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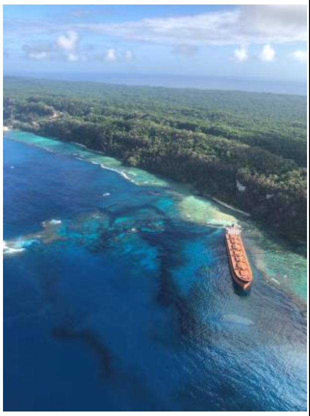
• Spills

Pollution in a remote and ecologically sensitive coastal area: grounding of the *Solomon Trader* (Rennell Island, Solomon Islands)

On 5th February 2019, the Hong Kong-flagged bulk carrier *Solomon Trader* (225 m; 38,779 GT) ran aground in Kangava Bay, Renell Island (Solomon Islands, South Pacific), while loading a cargo of bauxite from a mine site operated by an Indonesian firm.

The incident, linked to the passage of tropical cyclone Oma, caused damage to the ship's structure, including water ingress in the engine room and breaches in the fuel tanks, which soon resulted in leaks of oily water and IFO 380 from the wreck, forming of brownish streaks several hundred metres long. During the first 10 days or so, it was difficult to obtain accurate information on the spill (leakage point; flow rate; etc.) due to difficult access and adverse metocean conditions, which hindered initial assistance and rescue actions.

From the outset, the potential impact of this ongoing spill raised strong concerns given the national authorities' lack of experience in dealing with this type of situation[1] and given the environmental sensitivity of the region, which is close to a chain of coral reefs; Rennell Island also includes a UNESCO World Heritage site (ultimately unaffected by the oil). The quantity of bunker fuel on board was estimated at around 700 tonnes.



Aerial view of the Salomon Trader *and of the remote site where it grounded (source: MNZ)*

The Solomon Islands Government requested assistance from Australia on 16th February. Australia agreed to provide assistance and, under the provisions of PACPLAN (Pacific Islands Regional Marine Spill Contingency Plan)[2], dispatched experts and equipment from AMSA (and its New Zealand counterpart MNZ[3]) to carry out surveys and provide technical advice on incident management, in particular by integrating the crisis unit established in Honiara[4] alongside representatives of relevant public and private organisations (including the responsible party).

On the 24th, this request was extended to include participation in the response plan and operations; in this context, AMSA and MNZ jointly sent response equipment via 3 freight plane trips, and also dispatched a surveillance plane and a specialised vessel to the area. AMOSC[5] was also part of this support mechanism, with 2 teams of responders for response and monitoring/assessment. On 1st March, AMSA confirmed a fuel leak estimated at this stage at between 80 and 100 tonnes. On 7th March, the assistance mission launched response operations, first at sea with the deployment of equipment and nautical resources from Australia (plus support vessels from Honiara) in Kagava Bay.

Meanwhile, the Solomon Islands government charged the shipowner and charterer of the vessel with stopping the pollution risk by implementing salvage operations and securing the vessel. However the Indonesian company Bintan Mining Corporation (mining operator and charterer of the *Solomon Trader*), which had also been criticised for maintaining ore loading operations while a weather warning was in progress, claimed that this was the shipowner's responsibility (King Trading Ltd).

At the beginning of March, the shipowner and its insurer commissioned the specialised company Resolve Marine to salvage the vessel, while indicating delays in assessment and intervention due to difficulties in accessing the site, which was moreover remote and lacking in infrastructure and local resources[6].

1 The Solomon Islands National Disaster Management Office had indeed never before had to face this type of emergency (maritime rescue and oil spill response)
2 Regional framework for cooperative regional responses to major marine spills in the Pacific islands region.
3 Maritime New Zealand
4 (capital of the Solomon Islands, on Guadalcanal - i.e. approx. 250 km from operations)
5 Australian Marine Oil Spill Centre, an oil industry response cooperative operating in Australia.
6 Also according to the owner, acts of vandalism committed after the crew had abandoned the vessel reportedly led to the loss of shipboard resources that could have been useful for operations.

Fuel oil leaking from the Solomon Trader*, grounded against coral reefs (source: MNZ)*

During the second week of operations on the wreck, Australia and the Solomon Islands Government deemed the operations (e.g. lightering) to be appropriate, and confirmed that there were few additional oil leaks.

Australia handed over offshore operations to the salvage company, and terminated its response activities in the third week of March, while maintaining its support in monitoring clean-up and advising the national authorities. The vessel was refloated and towed away on 11th May 2019.

The IFO 380 spill, ultimately estimated at around 100 tonnes, caused oil to be washed up on almost 5 km of coastline, affected in a discontinuous manner and to varying degrees.

Despite this limited spread, coastal clean-up operations faced particular technical and logistical difficulties (in addition to those linked to the site's inaccessibility and remote location), in particular relating to the beaching of hundreds of heavily polluted logs, each about twenty metres long, from a casualty barge and a nearby logging yard. Response operations continued until July 2019.

Right: logs heavily oiled with IFO 380, washing up on the shores of Kagava Bay (Source: MNZ)

A number of points (and in some cases real challenges) relating to intervention in such a geographical context were pinpointed by MNZ.[7] Potentially applicable to other islands in the South West Pacific, these points more generally relate to the issue of international assistance. In short, the following are required:

- a good understanding of the country's regulatory/legislative framework where the operations are taking place, for coherent integration of assistance with any existing local schemes, plans, etc.;
- consideration of customs procedures and other possible issues for the transport of equipment and products (authorisations, quarantines, etc.);
- knowledge, preferably prior to operations, of entities/stakeholders potentially involved (e.g. government authorities, provincial authorities, local authorities, etc.; representatives of the responsible party: shipowners, insurers, technical experts, companies contracted for clean-up, salvage, etc.). The existence of regional agreements (here PACPLAN) is an advantage;
- against the regional context of isolation/remoteness for many island countries: HSE aspects in remote environments (responder health and safety); the possible dependence of the implementation/schedule of operations and the availability of military resources (freight aircraft, in particular).

Hose rupture and spill from an offshore platform (Petrobras, Brazil)

At the end of February, in the Campos Basin (approximately 150 km off the Brazilian state of Espirito Santo), the rupture of a hose during the transfer of oil between an offshore platform operated by Petrobras and an oil tanker caused an oil spill initially estimated, through aerial reconnaissance surveys, at almost 190 m³.

Two vessels reportedly carried out containment and recovery operations at sea, while aerial surveillance of the spread of the oil maintained. As the spill occurred far from the coast and was moderate in size, it did not threaten the Brazilian coast, as confirmed by the results of numerical drift modelling.

The oil operator notified the relevant offshore regulatory authorities and an investigation into the causes of the transfer line failure was launched (the outcomes of which are not known to us).

[7] Editor's note: reported by a representative of MNZ during the 8th Industry Technical Advisory Committee (ITAC) held in Southampton from 2nd to 4th October 2019.

Shipwrecking and oil spill off France (*Grande America*, Bay of Biscay)

During the night of 10th to 11th March 2019 in the Bay of Biscay, more than 330 km west of the coast of Charente-Maritime (France), a fire broke out on board the Italian-flagged ro-ro/container carrier *Grande America*, en route from Hamburg (Germany) to Casablanca (Morocco). The cargo comprised over 2,000 vehicles of all types (cars, heavy goods vehicles, earthworks machinery, motorhomes, etc.) and 365 containers (247 of which were stowed on deck). Forty-five of these contained substances classed as dangerous under the International Maritime Dangerous Goods (IMDG) Code[8], of varying types and quantities (including, by way of illustration, and for the highest quantities: 720 tonnes of hydrochloric acid, 85 tonnes of sodium hydrosulphide, 82 tonnes of sulphuric acid, 62 tonnes of resin in solution, 25 tonnes of prothioconazole, etc.). Some 2,200 tonnes of bunker fuel (IFO 380), 190 m^3 of marine diesel oil (MDO) and 70 m^3 of lubricants were also on board.

From the onset of this maritime crisis, the Atlantic Maritime Prefecture successively activated three aspects of the maritime ORSEC contingency plan: SAR (Search And Rescue), ANED (assistance to a vessel in distress) and POLMAR (marine pollution).

During the first few hours, as the fire spread inside the vessel which was soon to start drifting, priority rescue operations were difficult due to very rough sea conditions. The 27 people on board, who evacuated the ship on a lifeboat, were rescued by the British frigate *HMS Argyll*, which was on en route for Plymouth and was diverted by the MRCC Étel[9]. They were transfered to Brest onboard the French Navy vessel the *Argonaute*.

