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• Spills

Major spill of condensates into the marine environment (*Sanchi*, East China Sea)

On the evening of 6th January 2018, just over 150 nautical miles off Hong Kong in the East China Sea, a collision occurred between the Panama-flagged oil tanker *Sanchi (*operated by the National Iranian Tanker Company), en route from Iran to South Korea, and the Hong Kong registered grain carrier *CF Crystal*. This collision breached the starboard side of the *Sanchi*, immediately rupturing two tanks and causing the spontaneous combustion of the cargo, consisting of approximately 111,400 tonnes of natural-gas condensates. The fire rapidly spread throughout the ship.

After eight days of drifting at sea in an east/south-easterly direction (and in a territorially disputed area where the Chinese and Japanese waters meet), the *Sanchi*, engulfed in flames and wracked by successive explosions, finally sank in the afternoon of 14th January in 115 m of water in the Japanese EEZ.

At the same time, an unknown quantity of the cargo spilt unburnt into the sea from the ruptured hull of the tanker, the bunkers of which also contained around 2,000 tonnes of fuel oil at the time of the incident.

6th January: fire caused by the condensates spilt from the breached tanks, as seen from the bridge of the CF Crystal *(**left**); 7th January: fire raging on board the* Sanchi *(**right**) (source: MSA)*

The first and largest spill of natural-gas condensates from ships at sea recorded to date, this incident tragically resulted in the death of the 32 crew members of the *Sanchi,* 29 of whom were reported lost at sea.

10th January: fire-fighting operations (source: MSA)

11th January: continued fire and explosions (source: MSA)

By dispatching the first airborne and seaborne resources to the area, the Chinese authorities[1] assumed *de facto* command of the operations, giving priority to search and rescue (SAR) and fire-fighting efforts in the hope of assisting the crew of the *Sanchi*.

The Chinese Maritime Authority concentrated most of its actions and capabilities in these operations, supported by the coast guards of other neighbouring nations, notably the Republic of Korea and Japan, which mobilised air and sea surveillance assets and fire-fighting vessels, while the U.S. Navy also deployed reconnaissance aircraft.

During the first few days, the Chinese authorities focused primarily on SAR operations at sea, the difficulties in bringing the fire on the *Sanchi* under control meaning that the chances of survival of any crew members still on board were slim to none. Several attempts were made to get a rescue team onto the tanker, but these succeeded only on one brief occasion on 13th January.

On this date, a Chinese team managed to board the vessel, finding the black box and two deceased crew members, but had to be evacuated after some twenty to thirty minutes due to the risks involved (high temperatures, atmospheric

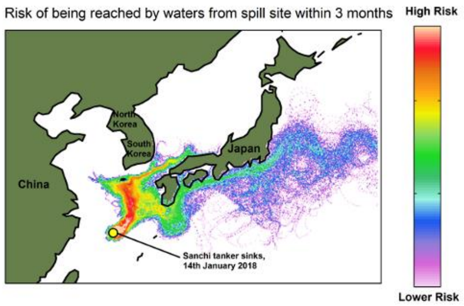
[1] The Chinese Ministry of Transport (MoT), through its Maritime Safety Administration (MSA) and China Rescue & Salvage (CRS) agencies, and the Ministry of Land Resources through its State Oceanic Administration (SOA).

pollution, explosions and fire).

*13th January: transfer of four SAR responders to the Sanchi from the Chinese vessel Shen Qian Hao (**left**); 14th January: persistent fire and a series of violent explosions causing the Sanchi to sink (**right**) (source: MSA)*

As regards the spill, the physical and chemical properties (significant light fraction) of the condensates[2] were responsible for both the spontaneous combustion (fuelled by the ongoing tanker fire) and the extensive spreading of a film with an iridescent/metallic aspect. These slicks, covering large areas (sometimes exceeding 100 km²), quickly dissipated under the effect of such natural processes as evaporation, photo-oxidation, and dispersion by hydrodynamics. Consequently, given the risks associated with the fire and explosions as well as the behaviour of the condensates, it was considered inadvisable to implement conventional containment, mechanical recovery, or even chemical dispersion techniques (dispersion actually occurring naturally here).

In the end, the uncontrolled burning of the cargo of condensates (and possibly some of the bunker fuel), along with the low persistence of the unburnt condensates spilt, probably helped to minimise the environmental impact of this incident. The aerial and nautical observations carried out by the Chinese and Japanese authorities in the first few days following the incident ruled out the risk of significant pollution of the coastlines in the vicinity of the sinking.



Calculation of the probability of pollution over the three months following the sinking of the Sanchi *based on the NEMO model (source: National Oceanography Centre)*

Furthermore, the National Oceanography Centre (NOC) and the University of Southampton (United Kingdom) performed numerical drift simulations[3] to determine the probabilities, calculated at dates before and after the sinking (12th and 16th January), of condensates or bunker fuel washing up along the coasts. The probability was considered: (i) low at 1 to 3 months (the model did not take into account the fate of the condensates, whether combustion or dissipation); (ii) affecting more specifically Japan to the east and the Republic of Korea to the north; and (iii) with most of the particulate matter carried by the Kuroshio current (thus drifting towards the north-east of Japan).

Following the sinking of the *Sanchi*, upwellings of condensates released from the tanker continued to burn into the morning of 15th January. After that date, and as well as a little persistent sheen caused by a residual quantity of the cargo, slicks of fuel oil began to be observed in the vicinity of the sinking.

Over the following days, the Japan Coast Guard (JCG) reported the presence of scattered slicks at distances of several kilometres from the wreck, drifting for the most part in a northerly direction within zones of between 10 and 20 kilometres in length and a few hundred metres in width.

Upwellings of heavy fuel oil from the sunken wreck of the Sanchi *(source: State Oceanic Administration (**left**) and Ministry of Transport of the People's Republic of China (**right**))*

Japanese and Chinese vessels conducted mechanical mixing operations at sea. Fragmented and lessened by the distance from the wreck, the slicks were considered to represent a low risk of pollution to Japanese coastlines. Several areas nevertheless experienced strandings of bunker fuel, notably the island of Takarajima at the end of January and the Amami Islands and Satsunan Islands at the beginning of February. These strandings were attributed to the *Sanchi* due to (i) their concomitance with the sinking and (ii) the nature of the oil (bunker fuel).

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[2] The cargo comprised two natural-gas condensates (phase 12 and phase 19) from the South Pars gas field (Iran) with a relative density of approximately 0.73 and a vapour pressure of approximately 11.8 psi (a floating and volatile product).

[3] Based on the high-resolution ocean circulation model NEMO.


In all, some twenty islands experienced varying quantities of strandings along their shorelines until February, requiring the implementation of clean-up operations coordinated by the JCG and the local authorities until June 2018.

Strandings of bunker fuel on the shoreline of Japanese islands (source: ITOPF)

In terms of the response organisation, we note the first application of the regional POLREP system to a real incident. Established under the United Nations' NOWPAP Action Plan,[4] POLREP is a standard system for reporting marine pollution online. During the 21st NOWPAP MERRAC Focal Points Meeting (held in July 2018 in the Republic of Korea), it would appear that representatives of NOWPAP member countries (China, Japan, the Republic of Korea and Russia) noted the advantage of this platform for the rapid online posting of data concerning the incident (location of the spill, status of the vessel, ongoing and planned response operations by Korea and Japan). This in turn reportedly facilitated the intervention on the part of the Chinese Maritime Safety Administration (MSA).

