)** Overview of the American Petroleum Institute (API) Joint Industry Task Force Subsea Dispersant Injection Project. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 678-703.

26 **Brandvik P.J., Johansen Ø., Davies E.J., Leirvik F., Krause D.F., Daling P.S., Dunnebier D., Masutani S., Nagamine I., Storey C., Brady C., Belore R., Nedwed T., Cooper C., Ahnell A., Pelz O., & Anderson K. (2017)** Subsea Dispersant Injection (SSDI) - Summary Findings from a Multi-Year Research and Development Industry Initiative. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 2762-2790.

27 **Coolbaugh T., Hague E., Cox R., & Varghese G. (2017)** Joint Industry Sponsored Effort to Evaluate Post-Macondo Dispersant Research. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 250-270.

28 Especially product approval and application procedures; aim of dispersion operations and goals in terms of impact mitigation.

29 Gulf of Mexico Research Initiative

- In terms of experimental studies, the following points can be noted:
  - Study funded by the Danish Council for Independent Research[30] aimed at determining, through a laboratory study but with a view to supporting in the decision-making process, the relationship between the conditions required for the ignition of a crude oil weathered to various extents (e.g. ignition time and temperature, heat production), the burn efficiency, and the sea state;
  - Development of an instantaneous measurement system for ISB efficiency[31] (to refine existing semi-quantitative methods based on visual observations), involving the integration of acoustic slick thickness data and data provided by infrared cameras operating in the visible range. Currently, the system can be used to calculate a burn rate, whose validation (comparison of pre- and post-burn weights) could result in a quantitative measurement of ISB efficiency.
- As concerns the fate of the burnt oil, we can make mention of two studies, including one by NOAA[32] which established that incidentally detected tarballs (contamination of shrimp nets) on the continental shelf of the Gulf of Mexico at a depth of 200 m were in fact ISB residues... These results argue in favour of taking account of ISB residues in NEBA/SIMA-type approaches, a previously non-existent practice. In addition, a literature review[33] suggesting that ISB effectively eliminates PAHs, given the content in the resulting vapours, soot and residues, was presented.
- SL Ross Environmental Research Ltd[34] presented the results of in situ assessments (North Sea) of the feasibility and efficiency of herders applied for offshore ISB operations. These series of tests, carried out during the NOFO exercise in June 2016 (Norway), pointed to their efficiency in relatively calm waters, which tends to decrease with wind force and agitation. We note that the burning residues could not be recovered as intended due to difficulties in tracking the slicks which were drifting relatively quickly.
- The contribution of herders to ISB in ice-infested waters was also discussed during a dedicated session covering several aspects of the IOGP (International Association of Oil and Gas Producers) Arctic Oil Spill Response Technology Joint Industry Programme (JIP) through:
  - microscale (SL Ross laboratory) and mesoscale (CRREL facilities[35]) work conducted in 2014-2015 to evaluate the efficiency of the available herders (ThickSlick 6535 and SilTech OP 40)[36] according to the degree of weathering of various types of crude oils (in order to estimate the window of opportunity for ISB). Overall, SilTech OP 40 generally proved to be more effective. The efficiency of the herders is reported to increase with oil evaporation, except when their pour point exceeds ambient temperature by 8 to 10°C. The technique also appears to work on reverse emulsions with a water content below 50%. The action of these agents on the slicks also appears to be (i) inversely related to the frazil concentration but (ii) promoted by slight agitation of the water body (without breaking waves). Work has also been carried out to evaluate the potential toxicity of herders, including standardised biotests (on the copepod *Calanus hyperboreus*) and impact assessments on the feathers of diving birds (guillemots and eider ducks)[37]. The toxicity thresholds are

[30] **Van Gelderen L., Rojas Alva U., Mindykowski P., & Jomaas G. (2017)** Thermal Properties and Burning Efficiencies of Crude Oils and Refined Fuel Oil. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 985-1005.

[31] **Panetta P.D., Byrne R., & Du H. (2017)** The Direct Quantitative Measurement of In-Situ Burn (ISB) Rate and Efficiency. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1006-1019.

[32] **Shigenaka G., Meyer B., Overton E., & Scott Miles M. (2017)** Physical and Chemical Characterization of In-Situ Burn Residue Encountered by a Deep-Water Fishery in the Gulf of Mexico. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1020-1040.

[33] **Fingas M. (2017)** The Fate of PAHs Resulting from In-Situ Oil Burns. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1041-1056.

[34] **Cooper D., Buist I., Potter S., Daling P., Singsaas I. & Lewis A. (2017)** Experiments at Sea with Herders and In Situ Burning (HISB). International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 2184-2203.