In terms of assistance to the vessel in distress (ANED), the Maritime Prefect mobilised various vessels including the frigate *Aquitaine*, the offshore tug *Abeille Bourbon* and the *VN Sapeur*, as well as aircraft; an incident management team was set up and based in the incident management centre at the Maritime Prefecture in Brest. The shipowner[10] contracted the salvage company Ardent, which dispatched two tugs to participate in fire-fighting operations. These operations proved unsuccessful, and were suspended due to the risk of causing the vessel to list.

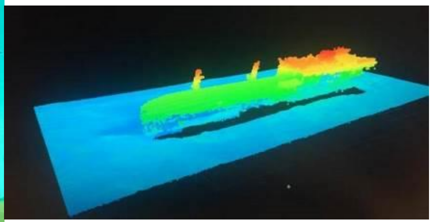
The container carrier/ro-ro vessel the Grande America *on fire in the Bay of Biscay (Source: French Navy)*

Despite response efforts, after the blaze had raged uncontrollably for two days with violent explosions in rough seas, the ship, which could be neither manoeuvred nor towed, sank in waters 4,600 m deep on 12th March. It is difficult to estimate how much of the HNS[11] cargo was burnt and how much sank with the vessel. As for the oil, upwellings of fuel oil were first spotted at sea on the morning of 13th March near the last known position of the *Grande America*.

As soon as the shipwreck occurred, aerial surveys conducted from French Navy and Customs aircraft were carried out to assess the risks posed by the containers fallen overboard and by the drifting oil; the French Navy's marine pollution response unit, reinforced by Ceppol experts, was deployed, still in deteriorating metocean conditions. It received support from Spanish vessels[12], initially the *Don Inda*, subsequently replaced by other vessels, and the *Ria de Vigo* –chartered by EMSA which also sent the *VN Partisan*.

The Maritime Prefecture tasked the Drift Committee (composed of representatives of Météo-France, SHOM, Ifremer and Cedre) with assessing the risks of the oil reaching the shoreline, by conducting a daily analysis of the drift forecasts for the slicks observed at sea (calculated by Météo-France's MOTHY model). Cedre also provided advice to the maritime authorities and those involved in offshore response, including through studies into the bunker oil's behaviour, carried out in its experimental facilities (Polludrome®) and in its analysis laboratory.

8 International Maritime Dangerous Goods Code
9 Maritime Rescue Coordination Centre (or CROSS in France)
10 Given official notice, on 11th March, by the Maritime Prefect for the Atlantic to take the necessary measures to stop the danger posed by the *Grande America* in the French EEZ
11 Hazardous and Noxious Substances
12 The Biscaye Plan was activated on 15th March.



***Above**: the structure of the* Grande America *lying on a soft bottom;* ***Left**: fuel oil leaking from one of the breaches in the wreck (source: www.premar-atlantique.gouv.fr)*

Concurrently with surface response efforts, the multi-purpose supply vessel *Island Pride*, a Norwegian vessel specialising in offshore work, arrived on site towards the end of March, chartered by the shipowner to locate and inspect the wreck of the *Grande America* using remotely operated vehicles (ROVs). The leaks from the wreck were plugged during the first half of April.

In often very difficult sea and weather conditions, which also contributed to the fragmentation and dissemination, in patches, of the fuel oil that had rapidly emulsified under the effect of mixing due to wave action, offshore operations had to be suspended several times.

As windows of opportunity presented themselves, operations nevertheless resulted, at the turn of March-April, in the recovery of 36 tonnes of solid waste and some 580 m^3 of a mixture of oil and water (unloaded in La Rochelle and Brest), as well as 6 drifting containers.

Wide spread, in the form of sheen, of the small light fraction present in the upwellings of bunker fuel (source: French Navy, 15.03.2019)

***Left**: Appearance of the emulsified fuel oil, fragmented into viscous clusters (14.03.2019);* ***Centre**: offshore containment operations on patches of fuel oil using booms (here deployed using a boom vane), and skimming operations using a Lamor offshore skimmer (weir + brush module), operated from the Argonaute via a reel-mounted umbilical (19.03.2019);* ***Right**: Hauling a Thomsea surface trawlnet, used to recover scattered clusters of viscous fuel oil, onto the deck of the* Argonaute *(source: French Navy)*

Onshore, an operational centre for the south-west defence zone was activated, due to the potential risk of shoreline oiling in at least 3 departments (Charente-Maritime, Gironde and Landes), which remained unaffected in 2019. During winter storms in February 2020, scattered strandings of tarballs on certain beaches in the Loire-Atlantique and Vendée areas were shown by Cedre to match the bunker fuel of the *Grande America*, which suggested the possibility of leaks from the wreck. These sporadic strandings were insufficient to justify activating the POLMAR shoreline contingency plan; their recovery was organised by the local authorities.

While repeated aerial surveys conducted using French Navy and Customs planes identified traces of fuel oil on 21st February in the incident area, their detection and further relocation were hampered by prevailing weather conditions.

Leak of bunker fuel from a container ship in a coastal waterway (*Dublin Express*, US)

At the end of March, a spill of bunker fuel from the container ship *Dublin Express* occurred in the Arthur Kill Waterway near Staten Island (New York State).

The vessel had previously experienced damage to one of its bunker tanks while en route from Port Everglades to New York, during a severe storm that caused more than a dozen deck containers to fall overboard.

Noticed during unloading operations at the Global Marine container terminal (New York), the breach (measuring 40 x 40 cm) was reportedly responsible for the leakage at sea of around 380 m^3 of heavy fuel oil (No. 6 fuel oil, as per the American terminology). The operations undertaken in the

Arthur Kill Waterway by the Unified Command set up to manage the spill, under the coordination of the United States Coast Guard (USCG) and bringing together all competent federal and regional agencies as well as the responsible party, resulted in the containment and recovery of around 130 m^3 of emulsion. SCAT (Shoreline Cleanup and Assessment Technique) surveys and recovery operations were conducted after scattered oilings were spotted locally on the banks of this waterway near Elizabeth (on the New Jersey side). Analyses were also conducted to investigate the possible link between the spill and arrivals of tarballs observed on some more distant sites around the same time.

Petrol (gasoline) spill following a collision between a tug and a gas tanker (Houston Ship Channel, US)

In May, approximately 4 km south-east of the Bayport Container Terminal in the Houston Ship Channel (Texas, US), a tug pushing two tank barges (*Kirby 30015T* and *MMI 3041*), each with a cargo of some 4,000 m^3 of petrol (gasoline), collided with the gas tanker *Genesis River*, which was transporting a cargo of butane and propane. While the collision had no impact on the latter vessel, one of the barges was damaged and the other overturned, releasing part of its cargo into the water, for a volume estimated by the United States Coast Guard (USCG) at around 1,430 m^3.
The nature of the spill, involving a light, volatile petroleum product, initially prompted the establishment of an exclusion zone of 1 nautical mile around the spill, with the temporary closure of the affected section of the waterway to traffic and the monitoring of air quality in the area.
According to the federal, regional and local authorities, grouped together within a Unified Command led by the USCG, more than 330 responders were mobilised for the spill response operations (aerial and nautical surveys, containment and recovery, protection of sensitive sites), as well as the securing and lightering of the tanks of the two barges. The Unified Command indicated that more than 1,000 m of both containment and sorbent booms were deployed in different configurations (containment, protection, etc.), with recovery on the water by skimming of approximately 60 m^3 of a water/oil mixture (precise ratio not specified in our information sources).

• Statistics

Oil spills in the United States in 2018: NOAA perspective

On the basis of the relevant information brought to its attention (notifications from other bodies such as the USCG for example, direct observations, etc.), the National Oceanic and Atmospheric Administration (NOAA) recently estimated that 137 confirmed oil spills had occurred in the United States in 2018, i.e. an average frequency of around 11 spills per month. It should be noted, however, that NOAA appears to have made no distinction here between accidental and deliberate incidents (e.g. operational discharges from ships, for example), or between “mystery” spills and those linked to an identified source or structure.

Thanks to the data provided, NOAA was able to estimate the extent of these spills in just under half of the cases (65 spills). According to the agency, the absence of such estimates for the other spills can notably be explained by events involving thin floating pollution (sheen, films, etc.), with therefore in theory relatively low volumes of oil. For the 65 spills that were quantified by NOAA for 2018, the volumes involved varied significantly, ranging from around 100 litres (30 gallons) to nearly 8,000 m^3 (2.1 million gallons).