Finally, by recalling the reality of the risk of spills in the region due to the dense maritime traffic routes towards countries that are known importers of fossil fuels (China, Japan, the Republic of Korea), this incident underscores the value for the latter in establishing cooperation agreements for the prevention and management of maritime crises of this nature (SAR, spill response, etc.).[5] Obviously, existing international initiatives (e.g. NOWPAP; see above) could support such multilateral approaches via revisions within this framework substantiated by the lessons learned from the *Sanchi* on organisational, logistical and technical aspects, impact assessment, etc.

For further information:
https://www.mardep.gov.hk/en/msnote/pdf/msin1817anx1.pdf

Spill of heavy fuel oil in a sensitive coastal area (Kodiak Archipelago, Alaska, US)

On 26th February 2018, a hurricane in the Kodiak Archipelago in Alaska (US) caused the collapse of a semi-abandoned private pontoon in Port William (south coast of Shuyak Island) and of a flexible tank of heavy fuel oil (No. 6 fuel oil, as per the American terminology) located within a building on this pontoon.


While the incident resulted in a moderate spill of just over 10 m^3 of fuel, the ecological sensitivity of the coastline (a large part of the archipelago being classified as a national wildlife refuge) motivated the prompt implementation of response operations.

*2nd March: containment booms (anchored) and sorbent booms around the collapsed docks and buildings (**left**); point source of the heavy fuel oil spill (**right**) (source: Alaska Chadux, LLC)*

These operations were supervised within a Unified Command by the U.S. Coast Guard (USCG), which assessed the extent of the spill by means of a helicopter dispatched from its station in Kodiak, in conjunction with the Alaska Department of Environmental Conservation (ADEC) and the response company Alaska Chadux Corporation. The latter, mandated by the USCG following activation of the *Oil Spill Liability Trust Fund*, deployed its personnel and nautical resources,

[4] Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region, which contains a Regional Contingency Plan for dealing with spills of both oil and hazardous and noxious substances (HNS). While the POLREP reporting system is part of this Regional Contingency Plan, it was not activated here as the incident occurred outside the geographical scope of NOWPAP.

[5] It is tempting to see an encouraging sign of such future cooperation in the approval, on 26th October 2018 during a bilateral summit between China and Japan, of a formal agreement to prevent the inadvertent occurrence of conflicts as a result of interactions between the vessels of both countries in the East China Sea, which includes areas of disputed sovereignty.

including two vessels of opportunity equipped with 100 m of containment booms and other recovery systems (skimmers of various sizes: Skim-Pack, Aqua-Guard, etc.).

During the first two days, however, winds of 45 to 60 knots, waves of around 3 metres, and sub-zero temperatures prevented safe access to and operations in the area of the spill.

It was not until 1st March that protection measures (boom in front of a sensitive beach) and other containment equipment (booms around the point source) could be installed on the water before the implementation of clean-up operations along the shoreline. At a local level, these sites required operations to remobilise the oil in the loose substrates through tilling or by means of water deluges (with recovery of contaminated effluents using sorbents), depending on the beaches concerned.

Pressure washing of rocky surfaces contaminated with heavy fuel oil was also necessary.

Flexible tank, visible at low tide (source: Alaska Chadux, LLC)

The response operations lasted seven weeks, involved some 52 responders, and resulted in the collection of “1,878 bags of waste”[6] according to the USCG. A crane barge was used to remove the debris of the damaged infrastructure. In the end, no visible impact on the wildlife in the immediate vicinity of the spill was reported.

Leak from a crude oil pipeline: fire and oil spill in a port area (Pertamina, Balikpapan, Indonesia)

During the night of 30th-31st March 2018, an oil spill was observed in the waters of Balikpapan Bay (Borneo Island, Indonesia). This spill spread in slicks on the surface of the port waters before catching fire in the morning.

In the initial stages of the contamination, the source of the spill, its rate of flow (i.e. sporadic or continuous), and the nature of the spilt product were unknown. Various hypotheses were put forward and reported in the press during the first few days after the slicks appeared: a merchant ship in distress, a tank or bunker leak, crude or refined oil, and so on. While to the best of our knowledge the factor that triggered the fire was not clearly identified,[7] the spread and drift of the slicks immediately caused the fire to spread to several ships, with the port services giving priority to fire-fighting operations to control its spread.

The fire-fighting and spill response operations quickly received support from the oil companies in the area, notably Chevron Indonesia and state-owned Pertamina, while the Indonesian government’s Ministry of Transport (MoT) established a task force with representatives from relevant local agencies and Pertamina.

*Smoke plumes in the port area (**left**; source: Xinhua/Rex/Shutterstock); Tugboat working to stop the fire spreading to a tanker (**right**; source: AP)*

A state of emergency was declared the day after the spill, and the local authorities informed port users and local residents of the high risk of outbreaks of fire as the oil spread (issuing a warning against any activity “that could start fires”). The incident claimed the lives of five fishermen and generated air pollution from smoke and volatile compounds, with the municipality of Balikpapan having to distribute masks to local residents.[8]

At the beginning of the crisis, and due to the lack of notification of a maritime incident in the area, the assumption quickly emerged of a spill related to the neighbouring facilities of the state-owned oil

[6] Volume and type of waste (solids, liquids) not specified in our information sources.

[7] Various rumours circulated on this subject including, in the days immediately following the spill, of organised burning operations (i.e. controlled in-situ burning with the aim of reducing the extent of the spill). Reported by various press sources and online media, and strenuously denied by Pertamina and other stakeholders, this assertion was based on a report by the Balikpapan Disaster Mitigation Agency (BPBD), which later acknowledged its mistake and immediately issued a public apology.

[8] More than 1,000 people reported having suffered from respiratory difficulties, nausea or vomiting.

company Pertamina (Refinery Unit V).

The refinery officials refuted this hypothesis for the first four days, citing the negative results obtained following initial visual investigations of their pipelines by divers and analyses of the floating product. The company suspected a leak of bunker fuel from the *Ever Judger*, a Panamanian ore carrier that had been anchored near the slicks (and that had perished in the resulting fire).

Pertamina continued the normal operation of its facilities until 4th April, when it was forced to admit, on the basis of new analyses of samples of the pollutant, that crude oil had indeed leaked from a 50 cm diameter subsea line running at a depth of about 20 m between the oil terminal and the refinery. The leaking section was then sealed. The most likely explanation is that it was broken when it was caught (and subsequently dragged over more than 100 m) by the anchor of a bulk carrier looking for a mooring during a period of very strong winds.[9]

According to the MoT, four days after the first slicks were noticed the pollution had spread over a surface area of 1,800 hectares, and over 13,000 ha the following day. Oil started washing up on the shoreline two days after the incident over a stretch of land covering 60 km, including 34 ha of mangroves. Six days after the spill, the oiled area was estimated at 13,500 ha according to the Ministry of Environment and Forestry, and at 20,000 ha by the Ministry of Marine Affairs and Fisheries (the latter estimation being based on satellite images).

Left and centre: *strandings of crude oil on beaches in Balikpapan Bay two days after the spill (source: AFP/Getty Images);* ***Right***: *oiled mangrove in Balikpapan Bay, 5th April 2018 (source: Greenpeace/Jurnasyanto Sukarno)*

The data available in our information sources are not very precise as regards either the volume spilt (the estimate by Pertamina being unknown) or the volume collected following the response operations on the water and along the shoreline.