[35] US Army Corps of Engineers Cold Regions Research and Engineering Laboratory

[36] **Buist I., Cooper D., Trudel K., Zabilansky L., & Fritt-Rasmussen J. (2017)** Ongoing Research on Herding Agents for In Situ Burning in Arctic Waters: Laboratory and Test Tank Studies on Windows-of-Opportunity. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 2915-2934.

[37] **Fritt-Rasmussen J., Gustavson K., Wegeberg S., Møller E.F., Nørregaard R.D., Lassen P., Buist I., Cooper D., Trudel K., & Jomaas G. (2017)** Ongoing Research on Herding Agents for In Situ Burning in Arctic Waters: Studies on Fate and Effects. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 2976-2995.

much higher than the concentrations measured in water during herder spraying and experimental burns. An effect on plumage structure (resulting in loss of permeability) was identified at potential concentrations encountered locally just after application. A study was conducted in 10 m^2 test tanks to investigate the fate of herders, in particular via the quantification of their components in air and water[38], aimed at specifying the environmental risks of ISB operations aided by the application of a herding agent: according to the authors, the product components were below detectable thresholds in air, and the concentrations detected in water were mainly detected at the surface. In offshore environments, unlike in test tanks, the product is expected to be diluted and degraded[39]. A final report providing details of these studies has since been published in August 2017, entitled Research Investigations into Herder Fate, Effects and Windows-of-opportunity;

- the results of efficiency testing (also conducted at Poker Flat)[40] on systems for (i) herder application and (ii) crude oil slick ignition, in Arctic conditions, by various aerial means (helicopter+Heli-torch, drones, various igniters...) (see LTML 44). These tests led to the development of a helicopter-deployable prototype, tested in January 2017, capable of both spraying herders and igniting slicks by means of a gelled fuel cartridge launcher module. The tests on this integrated herder application and igniter system are described in a recently published document (Integrated Igniter/Herder Application System)[41] available on the JIP website.

- Also on the theme of ISB in the Arctic, we note that the IOGP is working on the development of an ignition system designed to expand their operational scope to potentially remote areas; Helitorches have a limited capacity and, more importantly, significantly slow the helicopter's movements. This palletized airborne ignition system is able to carry approximately 1 m^3 of napalm. The fixed-wing Casa 212 and rotorcraft Sikorsky S-92 have been chosen to carry the device. More details are available in a document published on the *Arctic Response Technology JIP* website (Conceptual Design for a Long Range Aerial Ignition System for In Situ Burning).

- In terms of **cold water response techniques**, over and above ISB (see above), we highlight here the following points which were developed in detail:

- **Oil detection in ice and snow** was the most widely addressed issue in terms of response in cold environments, with a session specifically devoted to advances in this area. This was a logical focus given that whatever the chosen or authorised strategies (ISB, dispersion, recovery, etc.), the evaluation of the pollution remains an essential prerequisite for their implementation:
  - We note the review of advances in remote sensing research from the IOGP Arctic Oil Spill Response Technology JIP[42]. These efforts currently focus on the evaluation of: (i) Frequency Modulated Continuous Wave Radar (FMCW) systems deployed from aircraft (ii) various multi-wavelength infrared sensors available on the market, two technologies identified as promising during previous project phases[43]. A presentation[44] was also given on the test facilities (test basins, under-ice oil injection systems, etc.) at CRREL for these activities to be carried out as part of the Joint Industry Programme. Mention can also be made of the online publication of a

[38] **Bullock R., Aggarwal S., Perkins R., Schnabel W., & Sartz P. (2017)** Environmental Partitioning of Herding Agents Used During an In-Situ Burning Field Study in Alaska. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 2935-2954.
[39] As an indication, observed within 3 weeks in these closed/conservative conditions.
[40] **Potter S., Buist I., Cooper D., Aggarwal S., Schnabel W., Garron J., Bullock R., Perkins R. & Lane P. (2017)** Aerial Application of Herding Agents can Enhance In-Situ Burning in Partial Ice Cover. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 2955-2975.
[41] See also "**EQUPMENT EXHIBITION**" section below
[42] **Palandro D. & Mullin J. (2017)** Advances in Remote Sensing Research on Oil and Ice from the IOGP Arctic Oil Spill Response Technology JIP. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1819-1835.
[43] **Pegau W.S., Garron J., Zabilansky L., Bassett C., Bello J., Bradford J., Carns R., Courville Z. Eicken H., Elder B., Eriksen P., Lavery A., Light B., Maksym T., Marshall H.P., Oggier M., Perovich D., Pacwiardowski P., Singh H., Tang D., Wiggins C., & Wilkinson J. (2017)** Detection of oil in and under ice. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1857-1876.
[44] **Lamie & Zabilansky (2017)** Remote Sensing of Oil In and Under Ice in a Climate-Controlled Test Basin. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1836-1856.

summary document, Remote sensing guide to oil spill detection in ice-covered waters, designed as a reference tool for assessing and selecting appropriate remote sensing technologies (and deployment platforms) for oil spill detection and surveillance in ice-covered waters.