In the absence of more accurate data, it is indicated that only one of the 137 events in 2018 could be considered as a large spill according to the ITOPF classification[13], and 25 others as medium spills (the remaining 111 events, i.e. 80% of the spills recorded, therefore by deduction being small spills, again according to ITOPF’s terminology).

In terms of distribution across the US territory, the highest frequency of reported spills was observed in Louisiana (52 spills, on land or at sea – no further details given), followed by Texas (13 spills) and Alaska (10 spills). This is not particularly surprising given that these are states with a high number of oil and gas fields that play a major role in the country’s oil industry (although California, which also

[13] As a reminder, ITOPF defines large spills as those over 700 tonnes, medium spills as those between 7 and 700 tonnes, and small spills as those below 7 tonnes.

boasts a significant number of oil fields, is not listed alongside these three states).

It is difficult to compare these statistics with the annual spill reports produced by Cedre (regularly published in both the Sea & Shore and Inland Waters Technical Newsletters) due to the analysis criteria being specific to the scope of its missions (Cedre targeting spills affecting surface waters)[14], or with the statistics published by other organisations such as ITOPF for different reasons (in this case, the focus on ship-source spills). It should nevertheless be noted that the high prevalence of small spills reported by NOAA helps to highlight the chronic, scattered and cumulative nature of oil pollution, in the United States as in Europe, as opposed to rarer major incidents (such as the *Deepwater Horizon* spill which occurred ten years ago, in North America).

For further information:

https://blog.resourcewatch.org/2019/02/07/there-were-137-oil-spills-in-the-us-in-2018-see-where-they-happened/

● Response preparedness/(inter)national strategies

China Maritime Safety Administration: a new list of liquid bulk cargoes requiring spill prevention and response measures

In 2019, the China Maritime Safety Administration (MSA) expanded its spill prevention requirements for vessels undertaking ship-to-ship transfers of a number of specific cargoes in Chinese ports. These requirements consist in the obligation (i) to be able to rapidly deploy oil booms in the event of a spill, and (ii) to have previously entered into a pollution clean-up contract with a Ship Pollution Response Organisation (SPRO).[15] The requirements refer to the anti-pollution measures set out in article 41 of the Marine Environment Protection Law of the People's Republic of China, as well as Article 27 of the Regulations of the People's Republic of China on the Prevention of Vessel-induced Sea Pollution.

The regulations issued by the MSA cover 263 types of cargo, including: 16 persistent oils listed in Annex I of the MARPOL Convention; and 247 hazardous and noxious substances (HNS) transported as liquid bulk, as listed in Chapters 17 and 18 of the IBC Code[16] and in Annexes 1 and 5 of Resolution MEPC.2/Circ.24 of the IMO Marine Environment Protection Committee (MEPC), i.e. floating substances with a density less than that of water and with a solubility value of less than 0.1%.

For further information:
http://en.msa.gov.cn/

EMSA: chemical dispersion capability, spill response fleet

In 2019, the European Maritime Safety Agency (EMSA) set up a new stockpile of chemical dispersants in Ravenna, Italy, within the framework of its Equipment Assistance Service (EAS). Comprising 200 tonnes of Radiagreen OSD and the same quantity of Slickgone NS, this stockpile is intended to be primarily used in the Adriatic Sea, but can be mobilised beyond this region upon request from member countries in other parts of Europe. In addition, EMSA has also added ship-borne removable spray arms to its Equipment Assistance Service. This brings the number of EMSA's operational dispersant stockpiles to six, comprising a total volume of 1,400 tonnes of products, with four of these stockpiles being associated with the Agency's chartered fleet of spill response vessels and two with its Equipment Assistance Services.

For further information:
http://www.emsa.europa.eu/we-do/sustainability/pollution-response-services/oil-recovery-vessels/item/2785-equipment-assistance-service.html

[14] From various incident reports, bulletins and NOAA press releases, it would seem that the agency is also notified (with requests for its support and expertise) in the event of spills that do not necessarily result in water pollution.

[15] Before performing any transfer or loading/unloading operations, or before entering a Chinese port, in accordance with the requirements (concerning standards governing specialised companies) described in Article 33 of the Regulations of the People's Republic of China on the Prevention and Control of Marine Pollution from Ships.

[16] International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk.

Moreover, the supply vessel *Lundy Sentinel* (from Scottish operator Sentinel Marine), chartered since the end of 2018 by the European Fisheries Control Agency (EFCA) to ensure fisheries surveillance in international and EU waters, integrated EMSA's fleet of spill response vessels in 2019. This adaptation to this new type of mission falls within the context of (i) a recent agreement targeting broader cooperation between the two agencies, including for example the deployment of EMSA remotely piloted aircraft in support of the EFCS, and (ii) cooperation with the European Border and Coast Guard Agency (Frontex), whereby EMSA, EFCS and Frontex work together to support the national authorities.

View of the aft deck of the Lundy Sentinel during a spill response equipment deployment exercise (Vigo Bay; source: https://www.efca.europa.eu)

Adaptation of the Lundy Sentinel for this purpose included the integration of spill response equipment, specific training for crews, and participation in an exercise in Vigo Bay (Spain) in spring 2019.

IOPC Funds: the Republic of Guyana becomes the 116th Member State of the 1992 Fund

In the first quarter of 2019, the Republic of Guyana deposited instruments of accession to the 1992 Civil Liability and Fund Conventions, with both Conventions entering into force for Guyana on 20 February 2020, bringing the number of 1992 Fund Member States to 116.

Guyana was Party to the 1971 Fund Convention until it ceased to be in force in May 2002. The country had not been covered by the IOPC Funds since that time.

For further information:
https://iopcfunds.org/news/guyana-to-become-the-116th-member-state-of-the-1992-fund/

Vietnam: Ministry of Environment and impact assessment of marine oil spills

In 2019, the Vietnamese Ministry of Natural Resources and Environment issued a circular on the national regulations governing emergency response operations in the event of marine oil spills. This circular introduced the requirement to initiate a preliminary assessment of the risk for the environment within the first 10 days of an event being reported, this assessment notably consisting in establishing the pollution levels of the affected waters. Where these levels exceed the thresholds authorised under national standards, a detailed assessment of the types and extent of the resulting impacts on the environment must then be launched within 20 days of the initial findings.

We have no information concerning the details of this circular (any definitions of the area, type or methods of monitoring, etc.). However, it would appear that the idea is to establish the basis for implementing procedures aimed at rapidly ranking the severity of the pollution and, consequently, associating the obligations imposed on the liable party in terms of presenting response plans and measures to minimise the resulting environmental impact. In some cases, monitoring could also provide information to support decision-making by the authorities on the obligation of the liable party to draw up a plan for the clean-up and restoration of the oiled environment.

• Oil industry initiatives

OSRL: unmanned aircraft to support spill response operations

Since 2019, in order to meet the growing demand for such services on the part of its members, Oil Spill Response Ltd (OSRL) has been offering a service devoted to the mobilisation and operation of unmanned aircraft (UAVs, or drones) in support of oil spill response operations.

This service is based on call-off agreements made by OSRL with a number of providers of equipment and expertise throughout the world, with a view to offering a multi-country network ensuring reduced mobilisation times.

This outsourcing arrangement with specialised partners[17] was deemed to be the most cost-effective and flexible solution given both the highly evolving nature of technologies and equipment, and the

[17] Notably the companies Bristow Aerial Solutions, Sky-Futures, Vertical Horizon Media…

major disparities in national regulations in the field of UAVs (authorisations/permits, scope of usage, etc.). In addition to providing a flexible offer, the idea is also for OSRL members to be able to benefit from the most recent technologies available on the market, without having to invest in, maintain, or regularly renew their own fleet of UAVs.

The missions that UAVs could undertake in spill response operations fall into various fields identified over recent years: support for pollution surveys within specific contexts (extensive coastlines or those that are hard to reach by sea or land, etc.), verification of the effectiveness of response operations (positioning and effectiveness of floating oil containment systems, support for the monitoring of cleaned sites, etc.), and so on.

For further information:
https://www.oilspillresponse.com/globalassets/technical-library/information-sheets/tis-uav-service.pdf

• Hazardous and noxious substances

Third international conference on CBRNE risks (Nantes, 2019)

The third international conference on risks related to CBRNE (Chemical, Biological, Radiological, Nuclear, and Explosive) agents was held from 20 to 23 May 2019 at the International Convention Centre in Nantes, France. This conference, sponsored by several institutional partners (French Ministry of Armed Forces, fire brigade, etc.) and industry specialists (Dräger, BIG, etc.), brought together more than one thousand people around the main issue of population safety.