According to Pertamina, some 1,000 responders were mobilised for the five-day post-spill response operations, with the support of volunteers from various sectors of civil society (students, associations, local residents, etc.). These operations involved:

- At sea, some fifteen vessels deployed in four operational sectors, from the site of the spill to the more distant areas of Balikpapan Bay. These appear to have included specialised vessels for conducting containment and recovery operations as well as small boats for the spraying of chemical dispersants on certain slicks.
- On land, clean-up operations organised using both mechanical equipment (e.g. pumping by vacuum tank trucks) and manual techniques (using scoops, buckets, etc.).

Left: *dispersant application in the waters of the port (source: AFP/Getty Images);* ***Centre***: *manual collection of the strandings of crude oil using scoops (source: www.abc.net.au);* ***Right***: *primary storage at the top of the beach (pit with waterproof membrane) (source: Kaltim Post/Greenpeace)*

Four days after the spill, the Balikpapan Port Authority reported the recovery of 15,000 barrels of oil (i.e. 2,500 m^3). The following day, the Ministry of Environment and Forestry announced that “approximately 70 m^3 had been contained” on the water near the point source of the leak and that there had been a significant reduction in floating pollution since that date. Whatever the case, six

[9] Despite the fact that anchoring in this part of the bay is prohibited due to the presence of these subsea pipelines.

days after the incident, the Balikpapan Environment Agency estimated that 90% of the oil had been cleaned up.

An investigation was initiated to determine the causes and responsibilities related to this spill, with the decision at the end of April 2018 by the authorities of East Kalimantan Province to detain the vessel suspected of having hit the pipeline.

The Ministry of Environment and Forestry also imposed administrative sanctions on Pertamina, enjoining the company to improve its procedures for preventing and managing spills in areas subject to risks of this nature. In addition, the company was made responsible for the restoration of the oiled shorelines and required to pay compensation for the losses and environmental damage caused by the spill (the methods employed and results of the damage assessment are unknown).

Persistent pollution of port infrastructures by heavy fuel oil (*Bow Jubail*, Rotterdam)

On 23rd June, the tanker *Bow Jubail* collided with a structure in the port of Rotterdam (Netherlands) during a mooring manoeuvre. This collision caused a breach in the hull of the ship (which was sailing unladen) and the spilling of approximately 220 tonnes of fuel oil from a fractured bunker into the port waters.

The spill response operations, coordinated by the port authority and the Directorate-General for Public Works and Water Management, focused primarily on controlling the spread of the oil by laying booms as close as possible to the tanker. A number of infrastructures were nevertheless very quickly contaminated by the oil, with the prospect of the clean-up operations lasting several weeks. Following the recovery operations on the water, accounting for approximately 160 tonnes by the third day, the clean-up efforts over the following weeks focused mainly on the infrastructures (jetties, quays, riprap, moorings, etc.) and included the use of high-pressure washing with hot water to remove the weathered heavy fuel oil. Lingering oil required several kilometres of riprap to be replaced.

It is worth noting that two washing areas for the hulls of oiled ships were installed in order to facilitate the rapid resumption of maritime traffic – a priority for this port. In addition to the impact on port uses linked to the temporary closure of the shipping lanes in the vicinity of the spill, around a thousand birds were affected to varying degrees by the fuel oil.

• Statistics

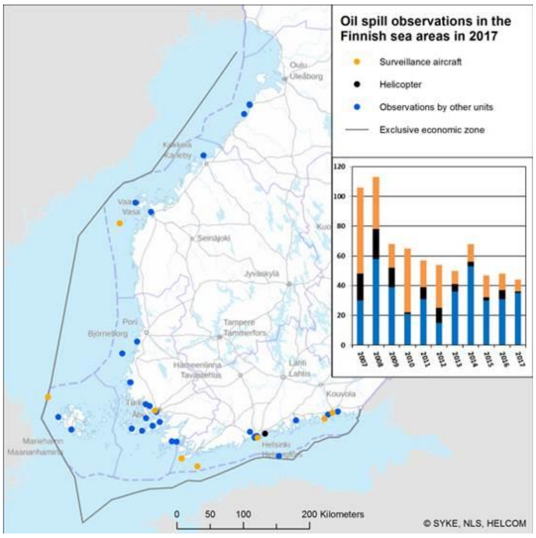
Baltic Sea: continued downward trend in the number of oil pollution reports in the Finnish EEZ

According to a report published in the first quarter of 2018 by the Finnish Environment Institute (SYKE) and the Finnish Border Guard, the numbers of reported illegal oil discharges in the waters of the Finnish EEZ in 2017 were down slightly on the previous year (44, compared with 48 in 2016).

Most of the cases were sighted near ports or the shoreline and the volumes were estimated to be low (with only one case representing approximately 1 m^3). This tends to confirm the downward trend observed in recent years in discharges into the Baltic Sea.[10]

In addition to the observation pressure exerted by Finnish aircraft (428 hours in 2017), the Border Guard and the environmental agency SYKE also highlight the contribution of the deterrent role of the European Union's efforts in monitoring oil discharges through the use (and subsequent on-site verification) of satellite images (267 in 2017) provided by the European Maritime Safety Agency's CleanSeaNet network.

For further information:
http://www.environment.fi/en-US/Maps_and_statistics/The_number_of_oil_discharges_observed_at(46132)



Distribution of the 2017 pollution reports in the Finnish EEZ (source: SYKE*)*

• Response preparedness/(inter)national strategies

Strengthening of the EMSA's fleet of oil spill response vessels: chartering of the *VN Partisan*

In March 2018, the European Maritime Safety Agency (EMSA) chartered the *VN Partisan* from the company SEAOWL France for a period of four years as a marine oil spill response vessel.
Based out of Brest (France) and capable of being mobilised in the Bay of Biscay area (i.e. between Vigo and Le Havre) within 24 hours, this former Norwegian supply vessel built in 1995 (contracted since January 2018 by the French Navy[11] as a "Plastron" ship) has a storage capacity of 1,000 m³.
Its entry into service in the EMSA's fleet of oil spill response vessels was set for the second half of 2018, after outfitting with the necessary equipment and systems for response operations at sea. These include remote sensing systems (Miros), containment equipment (two 15 m Lamor LSS15 Stiff Sweep Arms and two 250 m sections of Lamor LSP 1900 offshore single point inflation boom), and recovery equipment (Lamor LWS 1300 high-capacity skimmer, stored on a reel with umbilical hose control, and deployed using the Lamor LUT telescopic lifting arm).
For further information:
http://www.emsa.europa.eu/oil-spill-response/oil-recovery-vessels/vessel-technical-specifications.html

EMSA: drone charter contracts

At the end of 2018, and in light of the growing demand for maritime surveillance from European agencies and Member States, the European Maritime Safety Agency (EMSA) signed four contracts for maritime surveillance services using remotely piloted aircraft systems (RPAS).
Although not all of these contracts directly concern oil spill response (also covering, for example, requirements in terms of monitoring sulphur emissions, search and rescue operations, the detection of illegal activities, border surveillance, etc.), it is worth noting the chartering of light drones from Norwegian company Nordic Unmanned. This includes ten *Indago 2* quadrotor unmanned aerial systems (from American firm Lockheed Martin) intended to equip the oil spill response vessels in the EMSA's fleet.

[10] To which the Marine Environment Protection Committee of the International Maritime Organization has granted the status of "Particularly Sensitive Sea Area", as defined in the MARPOL Convention.
[11] Which remains the priority customer.