- Another presentation also showed the latest advances in the project, run by ExxonMobil over the past decade, to develop a Nuclear Magnetic Resonance (NMR) detection tool[45]. This helicopter-borne system is based on the analysis of disturbance in the terrestrial magnetic field. Feasibility tests, conducted in late 2016, demonstrated that this robust, promising system is able to detect a 1 cm thick layer of a oil under up to 1 metre of ice.
- Less "technological", yet still relevant for oil detection under and in ice and snow, SINTEF outlined the results of its field assessments using specially trained dogs (Svalbard, 2008)[46]. This ground-breaking work has since been adapted, with some degree of success, to the detection of old and/or buried oil (see previous Technical Newsletters), and appears to have attracted growing interest (although mainly in North America so far).

- The **modelling of oil trajectories in ice-infested waters** was also the focus of various presentations.
  - We note that of SINTEF on the developments to its OSCAR (Oil Spill Contingency And Response) model, which can now be used to visualise ice conditions and forecast their influence on an oil spill trajectory, thanks to input data from metocean models (TOPAZ4 and neXtSIM), developed by the Nansen Environmental and Remote Sensing Center (NERSC) and covering all Arctic waters[47]. Another again highly technical presentation[48] focused on a study, which is complementary to the previous study, of the contribution of input data from these models to the forecasts of RPS ASA's models OILMAP and SIMAP.
- Here we note two recent/ongoing evolutions in terms of the **feasibility of dispersion in Arctic waters** (part of the IOGP Arctic Oil Spill Response Technology JIP):
  - One concerns the estimation of the surfacing probabilities of oil droplets under ice (i.e. in low turbulence conditions)[49]. The idea is to support decision-making in relation to chemical dispersion, by addressing the potential risk of dispersed droplets coalescing in the event of drift under a layer of ice. Various experimentation and measurement campaigns (in the field and at various scales in the laboratory by SINTEF and collaborators) have helped to fine-tune the modelling of sub-ice turbulence profiles (approximately 2 orders of magnitude lower than in free water). The project ultimately aims to establish lookup tables indicating the surfacing probabilities of droplets dispersed under the ice, as a function of different variables (e.g. droplet size, oil density with 5 types considered here—4 crudes and 1 IFO180; mixing method following dispersant application—natural or mechanical turbulence, etc.).
  - SINTEF and SL Ross carried out a mesoscale evaluation of the dispersibility of several crude oils at various degrees of weathering, and with 3 dispersants (Dasic NS, OSR-52 and Corexit 9500), in variable environmental conditions[50] (salinity,

[45] **Palandro D., Nedwed T., Altobelli S., Fukushima E., Conradi M., Sowko N. & DeMicco E. (2017)** Oil in and under Ice Detection using Nuclear Magnetic Resonance. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1877-1889.

[46] **Brandvik P.J. & Buvik T. (2017)** Using dogs to detect oil spills hidden in snow and ice - A new tool to detect oil in Arctic environments. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 2219-2236.

[47] **Beegle-Krause CJ, Nordam T., Reed M. & Lundmark Daae R. (2017)** State-of-the-Art Oil Spill Trajectory Prediction in Ice Infested Waters: A Journey from High Resolution Arctic-Wide Satellite Data to Advanced Oil Spill Trajectory Modeling-What You Need to Know. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1507-1522.

[48] **French-McCay D., Bakhsh T.T. & Spaulding M.L. (2017)** Evaluation of Oil Spill Modeling in Ice Against In Situ Drifter Data from the Beaufort Sea. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1523-1542.

[49] **Beegle-Krause CJ, Nordam T., Davies E.J., Smith A.N., McPhee M., Faksness L.G., Reed M., Daae R.L., & Golbraikh E. (2017)** Oil Droplet Surfacing Probabilities Under Realistic Low Turbulence in Arctic Ice. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 2204-2218.

[50] **Faksness L.G., Belore R.C., McCourt J., Johnsen M., Pettersen T.A., & Daling P.S. (2017)** Effectiveness of chemical dispersants used in broken ice conditions. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1543-1558.

percentage ice cover, swell). The relationships between these parameters and the dispersion efficiency were examined and the most significant of them identified (e.g. influence of salinity, which varied depending on the dispersant used; low impact of percentage ice cover, etc.).