Recent history has shown that both civilian and military populations can be exposed to highly hazardous CBRNE agents, whether as a result of natural disasters, industrial incidents, armed conflict, or even terrorist attacks. To better respond to such events, governments have made budgets available to accelerate research with a view to ultimately benefiting from more effective countermeasures. NATO also participated in the event by sponsoring a workshop aimed at promoting discussions between the various stakeholders in this field. The objective of this workshop was twofold: to ensure better defence of the Alliance and, by extension, to enhance the protection of the populations that could potentially be exposed.

With regard to spills of hazardous chemicals, it is worth mentioning the proliferation of guides presenting the various response strategies that can be deployed, and notably that issued by the U.S. Department of Health and Human Services (HHS), entitled Primary Response Incident Scene Management (PRISM). This manual for operational staff in charge of spill response operations comprises three volumes: Strategic Guidance, Tactical Guidance and Operational Guidance (https://medicalcountermeasures.gov/barda/cbrn/prism). The UK government agency Public Health England also published a similar work entitled A Handbook to Support and Inform First Responders.

With respect to training, the spotlight was placed on interactivity through the growing presence of Serious Games such as those developed by Ankara University in Turkey. Via realistic scenarios in terms of both content and format (high definition graphics), trainees are placed in a situation simulating a CBRNE threat and a response based on currently available techniques and equipment.

More specifically in relation to response, recent developments in sensors now enable the real-time detection and monitoring of the toxic gas clouds that can form as a result of a chemical spill, thereby ensuring live monitoring of the exposure of responders, and even the populations concerned. In this respect, video cameras (a field that is seeing a growing number of applications) are increasingly drawing on FLIR technology. It is now possible to very accurately determine the boundaries of a gas cloud and to discern the distribution of concentrations therein. In addition, there have been numerous advances in techniques that reduce gas cloud formation following HNS spills (whether on the ground or on the water surface). Today, new materials are emerging that can be used either in the composition of the sorbents to be spread on the spill, such as Metal-Organic Frameworks (MOFs), or in the manufacture of gas mask filters, which thus see their range of applicability and their duration of service life increase.

Response preparedness: the West MOPoCo project (2019-2020)

Financed by the European Union's Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO), the West MOPoCo (Western Mediterranean region Marine Oil and HNS POllution COoperation) project brings together 12 partners (including Cedre), as well as the Principality of Monaco with its own funding. It aims to reinforce inter-regional cooperation in terms of preparedness and response to spills of oils and hazardous and noxious substances (HNS) at sea.

In addition to project management and communication, four areas of work are defined:

- The development or updating of spill response assistance tools: HNS response manuals, and tools developed by REMPEC such as the Maritime Integrated Decision Support Information System on Transport of Chemical Substances (MIDSIS-TROCS) or the Mediterranean Emergency Reporting System (MedERSys), etc.
- The assessment of the national contingency plans of the countries concerned and, if necessary, the formulation of recommendations for improvements to be implemented.
- The study of international cooperation mechanisms for emergency procedures in the area, and the strengthening of synergies between countries in the event of a spill.
- The organisation of regional workshops and training courses on the use of the developed or updated tools and procedures.

West MOPoCo is part of several cooperation agreements already in force, including the EU Civil Protection Mechanism, the WestMED Initiative, the 2002 Prevention and Emergency Protocol (Barcelona Convention), the Regional Strategy for the Prevention and Response to Marine Pollution from Ships (2016-2021), and other multilateral agreements.

For further information:
https://www.westmopoco.rempec.org/fr

U.S. EPA: list of 40 substances to be ranked for risk assessment

In 2019, the U.S. Environmental Protection Agency (EPA) issued a list of 40 chemical substances that were undergoing a prioritisation process it had initiated with a view to the assessment of their associated risks. This process is in accordance with the *Toxic Substances Control Act* (TSCA) that requires that, by the end of December 2019 at the very latest, 20 high-priority and 20 low-priority chemical substances be identified by the EPA for risk assessment.

The EPA website provides an explanation of the reasons for the choices of substances making up this list, as well as information on the data sources used to substantiate these choices (existing databases, manufacturers' data, various national and international public sources[18], publications, grey literature, etc.). Within the framework of this prioritisation process, the Agency examined the available data concerning various aspects of the substances (hazardous nature, exposure, uses, physicochemical fate, behaviour, transportation, etc.), the similarities between substances (chemical, functional – solvents, phthalates, for example), as well as the extent of their use in industry.

The 20 chemicals selected as candidates for designation as high-priority substances were proposed with three graduated "statuses" corresponding to the progression of the process in 2019. These were: "initiation", i.e. the first stage of the prioritisation process, with the substance undergoing a review of the available data to inform its designation ("high" or "low" priority); "proposed", i.e. the second stage of the process, proposing a designation of the substance as high- or low-priority for risk assessment; and "high/low", i.e. the stage validating this designation. For the 20 low-priority substances, the EPA based its work on a list of 30,000 chemicals, progressively refined according to various criteria, in particular the avoidance of redundancy with assessments already performed by other entities (within the American Administration, the OECD, etc.). The end of this process saw the proposal of 20 substances by the EPA.

Details of this initiative with the list of the 40 proposed substances are available on the EPA website. To date, the list of substances proposed by the EPA as high-priority includes the following (related and grouped by category): 8 halogenated organic compounds (2 dichlorobenzenes, 3 dichloroethanes, 1 dibromoethane, 1 dichloropropane, and 1 dichloroethylene); 5 phthalates; 3 flame retardants (halogenated and non-halogenated); 2 substances used as "chemical intermediates" (butadiene and phthalic anhydride); 1 fragrance ingredient; and, finally, formaldehyde.

For further information:
https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/chemical-substances-undergoing-prioritization-high

[18] U.S. EPA, International Agency for Research on Cancer (IARC/WHO), National Toxicology Program (NTP), National Institute for Occupational Safety and Health (NIOSH), Organisation for Economic Co-operation and Development (OECD), Agency for Toxic Substances and Disease Registry (ATSDR), California Environmental Protection, among others.

• Detection

Cold environments: nuclear magnetic resonance of the Earth's field and detection of oil under ice

The application of existing technologies and sensors (acoustic sensors, optical sensors, fluorometers, etc.) for the detection of oil in and under ice has been the subject of much assessment and research over the past few years. Another recently tested technology is nuclear magnetic resonance (NMR) of the Earth's field.

The use of NMR in this context, motivated by the anticipated increase in pollution risks in Arctic environments (and therefore all corresponding response operations), has experienced significant developments since 2006, with results deemed promising by ExxonMobil in particular, this company having studied its applicability, notably via the implementation of a helicopter-borne prototype.

The first assessments in this area concerned tests on the detection of a crude oil substitute in the presence of water and ice. These tests used an NMR antenna (based on the principle of analysing the disturbance in the Earth's magnetic field) with a flat coil/antenna prototype (1 x 1 m) acting as a transceiver, which successfully discriminated between the sea water and the simulated oil. Research subsequently focused on scaling up the prototype to a diameter of 6 m to increase the signal-to-noise ratio and enable detection under ice up to 1 m thick, as tested at the Cold Regions Research and Engineering Laboratory (CRREL) in Hanover (US).

At the end of 2016 in Newfoundland (Canada), an NMR antenna was deployed from a helicopter (at an altitude of between 30 and 60 m) to test the sensitivity of a reinforced prototype according to these implementation methods. This feasibility test phase concluded that the NMR system was capable of detecting a 1 cm-thick layer of oil under almost 1 m of ice.


Left: view of the reinforced NMR antenna prototype (Ø = 6 m) being tested in Newfoundland (Canada) in 2016; Right: deployment by helicopter (source: Palandro et al., IOSC 2017)

In 2019, a new publication provided an update on this technology and the main results and lessons learned from the R&D activities undertaken through this project led by ExxonMobil.

In operational terms, the advantages of the technique highlighted by the authors include that it (i) offers non-invasive detection of trapped oil (no coring, boring, etc.), (ii) does not require the deployment of personnel on the ice, and (iii) enables the rapid investigation of large areas (3 to 4 minutes to cover 30 m^2).

