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• Spills

Gulf of Mexico: repeated spills in the mouth of the Mississippi (US)

On 25th July 2016, near Lake Grand Ecaille in Barataria Bay (Plaquemines Parish, Louisiana, US), a crude oil leak occurred from an abandoned flow line (previously operated by Hilcorp Energy) in Lake Washington oil field. The operator estimated that 16 m^3 of crude oil, which had been remaining in the pipeline, had been released into the surrounding marshland. According to the Louisiana Oystermen Association, which filed a lawsuit following this spill, the leak resulted from damage to the pipeline during prop-washing operations, which involve mechanically scouring and widening channels for navigation using propulsion devices (propellers, turbines, etc.)[1]. To our knowledge, this hypothesis has not been officially confirmed either by the authorities or the operator.

The spill response was placed under the supervision of the US Coast Guard (USCG), which coordinated, within a Unified Command, representatives of the entities involved, from both the private and public sectors (relevant agencies and administrations, including the National Oceanic and Atmospheric Administration (NOAA), the Louisiana Oil Spill Coordinators Office (LOSCO) and the Louisiana Department of Wildlife and Fisheries (LDWF)).

USCG aircraft based in New Orleans were mobilised in order to assess the spread of the spill, which rapidly affected an area of over 2,000 hectares (8 square miles) in Barataria Bay, including areas of coastal marshland vegetation.

July 2016: Drift and spread of a crude oil spill from an abandoned flow line (Barataria Bay, Louisiana) (Source: USCG)

26/7/2016: Aerial view of the spread of the spill from the Hilcorp Energy pipe in the marshland of Barataria Bay (Source: USCG)

The spill response operations, conducted by a private spill response organisation (Environmental Safety & Health) contracted by the operator, involved the mobilisation, the following day, of 2 specialised containment and recovery vessels, as well as more than 900 m of containment boom, lined with sorbent booms, laid at the edge of the marsh to protect the vegetation and contain pockets of crude oil driven by the currents. Four days after the spill, actions (still in progress at the time of writing) resulted in the recovery at sea of 1 to 2 m^3 of a water/oil mixture and the collection of around 250 bags of oiled solids (mainly sorbents) according to the USCG.

Although this was a relatively small spill, it nevertheless illustrated the difficulties raised by the complexity of accessing a site (channels, meanders, streams, etc.) in coastal marshes, in terms of setting up (and the efficiency of) containment, protection and clean-up operations, which in this case involved the mobilisation of airboats which are commonly used locally.

Oiled marsh edges and protective measures (Source: J. Dermansky / RR)

Deploying booms from an airboat (left); Setting up bird scaring gas cannons (right) (Source: J. Dermansky / RR)

Furthermore, concern over impacts on coastal and marsh-dwelling birds, due to contact with oiled vegetation in the area affected by the spill, led to acoustic bird deterrents (gas cannons) being deployed throughout response operations.

Three days after this incident, just over 3 m^3 of crude oil was released from a leaking pipeline operated by Texas Petroleum Management near Southwest Pass (southernmost navigable channel

[1] This practice is prohibited in these delta environments, already fragile and threatened due to many anthropogenic activities

at the mouth of the Mississippi, again in Plaquemines Parish), before around 15 m^3 of crude oil escaped on 2nd August at Main Pass, again in the mouth of the river, from a well operated by Texas Petroleum Investment Company. Little detail was provided of the response operations, which were conducted by companies (Clean Gulf Associates, OMI Environmental Solutions) contracted by the operator, under the supervision of the U.S. Coast Guard, and the relevant agencies in the state of Louisiana (LOSCO, LDWF, Louisiana Department of Environmental Quality, etc.). The U.S. Coast Guard also carried out aerial surveys of the spread of the oil.

28/07/2016: Aerial view of the oiled streams in the estuarine marshland (Southwest Pass), due to a leak of crude oil from a pipeline (Source: USCG)

Finally, on 5th September 2016, near Bay Long and the barrier islands (in particular Cheniere Ronquille and East Grand Terre) marking the limit between Barataria Bay and the Gulf of Mexico, an amphibious excavator operated by Great Lakes Dredge & Dock Co. ruptured a section of pipeline operated by the Harvest Pipeline Co.

This incident, whose cause was not disclosed and which resulted in the release of around 20 m^3 of crude oil in the coastal waters, occurred during restoration operations on the chain of barrier islands bordering the American shores on either side of the mouth of the Mississippi[2].

The response was placed under the supervision of a Unified Command (UC) coordinated by the U.S. Coast Guard and implemented by ECM Maritime Services, contracted by the pipeline operator.

According to the USCG, over 150 responders and around 30 vessels had been deployed by 8th September, mainly to conduct containment and recovery operations on the water, deploying over 3,600 m of floating boom and around 10 skimmers.

*8/9/2016, Chenier Ronquille barrier island: **Left**: Booms laid diagonally to contain the free oil accumulating along the coastline; **Right**: Rinsing oiled vegetation using low pressure hoses deployed from airboats; containment systems on the water for remobilised oil (Source: www.nola.com /RR)*

Deposits of crude located along the vegetated shorelines were remobilised by rinsing (using low pressure hoses), before being contained and pumped off the water. Six days after the spill, the authorities announced that around 25 m^3 of oily water had been collected from the water. We are not aware of the final figures for these operations. The environmental impact of the spill proved to be limited: the UC estimated that approximately 200 birds were oiled to various degrees in the affected area. Around 10 specimens were captured to be cleaned and rehabilitated.