- Relatively few presentations focused on **mechanical recovery** in comparison to dispersion and ISB. The presentations on this theme were mainly given by representatives of US organisations (federal bodies, consultancy firms, etc.), yet they nonetheless addressed some very interesting points, in particular:

- thinking on the applicability of the ASTM F2709-15 procedure (US Standard Test Method for Determining a Measured Nameplate Recovery Rate of Stationary Oil Skimmer Systems) in order to verify the capabilities of equipment listed in contingency plans as recommended to oil operators by the authority in charge of relevant regulations (BSEE in this case)[51]. In particular, the measurement of rates and efficiencies in far from realistic conditions (permanent presence of the skimmer in oil slicks which, what's more, are between 50 and 75 mm thick) leads to an overestimation of the recovery capacity of a given equipment stockpile. Series of tests conducted at Ohmsett showed that, for a 6 mm-thick slick, recovery rates for an oleophilic skimmer[52] on a test oil only represent 7 to 18% of those measured with an "optimal" thickness of 50-70 mm. This factor—associated with the oil encounter rate—therefore naturally has a major influence on the calculation of the Effective Daily Recovery Capacity (EDRC), which is thus relatively unreliable. Consequently, it appears that the federal authorities recommend that the data obtained through the F2709-15 procedure be used rather to calculate the Estimated Recovery System Potential (ERSP)[53], an indicator which takes into account the oil encounter rate[54]. At the end of the presentation, it was also indicated that, as the F2709-15 procedure was established for static skimmers, ASTM's Committee F20 was considering the development of a standard for dynamic recovery (possibly with a view to revising the current standards or developing a new standard). Since the IOSC, further assessments of the influence of decreased slick thickness on recovery rates have been conducted on weir skimmers (DESMI Termite in July 2017). In relation to this question, the influence of decreased oil slick thickness on the recovery rate and efficiency is taken into account in the French AFNOR standard[55], the procedure applied by Cedre since 1995 to conduct skimmer evaluation tests.
- dissemination of information on a certain number of projects currently in progress, funded by the US Federal Government.
    - The Bureau of Safety and Environmental Enforcement (BSEE) presented projects led by the Bureau, NOAA, the U.S. Coast Guard, and the U.S. EPA[56]. To summarise in a few brief points, these recent or ongoing projects focus on:
        - The Development of a ROV Deployed Video Analysis Tool for Rapid Measurement of Submerged Oil and Gas Leaks, in which the visible features (dimensions, turbulence, fronts, etc.) are analysed via specially developed algorithms;
        - Remote sensing of surface slicks:
            - in **low-light environments**, with the development of a compact system operated by an unmanned aerial vehicle (Marine Scout[57]),

[51] **McKinney K., Caplis J., DeVitis D., & Van Dyke K. (2017).** EVALUATION OF OLEOPHILIC SKIMMER PERFORMANCE IN DIMINISHING OIL SLICK THICKNESSES. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1366-1381.
[52] Tests conducted here on Elastec drum skimmer and Crucial disc skimmer.
[53] Approach based on lessons learnt from the Deepwater Horizon spill, whose calculation takes into account the encounter rate (determining the slick concentration/containment capacity), the recovery rate (skimmers and pumps) but also the storage and settling capacity as well as the transfer capacity to onshore facilities.
[54] Which is reportedly capable here of, at the very least, identifying the limiting factor on the response capacity: the encounter rate (when it leads to an oil inflow rate to the containment area that is lower than the skimmer's nameplate capacity) or the skimmer (opposite case).
[55] NF T71A – 500: Equipment for abatement of water pollution by oil. Skimmers – Test methods for performance assessment in a controlled environment.
[56] **Meyer P. (2017).** Recent Research and Development Testing Conducted at Ohmsett – The National Oil Spill Response Research and Renewable Energy Test Facility. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1345-1365.
[57] Sensor developed by the U.S. Army Night Vision and Electronic Sensors Directorate (NVESD), based on technology used by the Army, capable of being installed on small drones.

which operates based on the contrasts measured in various infrared bands (LWIR, SWIR, NIR);

  - against the backdrop of an identified need for sensors capable of distinguishing slicks of fresh crude oil from weathered emulsion, calling for the evaluation of various technologies and prototypes, BSEE recently funded the currently ongoing development of a methodology specific to Ohmsett for the **creation of significant volumes of stable emulsions**, with realistic and reproducible characteristics, in order to conduct mesoscale tests in its tanks[58];
  - for the guidance of response operations at sea, the comparative assessment of **slick thickness detection** by various combinations of sensors (e.g. synthetic aperture radar, side-scan sonar, laser fluorimetry, microwave radiometry, electro-optics/infrared, RGB colour sensors, thermal IR, etc.) and drones (helicopters, planes, etc.). A review was also given of a past project to develop a ROV (remotely operated vehicle) prototype, fitted with relatively low cost acoustic sensors, capable of measuring (from below) the thickness of oil slicks ranging from 500 micrometres to over 3 cm thick (see LTML 41 for more detail). The project is now completed and the prototype is effective on fresh crude oil, but it would appear that further developments are planned to improve its accuracy for emulsions (as water content affects the identification of the water/oil interface);