For further information:

Altobelli S.A., Conrad M.S., Fukushima E., Hodgson J., Nedwed T.J., Palandro D.A., Peach A., Sowko N.J., & Thomann H., 2019. Helicopter-borne NMR for detection of oil under sea-ice. *Marine Pollution Bulletin*, Volume 144, Pages 160-166. https://doi.org/10.1016/j.marpolbul.2019.04.041

And also:

Chavez L., Altobelli S., Fukushima E., Zhang T., Nedwed T., Palandro D., Srnka L. & Thomann, H., 2015. Detecting Arctic Oil Spills with NMR: A Feasibility Study. Near Surface Geophysics. 13: 409-416. http://dx.doi.org/10.3997/1873-0604.2015023.

Palandro D., Nedwed T., DeMicco E., Thomann H., Fukushima E., Chavez L. & Altobelli S., 2015. The detection of oil in and under ice using nuclear magnetic resonance. In: *Proceedings of the 38th AMOP Technical Seminar on Environmental Contamination and Response*, Environment Canada. Ottawa, ON. 38: 1-7.

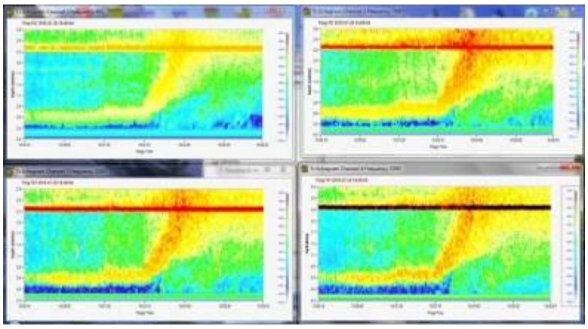
Submerged oil plumes: detection by multi-frequency ultrasonic echosounder

A series of tests to assess the performance of the multi-frequency Acoustic Zooplankton Fish Profiler (AZFP) for the detection of oil plumes in a body of water were recently conducted at the mesoscale at the Ohmsett test facility (US).

This acoustic echosounder was developed by the American company ASL Environmental Sciences. The assessments were jointly conducted by the U.S. Naval Research Laboratory (NRL) and the federal Environmental Protection Agency (EPA), with the financial support of the Bureau of Safety and Environmental Enforcement (BSEE). The applications of this system initially focused on monitoring the presence and abundance of pelagic organisms of potentially highly variable sizes (from zooplankton to fish), based on the use of several ultrasonic frequencies (i.e. greater than 20 kHz). The advantage of these frequencies lies in the intensity of backscatter of the signal with very small targets at high resolution levels. In addition, due to its low energy consumption, relatively compact format and low cost, this type of technology appears to be well suited to prolonged use when deployed from autonomous underwater vehicles, and as a complement to other technologies for detecting and measuring oil contents requiring the deployment of sensors (e.g. fluorometers) in relatively close proximity.

For the Ohmsett tests, the acoustic profiler was installed at the bottom of the test tank, while oil jets at varying flow rates and outlet pressures were successively created at different water heights above the device.

The backscatter values of the acoustic signal from the oil drops proved measurable, and were analysed for four distinct ultrasonic frequencies (455, 769, 1,250 and 2,000 kHz). It is worth noting that the jets also included air bubbles to simulate the presence of the gases typically associated with the plumes found at subsea blowouts. This resulted in more realistic testing of the ability of the AZFP to characterise particle size frequency distributions (i.e. of the oil droplets) in this type of context.



Acoustic backscatter images obtained simultaneously for four ultrasonic frequencies (source: ASL)

The strongest backscatter signals were measured at the highest frequencies (2,000 kHz), suggesting, according to ASL, a droplet size of around 100 µm in the tests.

Finally, comparison between both the backscatter data obtained at the ultrasonic frequencies and the known characteristics of the test oil jets could open up prospects for further developments in the calculation of drop size frequency distributions. At this stage, while acoustic backscatter alone does not guarantee the presence of oil, it does at least make it possible to determine, at distances of between 10 and 100 m from autonomous underwater vehicles, areas of the water mass with abnormally high acoustic backscatter in order to guide the deployment of other sensors for validation.

For further information:
https://aslenv.com/reports/ASL-Acoustic-Detection-of-Subsurface-Oil.pdf
https://aslenv.com/Doc/ASL-AMOP%202018-EDUARDO_LOOS.pdf

• Floating litter/debris

Microplastics at sea: OSIL sampler for characterisation and quantification

British company Ocean Scientific International Ltd (OSIL), which notably specialises in the manufacture of detection and sampling equipment for water monitoring (sensors, buoys, etc.), markets a sampler to study microplastics suspended in seawater, i.e. particles of various shapes (granules, fragments, fibres, filaments, etc.) less than 5 mm in size.

The Microplastics Sampler is capable of collecting a relatively large unit volume of water, namely 50 litres (or 100 and 300 litres depending on the model) at a selected fixed point (station). This approach offers a more accurate estimation of the concentrations of suspended particles than dynamic sampling using trawled nets. Indeed, according to OSIL, sampling by trawling is affected by the waves created by the advancing nets, with this varying according to the shape and size of the microplastics, thereby introducing a bias that can alter the representativeness of the samples collected.

Microplastics Sampler (source: OSIL)

The principle is similar to that of the Niskin bottles commonly used in oceanography: the sampler is a cylindrical device, submerged in a vertical position at the desired depth using a weighted line, and featuring a spring closure using a brass messenger. Housed in a steel frame, the sampler is designed to be placed vertically in the water, and is equipped with a stratified tap system. The top 5 litres are used for the study of floating plastics. The volume just below (40 litres) is used for the sampling of suspended particles more or less in density equilibrium with the seawater. Finally, the 5 litres at the bottom of the bottle can be separated by means of a removable chamber (with translucent walls), for the collection of the microplastics that settle the quickest (i.e. with the highest density).

For further information:
https://osil.com/content/uploads/2019/01/OSIL-Microplastics-Sampler-2021.pdf

- **Recovery at sea**

Lightering of floating storage capacities: the NorMar 4 Discharge System (AllMaritim)

Norwegian company AllMaritim recently added the NorMar 4 Discharge System to its range of pump systems. Designed for the lightering of floating storage capacities, it is particularly suitable for use in conjunction with the manufacturer's NOFI Current Buster range of oil spill containment systems.

This submersible pump mounted on an aluminium frame is equipped with removable HDPE floats (installed via a pin system, requiring no tools), similar to that of a weir skimmer.

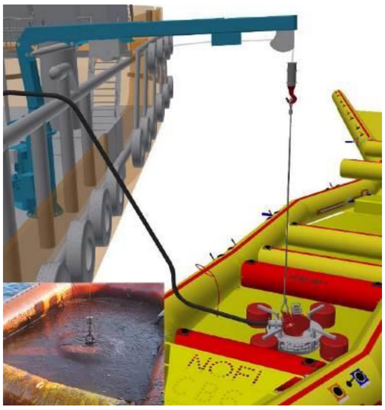

DESMI DOP-200 DUAL pump on aluminium frame with removable floats (source: AllMaritim)

With its dimensions (Ø x H = 1.75 x 0.75 m), the unit can notably be positioned in the separator and temporary storage area of a Current Buster system. The idea is to enable the one-off transfer of concentrated and thickened layers of oil to a vessel for storage (or, where appropriate, to a dedicated tank on the quayside) in the event of use with Current Buster systems and without removing the slick trawling equipment – thereby ensuring minimum interruption of the operations on the water.

The pump is a DESMI DOP-200 DUAL (maximum flow rate of 66 m^3/hour), a screw pump suitable for use with viscous products (and even products containing debris thanks to the blades located next to the screws at the pump inlet). Lifting eyes have been added to enable it to be mounted on the frame by two operators (minimum) and to be deployed/removed using a crane (on deck or on the quayside). It should be noted that it is the lateral (i.e. horizontal) discharge of the DOP-200 DUAL screw pump (which can also take a ring injection system) that is used here.

The system comes with a NorMar diesel hydraulic power pack (55-73 kW) and an unloading line (Ø 3 inches) mounted on an aluminium reel.

According to our information sources, AllMaritim also offers a version of the NorMar 4 with a DOP-160 pump. This version (not currently listed on the company's website) has a lower flow rate (30 m^3/hour) but is much lighter (approximately 30 kg, compared to the 58 kg of the DOP-200 DUAL pump), thereby reducing the effort required when handling it.



Modelling and photograph of the deployment of the NorMar 4 Discharge System (source: AllMaritim)

For further information:
https://www.allmaritim.com/en

Band skimmer: Arctic version of the Henriksen FoxTail

In 2019, the company Henriksen (Norway) added an "Arctic" version of its FoxTail model, a common type of equipment in Norwegian stocks, to its range of oleophilic Vertical Adhesion Band

(VAB) skimmers.