Trilateral cooperation agreement between Israel, Greece and Cyprus in the field of oil spill preparedness

At the end of a summit held in Cyprus in May 2018, Israel, Greece and Cyprus announced that they had signed an agreement to implement a sub-regional oil spill contingency plan. This summit stemmed from meetings between the interested parties in 2017 as well as a joint exercise, all organised with the assistance of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) as part of its role in supporting cooperation and mutual assistance between the Contracting Parties to the Barcelona Convention. As an extension of this initiative, REMPEC recently organised a follow-up meeting (Larnaca, Cyprus, in December 2018) to support the development of joint training in coordinated crisis management related to spills in the marine environment (response operations, sharing of information, etc.).

This agreement falls within an already-implemented process designed to promote a multi-stakeholder action plan to manage environmental impacts of various kinds (droughts, flooding, etc., like the fires that struck the region in 2016 and that motivated cooperation between these countries) and energy policy (such as the EastMed gas pipeline project concluded in November 2018 with Italy with the aim of linking the eastern Mediterranean and Europe).

Republic of Korea: risk analysis and distribution of equipment stockpiles

In an effort to improve response preparedness in the Republic of Korea, the Department of Coast Guard Studies recently published the results of a methodology developed to compare the distribution of the risk of oil spills occurring in the waters of the Korean EEZ with the distribution of the response capability (i.e. equipment stockpiles) across the region.

The spill risk assessment approach was based on the consideration of causal factors (shipping, presence of oil facilities, etc.) as well as descriptors of environmental and economic sensitivity – a new factor in the Korean context. These parameters are weighted according to an Analytic Hierarchy Process (AHP) to establish risk levels by region. These risk levels are then compared with the corresponding response capacities (equipment stockpiles), which are calculated and assessed in the light of quantitative recovery objectives (set out in existing Korean standards – see document on the national recovery capacity[12]).

This process of risk standardisation using the AHP approach was deemed satisfactory by the authors, who were thus led to re-assess the distribution of resources in order to ensure a perceived optimised balance between regional risks and equipment stockpiles.

For further information:
Ha M.-J., 2018. Modeling for the allocation of oil spill recovery capacity considering environmental and economic factors. *Marine Pollution Bulletin*, **126**, 184–190 (https://doi.org/10.1016/j.marpolbul.2017.11.006)

• Industry initiatives

Supply of equipment for response operations at sea: the Norwegian industrial OSRV Group

Norwegian oil spill equipment manufacturers Framo, Maritime Partner, Norbit Aptomar and NorLense have joined forces to form the OSRV (Oil Spill Recovery Vessel) Group with a view to bidding on contracts for the purchase or hire of all the resources required for recovery operations at sea (and even the conversion of service vessels into specialised response vessels).

The four stakeholders behind this unique commercial entity notably offer their potential customers the quick turnkey delivery (eight weeks) of all the remote sensing equipment for floating slicks (acoustic and IR systems from Norbit Aptomar) and the deployment at sea (using vessel provided by Maritime Partner) of containment and oil recovery/transfer equipment (supplied by NorLense and Framo, respectively).

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

[12] The national policy in South Korea requires having the necessary response capacity to recover one third of the maximum estimated spill at sea. For a given geographical area/region, the local stockpile must be able to ensure half of this objective, with the other half being provided by the deployment of resources from neighbouring areas. See **Korea Marine Environment Management Corporation, 2011,** *A Study on the Measure for the Advanced Concept of Oil Recovery Capacity & Advance*, pp. 23-46 (reference listed in the publication referred to in this article).

Extension of OSRL's range of subsea well intervention resources: Offset Installation Equipment

UK-based specialist company Oil Spill Response Limited (OSRL) announced in 2018 the commissioning of its Offset Installation Equipment (OIE), a technological development that complements the resources designed over the previous six years within the context of subsea well intervention services (SWIS) and includes intervention kits for well closure[13] or for the containment/recovery of spilt oil.

Resulting from a collaboration between the Subsea Well Response Project (SWRP) expert group formed in 2011 by several oil companies[14], the Italian oil exploration and drilling company Saipem, and OSRL, the OIE is a complementary system designed to enable the deployment and installation of subsea well intervention services in cases where vertical access to a wellhead is not possible. This can be done at depths of 600 m and at a safety distance of up to 500 m from the site of the incident.

The equipment is stored at OSRL's new base in Trieste, Italy, where Saipem is responsible for its maintenance. Its entry into service completes the SWRP initiative. The International Association of Oil & Gas Producers (IOGP), through its Well Experts Committee (WEC) and in conjunction with OSRL, will work to disseminate knowledge of this tool to all of its members as part of the process of promoting good practice in the control of offshore well leaks and blowouts that was initiated following the *Deepwater Horizon* incident.

For further information:
https://www.oilspillresponse.com/services/subsea-well-intervention-services/offset-installation/

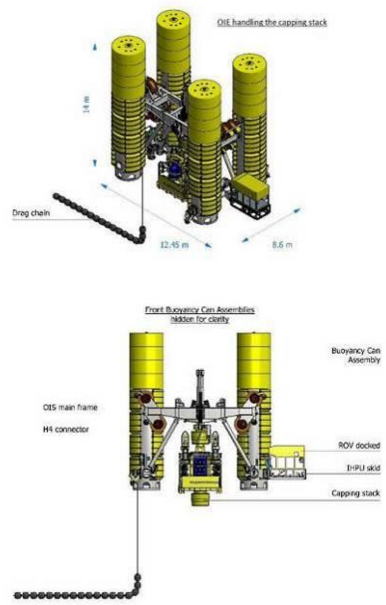


Diagram of the OIE, with adjustable flotation components for the remote positioning of a capping stack (source: OSRL)

OSRL also indicated that it was exploring logistical options for the rapid transportation by air of pre-assembled SWIS intervention kits (unlike ships, air freight currently requires the transport of individual, non-assembled components). The aim here is to reduce the current estimated time (approximately 30 days) required to set up a deep well intervention system on site.

Also on the subject of subsea response, the UK company entered into a strategic partnership in July 2018 with Texas-based Trendsetter Engineering and Boots & Coots, specialists in offshore well engineering. This partnership aims to provide OSRL members with greater access to experts and trained response personnel to support SWIS and training activities for control operations responsible for subsea spills. The initiative aims more particularly to meet the potential requirements of smaller operators rather than the larger companies, the latter often already having trained personnel available.

Finally, and still within this context of subsea incident management, a strategic cooperation agreement was also signed in December 2018 between OSRL and Genesis Oil and Gas Consultants Ltd., a specialist in subsea engineering.

Norway: annual NOFO exercise and assessment of systems with oil discharges at sea

As it has done every year since 1982, the cooperative NOFO (Norwegian Clean Seas Association for Operating Companies, bringing together all of the oil companies operating in Norwegian waters) renewed its annual Oil on Water exercise[15] in 2018, organised in cooperation with the Norwegian authorities (Norwegian Coastal Administration, NCA).

Held from 4th to 8th June at the former Frigg oil field in the North Sea, the 2018 exercise involved the performance evaluation of various newly developed, modified or marketed spill response

[13] OSRL's four capping stack systems are stored in Norway, Brazil, South Africa and Singapore, respectively.
[14] Including BP, Chevron, ConocoPhillips, ExxonMobil, Petrobras, Shell, Statoil and Total.
[15] With releases of oil at sea, generally of between 100 and 150 m^3 in total.

equipment and systems.