- The feasibility of mechanical recovery on slicks to which chemical dispersants have been unsuccessfully applied in terms of (i) recovery procedures (static tests on oleophilic disc and drum skimmers and (ii) containment by floating booms in dynamic mode (according to the ASTM F-2084 standard method)[59]. The results of comparative tests (treated oil versus untreated oil) suggest a marginal influence of dispersant application on water/oil mixture recovery rates (with a more marked influence for drum skimmers). However, dispersant application leads to a lower recovery ratio (greater water uptake by skimmers), with a subsequently low degree of separation of the recovered fluids. Containment by booms, which promotes dispersant/oil mixing during towing, is significantly impacted by the presence of dispersants. This issue, rekindled following the *DeepWater Horizon* blowout, is by no means new; assessments of the influence of dispersant application on the performance of various types of skimmers were conducted some ten years ago, with a report published in 2007 by the predecessor of the BSEE (US MMS) and SL Ross;
- The improvement of a skimmer system prototype (recently developed by Marine Pollution Control for the U.S. Coast Guard) for ice-infested environments (30 to 70% ice cover), composed of a skimmer head (Elastec TDS 118G or Desmi Helix) inserted in a cone-shaped "cage" fitted with floats which pushes back the ice around it (or even breaking it when a lifting arm is fitted) while letting the oil through. The prototype was tested in 2015 at Ohmsett, with support from CREEL; upon analysis of the results, a second phase (launched in 2017) is in progress and aims to design a system (i) to actively move ice from around the perimeter of the cage and (ii) attract oil towards the skimmer, two areas of improvement identified during the trials. To be continued...
- The development of 'smart skimming' technologies, under a BSEE-funded

[58] A specific presentation on this subject was given during a session on dispersants: **Stone K & Guarino A.G. (2017)** REALISTIC STABLE WATER-IN-OIL EMULSIONS AT OHMSETT. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 2826-2850. Interested readers can find further information on this subject in the presentation given by the authors at Clean Gulf 2017.

[59] For more details, see the presentation given by BSEE at Clean Gulf 2017.

project. This project aims to optimise floating slick recovery rates through the development of automated skimmers capable of autonomously positioning themselves in the thickest oil. The idea was to identify sensors capable of taking accurate in situ measurements which would be analysed in real time by the skimmer system and allow it to adjust its direction of travel via an autonomous control system (i.e. without external intervention). Under a contract with Alion Science and Technology, the performances of various sensors were initially tested at Ohmsett in 2015 and 2016, for a selection of models which could equip at least one commercially available skimmer. These tests were conducted on two types of sensors, for the measurement (in water) of: (i) oil slick thickness and (ii) the oil percentage in the discharge hose. Despite the limitations related to the sensors' performance in real-life conditions (for instance, strong wave action disturbs slick thickness measurements by causing contact loss between the sensor and the water surface), this project resulted in the construction of a prototype composed of a skimmer, a vessel and an autopilot, all available on the market, equipped with a specially developed unit comprising the sensors selected following the tests and software for data analysis and automated control of the prototype's operations. Further details of the future prospects and limitations of this concept are available in the report recently published by Alion Science and Technologies;

- The IceHorse project[60], also developed by Alion Science and Technologies on behalf of BSEE, culminated in the construction of a remotely operated submersible skimmer prototype designed to be deployed in patches of water between broken ice. The skimmer is an oleophilic drum skimmer (Elastec MiniMax) set inside a stainless steel mesh cage equipped with 3 ROVs (JW Fishers SeaLion-2) and a ballast system (air pumping) to regulate its buoyancy. An umbilical contains the hoses (oil discharge hose, air supply hoses for ballasts, etc.) and connection cables required to control the device via a control system located onboard the vessel. The concept was successfully assembled and tested at Ohmsett during the initial project (completed in 2016), which was followed by an improvement phase (2017-2018) aimed at making it more useful in an operational environment and expanding the ability to locate and guide the system from beyond visual sight of the tending vessel and under ice. The aim is to develop a commercial-off-the-shelf skimmer technology, with an integrated propulsion and ballast system.

- The Norwegian Coastal Administration presented the results of tests conducted at the Horten facilities to evaluate the performance of various types of skimmers—weir skimmers with oleophilic brush or disc modules and rope skimmers—on 4 types of oil[61]. These oils were: marine diesel (MDO); HDME 50 (Heavy Distillate Marine) and ULSFO (Ultra-Low Sulphur Fuel Oil), vessel fuels formulated to comply with IMO requirements relating to sulphur emission control areas; and WRG (Wide Range Diesel). This research was also motivated by the ban on the use of heavy fuel oil by ships in certain areas with a special protection status (such as the Svalbard archipelago). In current and agitation conditions, the results obtained suggest that the various systems are relatively efficient at recovering the oils in question, with the exception of ULSFO. With a high pour point (24°C), this oil was shown to solidify at the water temperatures used during the trials (between 0 and 2°C, Norwegian winter temperatures), forming scattered, rigid patches which were not easily seized by the skimmers tested.