Being based on a proven model, the development of this version was part of the "Oil Spill Response 2015" R&D programme co-financed by the oil industry and the Norwegian government via, respectively, the Norwegian Clean Seas Association for Operating Companies (NOFO) and the Norwegian Coastal Administration (NCA).

While the concept of selective oil recovery by oleophilic bands had already proved conclusive within the context of response operations in cold waters, potentially partially frozen, or in offshore environments,[19] this new model aims to extend the FoxTail's operating possibilities to extremely low temperatures, notably with a view to response operations in Arctic environments.

The Arctic FoxTail being tested in Longyearbyen (Svalbard) (source: Henriksen)

To this end, the new features introduced by Henriksen (and tested in Svalbard) consist in the addition of an insulating component (a type of cover, specifically designed to fit the model, its connections, etc.) and the integration of the transfer pump into the skimmer, as well as a hydraulic heating circuit.

As a result, and according to the tests carried out *in situ* by the manufacturer, the protection of the mechanical components against freezing and the heating of the recovered fluids enable the Arctic FoxTail to be implemented at temperatures as low as -21°C (i.e. 15°C lower than the standard version).

For further information:
https://hhenriksen.com/sea-resq-oilspill-recovery-arctic-foxtail/

Dynamic recovery at sea: DESMI's Octopus In-Line skimmer module

Danish manufacturer DESMI now includes a new offshore model operating at high pickup rates in its range of oleophilic skimmers. This new model is designed for recovery operations in dynamic mode through integration with the Speed-Sweep rubber boom recovery system.

The concept is relatively similar to the company's RO-SKIM. Consisting of an aluminium panel equipped with floats/stabilisers and incorporating a skimmer, it is intended to be integrated into the apex of the containment area, where it is connected between the deflection arms of the Speed-Sweep system (by means of the standard connectors used).

As its name indicates, and unlike the weir of the RO-SKIM, the skimmer device mounted on the front (i.e. located in the containment area) here comprises the equivalent of one module of the Giant Octopus skimmer (i.e. five longitudinal brush belts). The back of the device comprises the oil collection container and a DOP-250 DUAL screw pump (125 m^3/hour) for transfer to a storage tank.

View of the front panel (i.e. "internal" view) of the Octopus In-Line skimmer (source: DESMI)

Like the Giant Octopus model, the advantages of the Octopus In-Line skimmer include its selectivity, its flow rate, and its suitability for use on medium to highly viscous oils and emulsions.

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

• Recovery in inshore waters

Strong currents: new version of the Vikoma Fasflo skimmer

British manufacturer Vikoma recently announced the release of a revised version of its Fasflo skimmer, designed for the recovery of floating oil in relatively confined and fast-flowing waters.

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[19] Band skimmers are generally little affected by the agitation of the water body, but it is obviously still necessary to be able to deploy vessels and containment devices at sea.

The Fasflo 25 and Fasflo 75 are thus replaced by the Mini and Maxi Fasflo skimmers, with flow rates of 25 and 75 m^3/hour, respectively. The general design remains largely unchanged. It has a skimming head with a floating weir comprising two aluminium or fibreglass floats on either side, and fitted with connections allowing two deflector/funnel booms to be attached for deployment in dynamic mode (alongside a vessel) or in static mode (a boom moored on a bank, quay, pontoon, etc.). According to the manufacturer, the model can operate at incoming current speeds of up to 4 knots.

Maxi Fasflo deployed in dynamic mode (source: Vikoma)

For the Maxi version, the oil recovered in the weir is discharged to a storage tank (on shore or on board a vessel) via an integrated positive displacement pump (powered by the GP70 diesel/hydraulic power unit). For the Mini version, the oil is transferred via a small associated pump (diesel-powered V190D lobe pump).

It would appear that the modifications made to the original model essentially concern a reconfiguration of the skimmer opening, particularly at the level of the connectors which, being reinforced, also ensure better stability of the deflector booms. The latter now appear to be joined by transverse lines, and have been fitted with a connection linking their inflation valves.

For further information:
https://www.vikoma.com/Oil_Spill_Solutions/Skimmers/Fasflo.html

• Shoreline clean-up

Mini brush wheel skimmer: *the Lamor MicroMax Floating Skimmer*

Finnish company Lamor has added a new small oleophilic skimmer, the MicroMax Floating Skimmer, to its range of products.

This is a lightweight model with a brush wheel and a low flow rate (announced at 10 m^3/hour), derived from the *Lamor Rock Cleaner* (LRC, designed for shoreline clean-up), from which it takes the brush wheel and its aluminium frame, and to which two small, flat removable floats have been added (also made of aluminium). The LRC's handle and rigid arm assembly (housing the suction line and the hydraulic circuit ensuring the rotation of the brush wheel) are replaced here, at the outlet of the small hopper, by a rigid pipe to which the suction hose for the recovered fluids is attached (by means of a 2.5-inch Camlock fitting, and with the use of various suction equipment being possible).

MicroMax Floating Skimmer (source: Lamor)

While it does not boast a high flow rate, the advantage of this compact model (L x W x H = 70 x 55 x 30 cm, and weighing approximately 10 kg) lies in its ability to operate in restricted or confined spaces possibly in shallow waters. It can be used in natural environments (e.g. coastal pools/depressions, etc.) as well as in industrial applications. Primarily intended for use in manholes, drains, sumps, etc., its potential advantage in port contexts (bottoms of docks, corners of quays, etc.) can also be envisaged.

For further information:
https://www.lamor.com/micromax

Shoreline pollution surveys: third edition of the TERR/SCAT manual (Canada)

In 2019, the Emergencies Science and Technology Section (ESTS) of Environment and Climate Change Canada (ECCC, of the Canadian federal government) published the third edition of its guide for the surveying of oiled shorelines or banks.

Available in both English and French (*Shoreline Cleanup and Assessment Technique (SCAT) Manual; Manuel de la technique d'évaluation du nettoyage des rives (TERR)*), it essentially comprises an update of the methodological components (organisation, data management, etc.) of the SCAT method, whose implementation and acceptance following various and sometimes major spills had motivated new developments since the previous version of the guide (in 2000). The authors indicate that these developments take into account the experiences and lessons learned from responses to spills that occurred between 2000 and 2016 (e.g. *Selendang Ayu*, Aleutian Islands, Alaska, 2004-2005; *Cosco Busan*, San Francisco Bay, California, 2007; *Deepwater Horizon*, Gulf of Mexico, 2010-2013), as well as assessments of new surveys methods to support responders, including the potential use of service dogs (see LTML n°41).

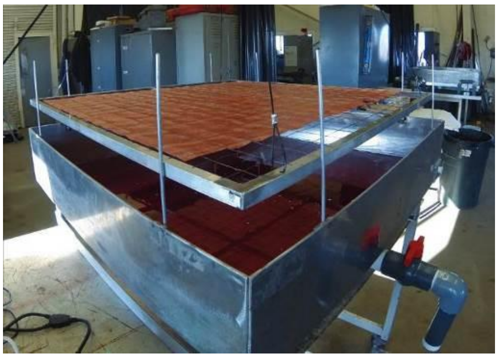
Source: ECCC

For further information:
http://publications.gc.ca/collections/collection_2018/eccc/En14-321-2018-fra.pdf (French version)
http://publications.gc.ca/collections/collection_2018/eccc/En14-321-2018-eng.pdf (English version)

• Products

Field-scale enclosed sorbents: search for standardised assessment protocols (BSEE/Ohmsett, US)

In the United States, the Bureau of Safety and Environmental Enforcement (BSEE) is developing a standardised procedure at its Ohmsett facility for testing the performance of sorbent products at the mesoscale. Indeed, while the American standard in force, ASTM F726 ("Standard Test Method for Sorbent Performance of Adsorbents for use on Crude Oil and Related Spills"), is suited to laboratory-scale testing of samples (6 x 6 cm), the federal agency's objective is to define a standard protocol for a relevant and reproducible assessment of the expected performance under "real" deployment conditions, which would benefit manufacturers and users alike.



Prototype structure/mount for sorbents (pads, mats) for standardised tests (source: Ohmsett/BSEE)

As early as mid-2018, BSEE indicated that the first phase of exploratory trials involving "two-dimensional" sorbents (mats, pads, textiles, etc.), had reached completion.