Within the framework of NOFO's assessment and R&D activities, the key objectives defined for this year's exercise comprised the following:

- Implementation of **in-situ burning (ISB)** operations, including the assessment of:
  - The contribution of pre-ISB spraying of herding agents.
  - The DESMI PyroDrone[16], a remotely piloted aircraft system (RPAS), for ignition of the slicks. Capable of operating at an altitude of up to 10 m, this drone is equipped with a camera (visible and IR) to pinpoint the position of the slicks in real time and to optimise the launching of the igniter.
  - The burn residues (measurement of ISB effectiveness) as well as the analysis of atmospheric emissions (responder health and safety concerns). These atmospheric emissions were analysed by Sintef via sensors mounted on an RPAS, following on from the trials conducted during the 2016 exercise.[17]

***Opposite**: collection net for burn residues, attached to a section of DESMI PyroBoom® (submerged skirt, with front line of ballasts) (source: DESMI)*

*Preparation of the DESMI PyroDrone (**top**) and disconnection of the ISB residue collection net (**bottom**) (source: NOFO)*

While the performance of the PyroDrone was considered satisfactory, a single igniter being sufficient for both the Oseberg crude and ULSFO (for areas of 100 m² and 50 m², respectively, in the boom), the ignition of the ULSFO took a little more time. The atmospheric measurements indicated very high concentrations of particulate matter in the smoke plume, with a very significant proportion of fine particles (< 2.5 µm), decreasing rapidly at its periphery. According to NOFO, the extensive data acquired during these trials, from both the sensors (on drones and ships) and the sampling of the residues, will be analysed for the purposes of assessing the health risks and environmental impact associated with ISB operations. With regard to the PyroBoom® fire booms, the following findings were noted: (i) leakage from the boom, prior to ignition, of the light Oseberg crude oil in greater quantities than for the ULSFO (more viscous); and (ii) significant damage to the emerged part of the boom at the end of the burns (between 43 and 48 minutes).

- Assessment/verification of the effectiveness (containment and selectivity) of various **mechanical recovery** systems, and notably:
  - The NOFI Spill Raider 1200S rapid deployment containment boom (mounted on a reel and with a single inflation point) when towed in formation at speeds of between 0.7 and 1 knot (i.e. slightly below the maximum of 1.2 knots stated by the manufacturer). For these trials, the boom was used with a FRAMO collection system (TransRec Weir 150) with a weir skimmer head. The performance of the whole system was satisfactory for both containment and selectivity (estimated at 84%).

[16] Development supported by NOFO and NCA within the framework of the *Oljevern 2015* R&D programme.

[17] During which a SidePak Aerosol Monitor from U.S. company TSI Incorporated was deployed by a drone for the real-time monitoring of particulate matter (up to 2.5 microns in size) in the smoke plumes produced by ISB operations.

- The LAMOR Marine Offshore Sweeper (MOS) 50 recovery boom, a deflection/funnel system for use in strong currents. Implemented during previous exercises, it was operated here at 3.5 knots with a prototype skimmer positioned at the apex of the boom. This prototype was adapted from the DESMI Octopus (see photo opposite) with one of the five brush belt modules (out of the three equipping the model) for use with viscous oils. Due to a few technical issues (disconnection of the discharge hose), the performance of the system could not be fully assessed.

DESMI prototype (using one Octopus module) mounted on the apex of a LAMOR MOS 50 boom (source: NOFO)

In this configuration, the single Octopus brush belt module nevertheless proved selective, despite issues with the stability/position of the prototype,[18] which could be improved according to NOFO. This also highlights the advantage of using aerostats to verify/control the deployment of the MOS 50 during operations.

- The performance evaluation of various remote oil sensing systems in terms of detection distances, potential to detect thin slicks, etc. These notably included systems operating in various wavelengths tested with some success, including the dual-wavelength (X- and Ka-band) GEMINI X-Ka radar from Italian company GEM Elettronica, and the Ku-band polarimetric detection radar from Norwegian firm ISPAS AS.

For further information:

Exercise report (in Norwegian) available at https://www.nofo.no/globalassets/pdfs/opv2018_sluttrapport.pdf

Prince William Sound: renewal of and technical developments for the industry's oil spill response fleet (Alaska, US)

In 2018, Alyeska Pipeline Service Company (APSC), the consortium of major oil companies that own and operate the Trans-Alaska Pipeline System (TAPS, which transports North Slope crude oil produced in the northern Alaska oil fields to the Valdez Marine Terminal), contracted Edison Chouest Offshore (ECO)[19] to provide oil spill prevention and response services in Prince William Sound.

Within this context, ECO mobilised various resources in the port of Valdez, including tugs, a supply ship, an Anchor Handling Tug Supply (AHTS) vessel, and six Oil Spill Response Barges (OSRBs). Four of the latter were newly built, with a gradual entry into service starting in the second half of 2018, following sea trials for the verification, notably by the USCG and the Alaska Department of Environmental Conservation (ADEC), of their compliance with the regulatory requirements defined within the framework of their missions (e.g. tug towing capacity).

With regard to oil spill response equipment, it is worth noting the emphasis placed on the search for technical improvements in both containment/recovery and the remote sensing of surface slicks (tugs fitted with infrared cameras).

CRUCIAL disc skimmers with fuzzy discs (source: Alyeska Pipeline Service

On the first point, the choice was made to equip each of the new response barges[20] with two high-flow oleophilic disc skimmers. Manufactured by American company CRUCIAL Incorporated, these were developed about ten years ago (tested in 2009)[21] on the basis of the company's ORD model, with a modified scraper and coating[22] of the discs, the fibrous, fuzzy nature of the latter increasing the contact surface with the oil.

The aim is to optimise selectivity (compared to weir systems, previously the most commonly used system in Prince William Sound) and recovery efficiency (compared to conventional discs).

[18] And also difficulties with the optimal adjustment of the brush rotation and pump settings.
[19] Replacing Crowley Maritime.
[20] OSRB-1 to OSRB-4, the first of which was delivered in August 2018.
[21] In the Ohmsett test tanks, then in Kachemak Bay (Alaska) for Prince William Sound Shippers.
[22] Produced by Abanaki under the trade name "Fuzzy".

Company)

It is worth noting that the flow rate is also intended to be higher, the models supplied each containing around 100 discs (i.e. the largest built by CRUCIAL to date with 20 discs more than the previous model).

In order to reduce the volumes of liquid collected, the containment devices selected are the NOFI Current Buster 8, a large model (50 m wide opening) of the recovery/funnel boom designed by the Norwegian manufacturer to operate in strong currents (up to 5 knots).

With these technical options, APSC aims to “double the recovery capacity compared with previous systems”.

Modelling of an ECO recovery barge with deployment (via lifting arms) of two CRUCIAL oleophilic skimmers in the NOFI Current Buster 8 temporary storage unit (source: Alyeska Pipeline Service Company)

As regards the design of the barges themselves, it is worth noting that the lines and pumps required to transfer the recovered fluids are placed below deck to reduce congestion topside (along with the associated risks) and to provide the space necessary for the storage and preparation of the equipment (e.g. inflation of the booms prior to deployment).

• Hazardous and noxious substances

HNS spills: results of the MARINER project

Funded by the European Union’s Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO), the two-year MARINER project (“Enhancing HNS preparedness through training and exercising”) concluded in 2018 under the coordination of CETMAR (*Centro Tecnológico del Mar*, Spain). The project 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*), the English partner PHE (Public Health England), and Cedre for France.