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[60] **Johnson G., Grayson C., & Stromlund A. (2017).** Innovative Oil Spill Recovery Technology Developments. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1382-1402.

[61] **Holt H.S. & Frost B.R. (2017).** Results of Testing of Oil Skimmers with Diesel and Hybrid Fuel Oils in Cold Seawater. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1403-1416.

EQUIPMENT EXHIBITION

Generally speaking, few entirely new systems were presented at this edition, perhaps due to the time since the *Deepwater Horizon* blowout, the most recent major incident to have prompted programmes and funding for the development (or improvement) of new equipment or, more simply, during which the capacities of pre-existing equipment were demonstrated: fireproof booms, offshore skimmers, ISB equipment, slick detection systems, etc.[62]

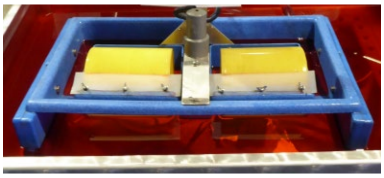
In addition to already well known equipment, we draw your attention to the following points which will be developed in subsequent Technical Newsletters based on further information made available to us:

- The UK manufacturer Vikoma presented a new recently released high capacity version of its Komara multi-skimmer (with a recovery rate of 150 m^3 according to the manufacturer). This system is a modular device comprised of brush banks and disc banks attached to a weir skimmer (which would appear to be the Cascade skimmer and its pump).

  Vikoma also presented its VikoMop, a rope skimmer available in 2 sizes, including one with very small dimensions, suggesting that it may be targeted towards industrial applications, as well as perhaps for spill response (for instance in water bodies containing considerable debris, or in wells).

Weir and oleophilic modules: Vikoma's Komara Multi-skimmer (**left**)*; Vikoma's Vikomop rope skimmer* **(right)** *(Source: Vikoma)*

- In the category of (very) small skimmers, mention can be made of the Elastec Mini Skimmer, a new skimmer head in the manufacturer's range of oleophilic drum skimmers. The model's two rotating drums are driven by a 12 volt electric motor, powered by a battery or mains electricity.



The Elastec Mini Skimmer, an oleophilic drum skimmer (Source: Cedre)

  This device's performance (nameplate capacity of just under 1 m^3/h) together with its small dimensions (l*w*h = 66*43*30 cm) suggest that this lightweight system (made of HDPE and weighing in at 6 kg) is earmarked for industrial use to recover mineral oil, diesel, etc. (it cannot be used in flammable or explosive atmospheres because of its electric motor), or possibly on small spills in calm waters (ponds, basins, etc.).

- The Canadian firm AQUA GUARD was presenting its RotoX skimmer which is now available on the market and is a revised version of its oleophilic brush RBS-TRITON™ skimmers, in this case with additional rotating blades. The purpose of these blades is to macerate and mechanically separate oil solids into slurry, then pump this slurry into a tank where the oil is recovered by the rotating brushes. The RotoX was developed to process slurry from settling ponds at oil facilities. However this system has also come under consideration for recovering extremely viscous oil trapped in ice, with field assessments conducted during the annual exercise organised by the U.S. Coast Guard in North American Arctic waters (Alaska) in August 2017. Despite the good buoyancy, manoeuvrability and self-propulsion of the prototype (controlled via an umbilical), the toothed discs did not perform as well as expected in terms of the maceration of ice floes. The manufacturer has announced that improvements are to be made.

[62] In addition, in 2017, no equipment demonstrations were conducted on the water, as has been quite often been the case in the past at IOSC/Interspill/Spillcon cycle events.

The modified RotoX prototype for collecting oil in ice-infested waters (source: Aqua-Guard)

The DESMI Smart Boom's monitoring buoy (Source: Cedre)

Prototype of the DESMI igniter (suspended)/herder application (on floor) system (Source: Cedre)