This stage notably included the design of a specific test frame, consisting in a metal mesh mounted on a horizontal aluminium frame, able to handle large samples in as calibrated and reproducible a way as possible (thereby minimising the variability between tests that can be potentially induced by manual intervention).

- The assembly is associated with a system of spring scales designed to ensure accurate data, as well as a system for acquiring said data. The procedure for using the tool was subject to validation, notably to determine the extent to which the adhesion of various oils[20] on the structure itself could influence the weight measurements performed after immersion. It would appear that the weight of the frame proved stable following an initial draining phase, with differences in load per adhesion of less than 5 grammes between successive tests, and a negligible amount of oil intake with respect to the weight of the structure.
- In short, the principle involves placing samples of sorbents measuring 90 x 90 cm, flat on the mesh, and then lowering this mesh into the "oil bath" (i.e. a 5 cm-thick surface layer it would seem) before lowering it to the bottom of the test tank. The sorbent floats freely in the slick to be absorbed for a specified period of time, before being lifted up by the structure to be weighed (before and after draining).

[20] Three types here: a hydraulic oil, a lubricant (Hydrocal 300), and diesel.

- Initial tests to assess basic characteristics (e.g. maximum absorption capacity, retention capacity and water content) were performed using three oils on two types of sorbents. The main aim of these tests was to assess reproducibility and to specify procedures (e.g. concerning the "Point of No Dripping" criterion, and corresponding time limits), as well as to check the consistency of the results obtained with those found under standard ASTM F726.

Development of the protocol continued in 2019, involving several oils (including one crude oil) and six sorbents, thus representing a wider range of materials and associated qualities.

According to BSEE, it would seem that the feasibility of incorporating the assessment of other operationally significant characteristics (absorption kinetics, mechanical strength during removal at oil saturation, buoyancy, etc.) was considered for potential inclusion in the protocol, which is to be ultimately submitted for approval to the *ASTM Committee F20 on Hazardous Substances and Oil Spill Response*.

• Dispersion

Subsea dispersant injection: development of effectiveness tests for chemical dispersants

Teams from Sintef and the National Technical University of Athens recently published a scientific paper proposing a methodology for the development of a new protocol for the laboratory-scale testing of the effectiveness of chemical dispersants applied by subsea dispersant injection (SSDI) in the event of offshore well blowouts.

The paper describes the exploratory approach adopted by the authors within the framework of this project to develop this type of test, dubbed DIET (Dispersant Injection Effectiveness Test).

In short, the aim is to integrate controlled conditions that are more representative of the specificities associated with an SSDI-type response (i.e. as opposed to spraying on surface slicks) into the DIET test protocol. These conditions notably include:

- the turbulence in the immediate environment (related to the outlet pressure of the oils);
- the characteristics of the oils concerned at the source of a blowout (in the form of unweathered plumes at high temperatures);
- the effective representation of the injection of dispersants (and not spraying or mixing), also taking into account the technical procedures envisaged for this injection operation.

The project also aims to quantify effectiveness via the continuous measurement of droplet sizes throughout the duration of dispersant injection in a constant oil flow (i.e. 1 minute in the test proposal adopted).

The paper details the methods implemented by the authors to identify the possible conditions of the DIET test using Sintef equipment (in this case, a test column measuring 80 cm high and 50 cm in diameter in which oil jets and small injection devices were reproduced, and equipped with an *in-situ* LISST laser granulometer). These conditions were applied to compare the effectiveness levels respectively measured for different dispersants (Corexit 9500, FINASOL OSR-52 and OSR-62, OSD Superdispersant 25 and Dasic Slickgone NS), injected in variable quantities and at different temperatures, for four different types of crude oils.

These results were compared with those obtained for the same crude oils, dispersants and quantities following the laboratory tests established for the assessment of dispersant effectiveness. On this point, the authors affirm that the strong differences found according to whether effectiveness was measured in a "conventional" way or as per this first development of the DIET protocol point to the need for a method specifically adapted to SSDI.

For further information:

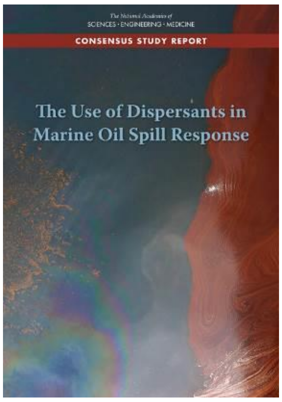
Brandvik P. , Daling P. , Dunnebier D. , Makatounis P. , Leirvik F. & Krause D., 2019. A Proposed New Laboratory Protocol for Dispersant Effectiveness Testing Adapted for Subsea Dispersant Injection. Journal of Environmental Protection, 10, 694-709. doi: 10.4236/jep.2019.105041

State of the art on chemical dispersion: update from the National Research Council (US)

In 2017, the U.S. National Research Council (NRC) entrusted the National Academies of Sciences, Engineering, and Medicine (NASEM) with the management of a project aimed at establishing an updated state of knowledge on chemical dispersion in oil spill response operations at sea. Completed in 2019 after a critical review of recently available references (reports, scientific papers, etc.), this project resulted in the publication of a consensus study report on various aspects of this strategy, including some that are subject to recurrent debate: effectiveness, fate/degradation and potential toxicity of chemicals and their compounds, etc.

The project built on the two previous NRC reports on the use of dispersants. In practical terms, it updated and expanded the previous version (2005), taking advantage of the numerous research studies funded in the wake of the *Deepwater Horizon* spill, during which the application of chemical dispersants (by subsea dispersant injection in particular) proved to be unprecedented in scale – as did the ensuing controversy over the potential associated risks (newly identified, assumed, rediscovered, etc.) on the environment or on human health.[21] This work, which involved the integration of new factors, was largely based on the analysis and synthesis of the literature published since 2005 on the properties of dispersants and current practices for their assessment (laboratory methods/procedures, effectiveness and toxicity tests, etc.).

Although not strictly speaking "*Deepwater Horizon* feedback", a very large proportion of these publications referred to this spill. The studies and data considered relevant were targeted because they took into account a number of operational realities (e.g. exposure to more or less realistic concentrations and durations in the experimental work).



The updated paper (The Use of Dispersants in Marine Oil Spill Response) was published in 2019. It is interesting to note that the editorial board included participants from academic research (often funded under GoMRI) and some scientists working for oil companies or agencies specialised in oil spill response, more versed or experienced in the topic under study (knowledge of response strategies, motivations behind and expectations for chemical dispersion, etc.).

Among the new points raised, it is worth noting the improvement of knowledge regarding the potential action of dispersants on the fate of submerged oil plumes/jets/blowouts, and the identification of areas of uncertainty that still need to be clarified (in particular concerning gas and fluid dynamics/mechanics at a subsea well blowout).

With respect to the inherent toxicity of dispersants for the environment, the general view seems to be that the concentrations of dispersants in the water body, following DWH, most likely never approached the toxicity thresholds established for these substances. Qualitatively, the toxicity of the current formulations of the tested/approved substances was not identified as a reasonable basis for challenging their use.

Other points developed included the apparent acceptance of a conceptual diagram of the mechanisms potentially involved in the presence of marine oil snow sedimentation and flocculent accumulation (MOSSFA), this diagram being consistent with some of the processes suggested by *in-situ* observations in the Gulf of Mexico or the results of various laboratory experiments. However, there appears to be agreement on the fact that, to date, no evidence has been identified to either verify or quantify the potential influence of chemical dispersion in the occurrence of significant MOSSFA-type scenarios.

The hypothesis of the potential effects of chemical dispersion on human health, influencing either directly (e.g. through inhalation, contact with the skin, or ingestion of contaminated food) or indirectly (e.g. psychologically) the fate of certain compounds of a treated oil (BTEX, PAH, etc.), also appears to be confirmed. As for the effects on health (whether direct or indirect) potentially linked to the substances themselves, existing studies on the subject were considered to be too few to definitively rule on this point.

In addition to this report, interested readers can consult a short 4-page summary of the main points identified by the expert committee involved in the writing of the document (https://www.nap.edu/resource/25161/Oil%20Dispersants%204-Pager%20final.pdf).

While this document focuses on spills off the coast of the United States, it is clearly of interest beyond these borders.

For further information:
https://www.nap.edu/catalog/25161/the-use-of-dispersants-in-marine-oil-spill-response

[21] Generated to a significant extent by the scientific community itself.