As MARINER’s objective was to enhance preparedness to respond to HNS spills (see LTML n°45), the project resulted in the publication of numerous tools that can be downloaded from the project website, including the *training package* and the *MARINER Knowledge Tool*, which lists the research institutes and projects having produced accessible data on HNS spills.

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

• Slick drift

Upgrade of the MOTHY drift prediction system (Météo-France): version 4.5

The new version (4.5) of the MOTHY (*Modèle Océanique de Transport d’HYdrocarbures*) drift prediction system has been operational since July 2018. It replaces version 4.4 (2016), which saw the integration of improvements to the calculation of drift probabilities for floating objects and the extension of the high spatial resolution domain (10 km grid) of the ARPEGE global wind model (notably to the Arctic, Caribbean and South American sectors, including the French West Indies and French Guiana).

The new enhancements in version 4.5 include: the Mediterranean Forecasting System (MFS), a numerical ocean prediction system that produces more accurate current forecasts for the entire Mediterranean Sea; shallow water drift calculations for SAR targets (panel of 72 distinct targets, defined as part of operations to locate and rescue people in distress); and the drift of sargassum seaweed, with its berry-like air bladders (pneumatocysts) on the surface and its mats floating subsurface (complicating the forecasting of mass influxes, an acute problem in the French West Indies).

For further information:
http://www.meteorologie.eu.org/mothy/statistiques/

• Decision support

IPIECA Guidelines on implementing spill impact mitigation assessment (SIMA)

IPIECA, API and IOGP[23] have jointly published a document entitled "Guidelines on implementing spill impact mitigation assessment (SIMA)", proposing a model approach for the process of assessing and selecting the best response strategies for minimising the environmental impact in the event of a spill.

The purpose of the proposed approach is to support the recommendations already formulated by IPIECA-IOGP (revised in 2016) regarding the need to perform a net environmental benefit analysis (NEBA[24], this term being henceforth replaced by SIMA). More specifically, the aim here is to propose a harmonised process for conducting this analysis, taking into account ecological, socio-economic, and even cultural aspects.

Generally speaking, the SIMA process comprises four successive stages which can be summarised as follows:

- Compilation of spill data in terms of (i) oil fate/behaviour and trajectory, (ii) sensitive resources at risk (sensitivity atlases), and (iii) identification of possible/conceivable response options within the context of the spill.
- For each sensitive component identified, an initial assessment of the expected outcome of non-intervention (impact – and if so, level of severity – or not), followed where appropriate by the attribution of a "ranking" corresponding to the expected level of impact mitigation of each of the conceivable response options.
- For each response option, an assessment of the expected theoretical environmental benefit (i.e. assessment/sum of the rankings assigned to the various components depending on the option under consideration), in order to compare the scores thus obtained for the various intervention possibilities (including non-intervention).
- Selection of option(s) in accordance with local priorities and issues (e.g. trade-offs between socio-economic and environmental sensitivities).

Beyond the semi-qualitative nature of this approach, which in theory enables relatively rapid implementation, one of its advantages is that it provides a certain degree of legibility and traceability of the reasons underlying the strategic response choices.

For further information:
http://www.ipieca.org/resources/awareness-briefing/guidelines-on-implementing-spill-impact-mitigation-assessment-sima/

• Containment

Submerged oil: the MarkMaster V oil filter boom

American company Parker Systems, Inc. (PSI) has recently added the MarkMaster V model to its range of Oil Filter Curtain Booms. The MarkMaster V is marketed as being suitable for the containment of "Group V Class" oils, according to the American Petroleum Institute (API) classification, i.e. those with a relative density that makes them likely to become submerged and to drift in midwater (and even eventually to sink) when spilt in the marine environment.

[23] Respectively: *International Petroleum Industry Environmental Conservation Association*; *American Petroleum Institute*; *International Association of Oil & Gas Producers.*

[24] While the term "benefit" has been replaced because considered inappropriate in the context of pollution, the general concept remains broadly the same.

From a structural perspective, the MarkMaster V is similar to a silt curtain. It comprises a permanent float, which is available in different diameters (from 15 to 30 cm), supporting a detachable skirt made of oleophilic *X-Tex* filter fabric (from Ultratech International),[25] with dimensions ranging from 0.12 m to 0.37 m.

Available in sections measuring 0.75 m, 1.50 m or 3 m in length, the system is designed for use as protection in rivers with weak to moderate currents (e.g. in front of sensitive sites or along riverbanks) in the event of sunken oil, a recurring problem in North America in particular and linked to the increasing use of non-conventional oils (oil shale, oil sands, etc.).

The MarkMaster V boom with detachable oleophilic filter skirt (source: www.parkersystemsinc.com)

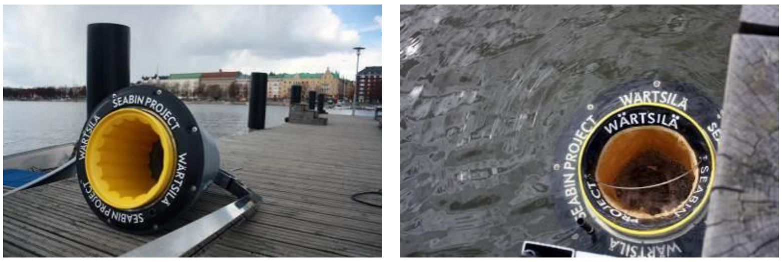
For further information:

http://www.parkersystemsinc.com/booms-barriers/markmasterv/

• Floating waste/debris

Seabin, PortBin, Trash Bin: "filter bins" for waste recovery in port waters

The industrialist Wärtsilä, a specialist in boat propulsion systems and increasingly concerned with current environmental issues, supported the implementation in Scandinavia in spring 2017 of the Seabin project, with the installation of its first Seabins in several Finnish ports (notably Uunisaari and Helsinki in May and June, respectively). The brainchild of two Australian boat builders, working together since 2015 within the company Seabin Pty Ltd, this project promotes equipment for collecting litter in port waters (or on any relatively sheltered body of water where floating waste can accumulate). It currently mobilises half a dozen partners to assess the effectiveness of the Seabin system on various pilot sites: in France (La Grande Motte), Montenegro (Porto Montenegro), Spain (Port Adriano), Bermuda (Butterfield) and the United States (Safe Harbor Marinas).



Views of the V5 Hybrid prototype of the Seabin floating waste collector (source: www.wartsila.com)

The model launched in 2017 is the V5 Hybrid version of the prototype. Resembling a floating dustbin (HDPE construction; Ø x H: 0.5 x 0.5 m), it is moored to a floating pontoon and equipped with a weir lip adjusted to the water surface via a submersible pump (electric, 12V; 25 m^3/hour).

The floating waste, carried by the current into the vortex created at the weir lip, is collected in a removable and reusable catch bag, with a mesh size designed to retain micro-plastics bigger than 2 mm.

Within the framework of this project, these prototypes were donated to the various pilot sites, the managers of the ports concerned being responsible for maintaining and monitoring them as well as for providing Wärtsilä with data on collection performance (quantity and quality of waste collected) or any technical issues. The objective of placing them on the market by the end of summer 2017 has now been achieved.

Also worth mentioning is the launch in 2017 of the PortBin system, again of Scandinavian origin, by Norwegian company SpillTech AS, the exclusive dealer of the range of oil spill response equipment manufactured by Henriksen. This is a vortex skimmer for floating waste fixed to a quay (and boasting a tide-compensating design), combining robust components (container derived from an oil skimmer) and displaying a significant water inflow rate (147 m^3/hour). The container consists of a basket with open mesh,[26] which would appear to makes the PortBin suitable for collecting litter. Based on a

[25] Made of recycled synthetic fibres, its interstitial structure is designed to ensure a large contact surface between the fibres and the liquid to be filtered, while ensuring free circulation of this liquid (see LTEI n°21).