- The firm DESMI was also presenting SeaHow equipment (Finland), following a partnership between the 2 entities announced some 2 months prior to IOSC. SeaHow markets equipment for port and inshore uses which is complementary to the Danish manufacturer's marine and offshore equipment. The systems on display are modular, detachable recovery systems for small vessels of opportunity (e.g. SeaHow MiniBagger, see LTML 42-43). As for DESMI solutions, we note the Smart Boom, a sort of "sentry" system which is able to detect oil in the containment area (via a non-contact fluorometer, the Slick Sleuth), thanks to a monitoring buoy positioned between 2 sections of boom using ASTM connectors. The monitoring buoy is also equipped with GPS and a satellite real-time data transmission system.
- Also on show was a prototype of the helicopter-borne system developed by DESMI[63], as part of the IOGP Arctic Oil Spill Response Technology JIP for ISB. This system is designed to (i) spray herders and (ii) ignite the thickened slicks. The tank, pump and spraying hose (60 m long, on a reel) are placed inside the helicopter under which the igniter launcher is suspended (visually resembling a conveyor belt, containing 15 cartridges of Avgas, aviation fuel). The volume of herder applied is 4 to 5 litres per km (around the edges of the slick). The igniters are then launched from a height of approximately 5 m, and are programmed with a 2-minute delay to allow the slick to recoalesce after water entry of the igniters. The launcher is also fitted with a wide-angle video camera (visible and IR) and GPS positioning for tracking.
- Among new solutions, we note an interesting series of skimmers that go by the name of Otter skimmers, recently developed by Pacific Petroleum Recovery Alaska (PPR Alaska). Mounted on a catamaran-type structure comprising detachable steel tubes with inflatable floats made of thick canvas, these systems are compact and designed for quick deployment. The Sea Otter and River Otter[64] are designed to operate in dynamic or static mode in inshore/port waters, in rivers, etc. The device is equipped with a system that generates an intensified flow of water towards the skimmer entrance thanks to 2 deflection arms in a V-configuration. This promotes the creation of a vortex, which is stronger when the inflow is faster (in dynamic mode or set up facing into the current): a horizontal blade positioned below the surface evacuates the water intake by underflow, while the surface layer (and oil) is transported into an intermediate storage and vortex separation chamber (which also generates the inflow current). The oil is then selectively pumped into a second tank. The separation chamber features water evacuation with an internal float valve system at the water/oil interface. The whole system is remotely operated (monitoring of filling levels, pumping into second tank, valve control, etc.) and computer controlled via a user interface.

[63] In collaboration with SL Ross Environmental Research Ltd. and ExxonMobil Upstream Research Company.
[64] Low draught model suited to shallow water sites

A small-scale model on show to illustrate the PPR Alaska Otter skimmer concept (here on the catamaran Fish Cat*) (Source: Cedre)*

This concept is a recent development, initiated following the Deepwater Horizon blow-out[65]. In their first appearance at an IOSC, PPR Alaska announced the system's excellent performance (with demonstration videos to support their claims)[66] in terms of recovery ratio (98 %), and the capacity to recover sheen demonstrated during tests at oil facilities.

- The Canadian firm WindTrans Systems has developed and now markets a new positive displacement pump, the Zelda II HVLS (High Volume Low Speed), which is capable, as its acronym suggests, of transferring large volumes of fluids at low rotational speed. It therefore has interesting potential for transferring oil, given that it reduces (in addition to wear and heat generation) cavitation and emulsification of the pumped oil. The Zelda II HVLS is self-priming and can be operated manually (with a hand crank) or driven by a motor. This light aluminium pump can be transported to sites that cannot be readily accessed by vehicles.

  A few weeks prior to IOSC, the manufacturer took the pump to Ohmsett to conduct lift tests on a low viscosity oil (300-200 cP) and an oil roughly equivalent to an IFO 180 (8240-2000 cP), in order to test the pump's self-priming capacity and determine its flow rate at different lift heights of up to approximately 5 m. The equipment reported gave satisfactory results, both when operated by hand and when powered by a hydraulic motor.

The WindTrans Zelda II HVLS pump (Source: Cedre)

• Research

In Situ Burning: recent scientific publications

For a few years now, the use of chemical herding agents to optimise in situ burning (ISB) operations on oil slicks in Arctic waters has been considered a promising strategy by various oil industry stakeholders[67]. Against this backdrop, the industry has funded research and development actions, in particular to develop equipment capable of applying herders then igniting slicks from aerial platforms. The expected benefits are operational, by minimising response times in ice-infested waters that are difficult to access and often remote, as well as improving responder safety.

Although many experimental studies suggesting the efficiency of ISB have been published, few articles in scientific journals were as yet available on the feasibility and benefits of aerial spraying of herders. This is one of the focuses of the IOGP (International Association of Oil and Gas Producers) Arctic Oil Spill Response Technology Joint Industry Programme (JIP), also cited elsewhere in our Technical Newsletters (see also the article above on IOSC 2017, containing a summary of and references to presentations given on this theme).

In 2017, the partners involved in this project (University of Alaska Fairbanks and SL Ross

[65] And competing in the Wendy Schmidt Oil Cleanup X Challenge launched in 2011 by the X Prize Foundation, with support from Shell, to inspire the emergence of more efficient recovery resources than those available during the Deepwater Horizon spill, considered disappointing.
[66] Including tests conducted at the Cook Inlet Spill Prevention & Response, Inc. (CISPRI) test facilities in Nikiski (Alaska).
[67] See also, in the article above on IOSC 2017, the summary of and references to presentations given on this theme

Environmental Research) published 2 articles which together present the methodologies and results of their experimentation on this topic: in the laboratory, at mesoscale, and in test tanks (specially built at Poker Flat, Alaska) where herders were sprayed by helicopter.