Marine snow and chemical dispersion: a critical summary

The Marine Pollution Bulletin recently published an interesting article providing a critical summary of existing studies and papers on the subject of marine snow, primarily since the *Deepwater Horizon* (DWH) spill. This term refers to the natural phenomenon of the sedimentation of aggregates of various detrital particles (mineral matter, organic matter from plankton production, etc.) in the water mass. More precisely, the issue examined here is that of the potential implication of oil spills and their chemical dispersion on the intensity and even occurrence of "showers" of contaminated suspended matter. This hypothesis has been suggested by several authors of experimental studies on the subject since 2010, and can be explained by various mechanisms:

- It has been suggested that the adsorption of oil droplets in density equilibrium in the water mass on fine particles in suspension (similar to the subsea plumes observed in the Gulf of Mexico following the Macondo well blowout) leads to the formation of oil-mineral aggregates (OMAs), which cause significant sedimentation of the pollution on the seabed.
- More recently, following the DWH spill, and on the basis of laboratory observations of flocculation phenomena[22] resulting from the bacterial degradation of dispersed droplets, other authors now suggest that chemical dispersion could actually promote the *in-situ* formation of oil-contaminated snow and, consequently, the transfer of pollution from the surface to the seabed.

The article reviews both the expectations (objectives and context) for chemical dispersion operations in the event of an oil spill at sea, and current knowledge of the mechanisms of adsorption, flocculation, degradation, etc. This knowledge is critically compared with the conditions under which the experimental studies mentioned above were conducted. The authors conclude that while the phenomena leading to the formation of OMAs are in principle possible, the hypothesis of significant flocculation (i) linked to the biodegradation of droplets at the concentrations that these are likely to reach *in situ,* and (ii) aggravated by the application of chemical dispersants, remains open to debate and requires to be substantiated by relevant complementary studies.

It should be noted that this unresolved issue is no less important (i) due to its implications on response strategies (notably on their perception, their questioning and, perhaps in the future, their legitimisation), and (ii) within a context of regular publications referring to the hypothesis of vertical transfer of pollution via flocculation phenomena, thus accepting it more or less implicitly (for example, for the development of numerical models,[23] or to discuss the results of monitoring of the deep benthic environment[24]).

For further information:

Brakstad O.G., Lewis A. & Beegle-Krause C.J., 2018. A critical review of marine snow in the context of oil spills and oil spill dispersant treatment with focus on the *Deepwater Horizon* oil spill. *Marine Pollution Bulletin* **135**, 346–356; https://doi.org/10.1016/j.marpolbul.2018.07.028

• Research

Electromagnetism for oil spill containment and recovery

As a result of a project initiated several years ago, the American company Natural Science LLC and the Fermi National Accelerator Laboratory (Fermilab)[25] recently announced the signing of a license agreement granting the former the rights to use an Electromagnetic Oil Spill Remediation Technology, dubbed E-MOP, designed for oil containment and recovery via a patented electromagnetic boom system, implemented in conjunction with a process involving the prior magnetisation of the oil concerned. The principle is based on the phenomenon of preferential incorporation of particles of microscopic magnetite (Fe_3O_4) into the oil: the oil-water mixture (i.e. an oil spill in an aquatic environment) is first seeded with the magnetite particles.

[22] In other words, the formation of mucilaginous clusters, possibly of a density greater than that of seawater.
[23] For example **Dissanayake et al., 2018.** Numerical Modeling of the Interactions of Oil, Marine Snow, and Riverine Sediments in the Ocean. https://doi.org/10.1029/2018JC013790
[24] For example **Schwing et al., 2018.** Tracing the incorporation of carbon into benthic foraminiferal calcite following the Deepwater Horizon event. https://doi.org/10.1016/j.envpol.2018.02.066
[25] Managed by Fermi Research Alliance LLC (a partnership between the University of Chicago and the Universities Research Association - URA) on behalf of the U.S. Department of Energy's Office of Science.

This phenomenon apparently results in a magnetic colloidal suspension that can be moved using a magnet, in this case an electromagnetic boom, possibly supplemented by a belt skimmer (also electromagnetic). Natural Science LLC, which has developed prototypes of these systems, believes that they could advantageously replace conventional booms and skimmers. The company has also developed a magnetic oil/magnetite separation process.

One of the arguments put forward by the developers in favour of this method is that magnetite is not only a naturally occurring substance, it is also widely available worldwide. This would therefore reduce international shipping costs and procedures as well as procurement costs compared to other response products such as sorbents or chemical dispersants. Furthermore, according to Natural Science LLC, the optimal magnetite-to-oil ratio[26] is sufficiently low to consider the necessary quantities of magnetite to be minimal by comparison with sorbents.

Top: *modelling of the E-MOP assembly (i.e. electromagnetic boom, collector and separator) mounted on a recovery barge;* ***Bottom***: *electromagnetic belt (e-ramp) prototype in action (source: Natural Science LLC)*

This proposal is reminiscent of previous Greek and Brazilian attempts in this field (development of methods for recovering slicks after the spreading of magnetic particles), which to the best of our knowledge have never been developed beyond the laboratory due notably to prohibitive application quantities. This problem is not new and has previously been encountered in the application of products designed to “trap” free oils in the aquatic environment (e.g. gellling agents).

For further information:
https://partnerships.fnal.gov/technologies/emop/
https://emop.fnal.gov/docs/docs.shtml
https://www.naturalscienceusa.com/
https://news.fnal.gov/2019/11/fermilab-oil-spill-cleanup-technology-among-finalists-for-rd-100-award/

• Impacts

In-situ **monitoring of oiled coastal marshes: factors influencing restoration dynamics**

The year 2019 saw the publication of the findings of a scientific assessment concerning the restoration processes of the communities of benthic endofauna and plants of the coastal marshes of Barataria Bay (Louisiana, US), the exposed edges of which had been polluted to varying degrees by strandings of crude oil from the *Deepwater Horizon* spill (April 2010).

The study provides additional information on the factors influencing the restoration dynamics of this type of habitat, generally considered to be highly sensitive to oil pollution, especially since the possibilities for response operations here are often limited.

This assessment concerned the monitoring of the northern sectors of Barataria Bay between 2011 and 2016, with the aim of examining the relationships between the dynamics of pioneer benthic species and those of micro- and macrofloral assemblages given the levels of contamination of the substrates, and of deducing the mechanisms determining the long-term return to normal of the endofauna communities characteristic of these environments.

In summary, while certain restoration phenomena concerning the main taxa present in the typical communities of these coastal marshes were identified over the medium term, less than two years following the initial impact, their numbers were not completely restored in the most intensely affected sectors (i.e. after about six years). In this respect, the authors emphasize how the rate of restoration changed as some of the primary components of the habitat recovered:

- In the initial stages, the dynamics of various meiofaunal groups (nematodes, copepods), and

[26] Of which we have no knowledge.

those of most of the polychaete annelids as well as certain malacostracans (tanaidaceans, amhipods), were significantly linked to the recovery of the microphytobenthos and to the reconstitution of the habitat represented by the *Spartina alterniflora* plant cover. The same was observed for the recruitment of juvenile classes of bivalves.

- In the longer term, however, at sites that were initially heavily oiled, the persistence of relatively high levels of oil in the sediments appeared to limit the restoration of benthic biocenoses. In particular, the authors measured low recovery rates for several micro- and meiobenthic invertebrate taxa, in connection with significantly lower than normal biomasses and densities of *Juncus roemerianus* (the North American rush that traditionally dominates the plant assemblages of the region's coastal marshes, alongside *S. alterniflora*).

It should be noted that, thanks to this multi-year monitoring, the authors were able to highlight the decisive role of plant species (here, *S. alterniflora* and *J. roemerianus*) at the various stages of the restoration of the benthic biocenoses of coastal marshes polluted by oil, by modifying the habitat over the short term and the quality of the soil over the long term.

Regarding restoration measures for such environments, the authors suggest how a preferential orientation towards the reintroduction (e.g. planting) of founder species would stimulate the resettlement of organisms making up the first levels of the food web (primary and secondary producers, etc.).

*Restoration stages of the edge of a coastal marsh heavily oiled in 2010: monitoring at 9 months (**left**) and 2 years (**right**) following the initial oiling (Barataria Bay, Louisiana) (source: Fleeger et al., 2019)*

For further information:

Fleeger J.W., Riggio M.R., Mendelssohn I.A., Lin Q., Deis D.R., Johnson D.S., Carman K.R., Graham S.A., Zengel S. & Hou A., 2019. What Promotes the Recovery of Salt Marsh Infauna After Oil Spills? *Estuaries and Coasts*, **42**, 204–217. https://doi.org/10.1007/s12237-018-0443-2