[26] Of the order of a few centimetres, apparently, according to the images and films available on http://spilltech.no/index.html.

similar concept of vortex collection, the manufacturer DESMI has developed its Floating Trash Bin, derived from its weir skimmers for floating waste.

For further information:
http://seabinproject.com/
http://spilltech.no/index.html

• Recovery at sea

Surface net trawlers: a revised version of the NOTIL

The NOTIL is a surface trawler designed by French company Marine Tech and mainly used for the recovery of viscous/emulsified oil or other floating debris (notably litter and seaweed).

Consisting of a foldable aluminium frame and a polyethylene net (capacity 10 m^3), the system is relatively compact (W x L x H = 1.2 x 1.8 x 1.2 m) and sufficiently light (50 kg) to be carried on board and towed by various types of boats with sufficient power (engine of at least 50 hp). After launching, the drag exerted on the NOTIL by the water deploys the structure, with the net opening like an umbrella. A rope is used to close the net before the system is retrieved by a support vessel (or even on board if the towing vessel has sufficient deck space).

Marine Tech recently modified the NOTIL to facilitate handling operations, with the development of a new net design comprising a bottom-opening device for easier emptying of the contents collected in the net.

For further information:
www.marinetech.fr

• Monitoring and in-situ measurements

Remote sensing by high resolution and dual polarisation: the ISPAS OSD radar system

Norwegian company ISPAS has developed a radar system (ISPAS OSD) for the detection of floating oil slicks. This system offers high resolution via a high-frequency electronic antenna (Ku-band, microwave frequencies) with dual polarisation, and which can be oriented for 360° surveillance.

One of the advantages of this system is that it can effectively assess the presence and size of oil slicks in calm waters, conditions in which the more common X-band systems are generally limited. Dual polarisation enables detection based on the calculation, using specific algorithms, of the differences in attenuation of surface waves (measured here at high frequency) between areas on the water with and without oil.

The technology used by ISPAS led to the design of the first prototypes in 2009, tested regularly throughout their development during the 2010s with the support of several Norwegian oil companies (most recently at the NOFO 2018 Oil on Water exercise; see above). The new system, designed for monitoring purposes at offshore installations or for oil spill response operations from ships, was presented during the Spill Industry Seminars at the 2018 Interspill international conference and exhibition.

Moreover, trials of the system were conducted in 2015 in the tanks of Ohmsett (US) in order, notably, to test its capacity to distinguish between various types of oil and, above all, to estimate the thickness of slicks in various simulated sea states; this being possible, according to the manufacturer, by linking the data measured in dual polarisation.

For further information:
http://www.ispas.biz/

Detection and measurement of slick thicknesses

The U.S. Bureau of Safety and Environmental Enforcement (BSEE) commissioned the American University of Beirut (AUB) to develop systems for measuring oil slick thickness. The first phase of this project, concerning the identification of equipment to guide response operators during mechanical recovery operations at sea, was completed in 2018.

An initial sensor prototype was developed for the near real-time measurement of the thickness of slicks of various crude and refined oils (with radio transmission of data). One of the key points in the specifications is the system's reduced size, which enables it to be mounted on a weir skimmer (or an autonomous reconnaissance vehicle) during response operations.

Its principle is based on measuring capacitance values using a set of conductive electrodes immersed in the floating slick, the relative differences in these values reflecting the presence of interfaces between different layers of fluids and/or gases (e.g. air/oil, oil/water, etc.) and from which the thickness of the oil slick is determined (depending on the dimensions/positions of the electrodes). Based on capacity differences instead of absolute values, it would appear that this calculation does not require calibration. The prototype has been designed to operate in a range of thicknesses from 3 mm to 1 cm; a range that could be extended with the integration of certain design modifications.

Capacitance sensor mounted on a weir skimmer (here a DESMI Termite), being tested in the Ohmsett test tanks (source: AUB)

Its communication module currently ensures data transmission within a radius of 200 m, and it is also equipped with a GPS. The concept was tested at Ohmsett under different test conditions: on several types of oil, in both calm and choppy waters, and in static and dynamic mode. It would appear that the results were globally encouraging, with a margin of error in the estimation of the thicknesses of between 1 and 10 mm depending on the test conditions. In particular, accuracy was affected by strong agitation of the water body and/or the use of heavy/adherent products (causing the more or less rapid oiling of the electrodes). Phase II of the project, scheduled for 2018-2020, will investigate ways to improve this aspect.

Prototype buoy with LED spectrophotometer (source: AUB)

A second concept was developed, namely a LED spectrophotometer (for measuring the absorbance of light rays) intended for use on thinner oil thicknesses of between 100 µm and 3 mm.

The light source is provided by light-emitting diodes arranged under the surface of the water in a focused beam that, as it passes through the oil layer, is directed to a photoelectric cell (photodiodes) located above the surface. The relationship between the intensity of the electric signal and the thickness of the oil requires calibration prior to the implementation of the prototype, which is also equipped with GPS and real-time data radio transmission systems. Mounted on a buoy, this prototype could be used with a float for estimating the volumes (extension x thickness) of the slicks.

The performance of a prototype was assessed, also at Ohmsett, under variable conditions of agitation of the water body and on thin layers of two types of oils. While the detection (absence/presence of oil) proved effective, certain limitations were identified in the accuracy of the thickness measurements for reasons similar to those mentioned above (i.e. related to the intensity of agitation of the water and to the oiling of the cells). These limitations are currently the subject of research into possible enhancements to the system. It is worth noting, however, that the characteristics of the oils tested – and more precisely their "opacity" as a function of their thickness – could cause the range of thicknesses measurable using this technology to reach a ceiling below the 3 mm envisaged.

For further information:
https://www.bsee.gov/sites/bsee.gov/files/research-reports//1078aa.pdf (Phase I report of the project "*Development of an Oil Thickness Sensor*")

Aerostat 3: small tethered balloon for monitoring polluted surfaces

Since 2018, American company Elastec has been marketing the Aerostat 3, a small-volume (3 m^3) tethered balloon advertised as a compact and relatively inexpensive version of an aerial surveillance system that is also simpler to operate than a drone, for example, and requires less expertise.

Inflated with helium, the aerostat can remain in a stationary position for extended durations to enable real-time monitoring of floating pollution or even to check the effectiveness of response systems (containment or recovery, for example) using an on-board camera equipped with a wireless communication system.

From a visual perspective, the model is strongly reminiscent of the Hawk Owl developed by British company *Owls Surveillance Ltd*, but with a smaller volume (15 m^3 for the Hawk Owl).

Aerostat 3 (source: Elastec)

Equipped with a signalling system (radar deflector and LED lighting), the Aerostat 3 is designed to be able to attain altitudes of up to 200 m, secured to an anchoring system via a rope made of UHMWPE[27] fibre (Dyneema, from Dutch company DSM) chosen for its resistance (torsion, abrasion, etc.), its light weight, and its low elongation/deformation properties.

It is also worth noting that the small on-board digital camera (action camera) is mounted on a gimbal stabiliser with three motorised axes, controlled remotely via software and a joystick.