Overall, the various results obtained have reassured the authors on the validity of the operational concept of airborne herder application and slick ignition, in particular given the burn rates estimated at between 60 and more than 90% in the Poker Flat test tanks. These publications provide scientists, industry and regulatory authorities (currently mainly American) with data on the potential applicability and limits of this technique. They would appear to encourage further research into the specific products, equipment and procedures required to implement this strategy (according to the type of oil, degree of ice cover, etc.).

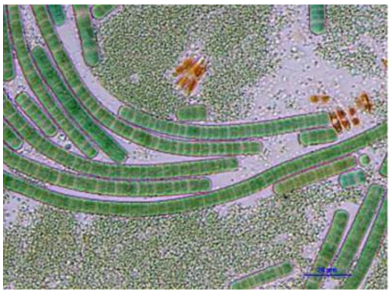
For further information:

Aggarwal S., Schnabel W, Buist I., Garron J., Bullock R., Perkins R., Potter S. & Cooper D., 2017. Aerial application of herding agents to advance in-situ burning for oil spill response in the Arctic: A pilot study. *Cold Regions Science and Technology*, **135**, 97-104. https://doi.org/10.1016/j.coldregions.2016.12.010

Bullock R., Aggarwal S., Perkins R. & Schnabel W, 2017. Scale-up considerations for surface collecting agent assisted in-situ burn crude oil spill response experiments in the Arctic: Laboratory to field-scale investigations. Journal of Environmental Management, 190, 266-273. https://doi.org/10.1016/j.jenvman.2016.12.044

Interreg South Baltic project: SBOIL - Oil spill response through clean-up with biogenic oil binders

The University of Rostock (Germany) took on coordination of an EU-funded project under the Interreg transboundary cooperation programme for the South Baltic region. Dubbed SBOIL, South Baltic Oil spill response through clean-up with biogenic oil binders, the project runs from July 2016 to July 2019 and aims to produce a multilingual handbook (i) summarising the essential information on marine oil spills and response strategies and (ii) presenting the crisis organisation in the countries of this region (Denmark, Germany, Lithuania, Poland and Sweden).

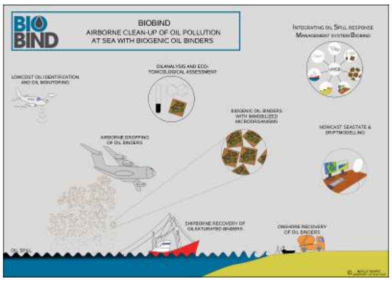


More specifically, SBOIL builds on the BioBind project (2011-2014)[68], which aimed to develop an oil recovery system for coastal shallow water areas and adverse weather conditions which would be compatible with existing concepts. In short, it focused on developing an oil-binding, biodegradable, oil-degrading material (wood fibres, with added micro-organisms[69]), dropped by aircraft onto oil slicks before being recovered by surface nets. This development fell within a broader strategic concept comprising the necessary operational considerations for implementing this “green” technology. These aspects, some being quite common, included: the identification of a low-cost remote sensing method for slick tracking, the modelling of surface currents in the relevant region, the identification of equipment and procedures for aerial application of the identified material and for its recovery at sea (or on the shoreline, in the case of adverse weather conditions preventing shipborne recovery).

[68] Research project funded by the German Federal Ministry of Economics and Technology (Bundesministerium für Wirtschaft Und Technologie), including 7 partners (German universities and businesses).

[69] Focus of a poster presented at IOSC 2014 (Safonova E. & König S., 2014. Novel oil-degrading algal-bacterial associations for the treatment of oil pollution in the Baltic Sea)

The aim of SBOIL is therefore to expand on this approach, by establishing it as a mainstream option alongside existing response techniques. Aspiring to improve the preparation and implementation of collaboration between authorities in charge of managing incidents at different levels (local, national, regional...), the project is set to include national and international workshops, exercises and training courses, as well as the development of a training kit on the BioBind technique.



***Top**: appearance of the biodegradable oil binders identified through the BioBind project; **Middle**: algae and cyanobacteria identified as oil-degrading agents; **Bottom**: diagram illustrating the concept of BioBind application operations (Source: http://www.biobind.de)*

SBOIL includes partners from Sweden (World Maritime University, Malmö) and Poland (Maritime University of Szczecin)

For further information:

SBOIL: https://southbaltic.eu/-/sboil-south-baltic-oil-spill-response-through-clean-up-with-biogenic-oil-binders
BioBind: http://www.biobind.de/english.html

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