For further information:
https://www.elastec.com/products/aerial-surveillance/#photos
https://www.owls-surveillance.com/

CLAM: field kit for the sampling and extraction of chemical contaminants in the marine environment

The North American company Aqualytical has developed a small-scale device called CLAM (Continuous Low-Level Aquatic Monitoring) for the in-situ sampling of organic contaminants in the marine environment.

Weighing less than 900 grammes, this system has a rounded polycarbonate shell (about 15 cm in diameter), is powered by an autonomous battery, and houses a small submersible pump that creates a flow of water (of a volume that can be measured using a flow meter) passing through a solid phase extraction cartridge (SPE discs).[28] The target compounds are dissolved organic semi-volatile compounds, notably phthalates, organochlorine or organophosphorus pesticides, PCBs, etc.

Tested by various government agencies in the US (and notably by NOAA in 2018), one of the advantages of this system is its autonomy of 48 hours. This enables the analysis of large volumes of water and thus, as required, (i) the integration of conditions over a relatively long period of time, as well as (ii) the ability to detect very low concentrations (below detection limits in one-litre samples of water, according to the comparative assessments conducted by NOAA). In addition, cartridge extraction enables storage for several weeks prior to laboratory processing, a major advantage over more usual spot water sample analyses that require shorter deadlines.

Detailed view of the CLAM system and the complete field kit (CLAM 5000) (source: aqualytical.com)

For further information:
https://aqualytical.com/water-monitoring-extraction-kits/

[27] Ultra-high molecular weight polyethylene.
[28] Compliant with US EPA Method 3535.

• Dispersion

Approval procedures for chemical dispersants in the UK: transition to the Baffled Flask Test (BFT)

At the request of the United Kingdom's Marine Management Organisation (MMO), Cefas[29] re-examined and finally revised the procedures in force in the UK for testing the effectiveness of dispersants. This request was motivated by the perceived need for (i) a better standardisation of tests, (ii) an improvement in the quality of the procedures in terms of health and safety in particular, as well as (iii) greater harmonisation with international procedures. The results and analytical procedures specific to the Baffled Flask Test (BFT) of the U.S. Environmental Protection Agency (US EPA) were compared to the standard protocol used in the UK (LR448).

The results of the recently published Cefas study suggest that the dispersant effectiveness results obtained under the two standards are similar, and therefore lead to comparable conclusions. With this in mind, Cefas identified the following advantages of the BFT procedures over the LR448 protocol:

- greater standardisation of test equipment for better comparability between different laboratories;
- no requirement to use some of the potentially hazardous chemicals found under the LR448 protocol;
- better control of product mixing conditions and subsequent chemical analyses, as well as a BFT design enabling the simultaneous analysis of multiple samples for better consideration of the influence of various aspects of the test (mixing ratio and speed, temperature, solvents used, etc.).

Given these conclusions, the BFT method has now been adopted by the UK as the new standard for dispersant effectiveness testing.

For further information:

Sühring R., Smith A., Emerson H., Doran D., Mellor P., Kirby M.F. & Christie B., 2018. Qualification of oil-spill treatment products – Adopting the Baffled Flask Test for testing of dispersant efficacy in the UK. *Marine Pollution Bulletin*; 129 (2), 609-614. https://doi.org/10.1016/j.marpolbul.2017.10.038

The potential influence of sunlight on the chemical dispersion of floating oil slicks

Published in 2018, a scientific study funded by the National Science Foundation (NSF) and led by the Woods Hole Oceanographic Institution (WHOI) suggests that the natural photo-oxidation processes of floating oil slicks can, within a matter of hours, cause the oil to degrade into compounds that could potentially no longer be effectively treated by chemical dispersants.

The results of this experimental work conducted in the laboratory basically demonstrate how sunlight rapidly produces a photo-oxidised oil, the compounds of which show a decrease in solubility in the solvent contained in dispersants. This lower solubility would potentially limit contact between the surfactant molecules and the photo-oxidised oil, which in turn would be likely to reduce the effectiveness of chemical dispersion (i.e. the transformation into droplets, the first phase of dispersion).

The authors performed their assessments on crude oil samples from slicks collected almost immediately after their formation on the water surface in the wake of the *Deepwater Horizon* spill (Gulf of Mexico, US, 2010). Following photo-oxidation under controlled conditions, dispersibility tests were conducted, over time, using the BFT procedure from the US EPA (the standard in force in the United States) with Corexit EC9500A (dispersant-to-oil ratio of 1:20). It would appear that these tests showed a significant decrease in the effectiveness of the dispersants within just a few hours, and up to 30% or more after a few days.

In summary, the authors of the study suggest that, among the natural weathering processes of oil at sea, photo-oxidation plays a less negligible role in the "window of opportunity" for the application of chemical dispersants on surface slicks than was previously thought. They posit that, in addition to the environmental parameters controlling evaporation and emulsification (the main processes generally considered as decisive), sunlight could play a determining role in the decision whether or not to apply dispersants.

[29] Centre for Environment, Fisheries and Aquaculture Science.

For further information:

Ward C.P., Armstrong C.J., Conmy R.N., French-McCay D.P., & Reddy C.M., 2018. Photochemical Oxidation of Oil Reduced the Effectiveness of Aerial Dispersants Applied in Response to the *Deepwater Horizon Spill*. Environmental Science & Technology Letters, 5, 226−231. http://dx.doi.org/10.1021/acs.estlett.8b00084

• Research

Transport industry: ITOPF support for research

In 2018, the winner of the seventh ITOPF R&D Award was the ExpOS'D (Experimental Oil Spill Data-sharing) research project led by the NHL Stenden University of Applied Sciences (Netherlands), in partnership with the Royal Netherlands Institute for Sea Research, the University of Essex (UK) and the Wageningen University & Research (Netherlands). This study aims to validate and calibrate a dispersion model for the assessment, for a given spill, of the comparative fate and behaviour of oil slicks subject to two alternative dispersion hypotheses: chemical (dispersant application) and natural (no intervention). The idea behind this study is to provide decision-making support by taking into account longer-term mechanisms than those involved in the initial phases of dispersion (droplet formation then dilution), with the effects on the water column being considered in order to determine the potential (or lack thereof) for the formation of precursor sedimentation/flocculent accumulations of oil in the "marine snow" (the controversial MOSSFA concept[30] formulated following the *Deepwater Horizon* spill).

The 2019 ITOPF R&D Award went to Sintef for a project on the characterisation (weathering and behaviour) of low sulphur fuel oils (LSFOs), an emerging issue connected with Sulphur Emission Control Areas (SECAs) and in the run-up to the planned global reduction to 0.5% sulphur content in bunker fuels by 2020. The project has already received support from the Government of Canada within the framework of its "Multi-Partner Oil Spill Research Initiative" (MPRI) programme and from the Norwegian Coastal Administration (NCA).

• Fines and legal proceedings

***Deepwater Horizon* spill compensation: over US$65 billion**

At the beginning of 2018, British company BP announced that it had recorded an additional US$1.7 billion for the settlement of claims arising from the 2010 oil spill in the Gulf of Mexico (US). Resulting from a higher than expected valuation of claims in the last quarter of 2017, this brings the total compensation paid out by the company (including fines, compensation to victims, and clean-up costs) to around US$65 billion.

While more than 99% of the 390,000 claims under the settlement programme overseen by the U.S. courts had been processed by this stage, BP had indicated that it expected to incur additional costs of $3 billion to settle the outstanding claims in 2018, instead of the $2 billion previously envisaged for this year.

[30] Marine Oil Snow Sedimentation and Flocculent Accumulation