While the quantities spilt during such incidents are generally limited, their chronic occurrence in this geographical area struck by the *Deepwater Horizon* disaster has left its mark on public opinion and on fishing professionals. While the oil industry continues to be of great socio-economic importance here, the delta region is doubtlessly a hotspot in terms of the associated environmental risk: in terms of oil spill risks alone, the National Response Center (NRC) states that 20% of oil pollution in the US affects Louisiana, both in terms of frequency and volume (1,500 spills per year in this state with an average annual volume of 1,250 m^3).

Non-persistent pollution due to rig grounding (*Transocean Winner*, Scotland)

On 8th August 2016, the semi-submersible drilling rig *Transocean Winner* was being towed to Malta by the tug and anchor handling vessel *Alp Forward* when it ran aground on the rocky shores of the

[2] Incidentally, this project comes under the measures taken as part of the Natural Resource Damage Assessment (NRDA) process launched following the *Deepwater Horizon* spill which occurred 6 years earlier. This $36-million project draws from the billion dollar fund provided by BP, based on an arrangement concluded with the federal authorities in April 2010 intended to support the Early Restoration Framework, implemented before the damage assessment phase was even finalised. In the very early days of the Deepwater Horizon disaster, the idea of a Sand Berm Barrier Project (put forward by a Dutch consortium and fervently supported by the authorities of the state of Louisiana) was perceived by some as the only means of preventing the slicks drifting at sea from entering the coastal marshes, while others saw this as an opportunity to promote a wider restoration project, already under consideration, for these islands recently devastated by a series of hurricanes (including Katrina and Rita in 2005).

Isle of Lewis (Scotland) after the tow-line broke during a storm.

The metocean conditions began to deteriorate and violent winds thwarted attempts to establish the emergency tow, while accelerating the rig's drift, causing it to run ashore in Dalmore Bay.

During the following hours and days, no pollution of the inshore waters was visually observed, either leaking from the structure (around which a 300 m-radius safety zone was set up as a preventative measure) or in the surrounding area. At sea, aerial surveys also confirmed that no sheen was visible.

The Transocean Winner *rig grounded on the Isle of Lewis (source: UK MCA)*

Nevertheless, the day after the rig ran ashore, the Transocean and SMIT Salvage experts who boarded the rig to assess its damage found that 2 of the 4 onboard diesel tanks were cracked and leaking. According to the UK Maritime and Coastguard Agency (MCA), in charge of supervising the operational management of the incident, the platform had been transporting 280 tonnes of diesel when the incident occurred. MCA estimated the maximum volume spilt at 53 tonnes, a quantity unlikely to generate a significant environmental risk given the low persistence of this type of fuel as well as the high dissipation potential due to weather conditions (subsequently confirmed by observations).

Following a full assessment and the removal of the some 200 tonnes of diesel remaining in the bunker tanks (and transferred onto a supply vessel mobilised by the operator), the platform was refloated 2 weeks after it ran aground, and towed over 60 km to Broad Bay (Isle of Lewis), where it awaited transfer to a shipyard for repair. No further pollution was observed by MCA during overflights conducted during the towing operations. The exclusion zone was maintained in Dalmore Bay until it was confirmed that no further risks (in particular debris) related to the *Transocean Winner* remained.

Potential transboundary pollution from an oil terminal (Aqaba, Jordan)

On 23rd August 2016, a breach occurred (cause not disclosed in our information sources) on a pipe at an oil terminal in Aqaba (Jordan), causing a spill of around 200 m^3 of crude oil, an unspecified proportion of which leaked into the port waters. The spill response, implemented by the Jordanian authorities, mainly consisted in containment and recovery operations on the water. The use of dispersants was rejected due to the proximity to coral reefs, given the potential environment impact of this option.

While the Jordanian authorities stated that they were able to handle this spill without assistance from other countries, the Ministry of Environmental Protection of Israel – Jordan's immediate neighbour with a dozen kilometres of coast bordering the Red Sea – indicated that it was prepared to provide assistance, anticipating the risk of the oil reaching the shores of Eilat (ultimately, analysis of local currents showed that the Israeli coastline was unlikely to be affected, with the oil more likely to drift south/south-east, i.e. towards Saudi Arabia). The 2 countries had previously worked together in the field of spill response, in particular through joint exercises, the most recent of which was held less than a year prior to this incident.

Heavy fuel oil spill in a port from a bunker vessel: small spill but significant impact (*Trident Star*, Malaysia)

On 24th August, a tank overflowed onboard the bunker vessel *Trident Star* (3,177 GT), during loading operations at the ATB Vitol oil terminal in the port of Tanjung Pelepas (Malaysia). This spill, of unspecified cause[3], led to an estimated 40 tonnes of IFO 500 being released into the port waters. This resulted in 3 to 4 kilometres of port infrastructures being oiled, including wharfs and riprap.

[3] An investigation to determine the circumstances surrounding this incident is believed to have been launched at the request of the Malaysian Department of Environment.


Containment of heavy fuel oil trapped under wharfs (built on concrete piles) at the ATB Vitol oil terminal (Source: ITOPF)

The highest levels of oil were reported at the oil terminal, near to the spill point, i.e. on a wharf and on its supporting concrete piles, which were more difficult to access.
This small spill was managed locally[4] by the authorities at the Port of Tanjung Pelepas, which set up an Oil Spill Response Team. Clean-up was carried out by a specialised company contracted by the terminal's operator. The operations initially focused on containing and recovering, near to the source, the free floating oil under the wharfs, before cleaning up the infrastructures and the hulls of several oiled vessels alongside the wharf.
The most apparent impact of this spill was on operations at this busy oil terminal[5], which were suspended by the port authority, and on traffic in Johor Port, which was affected to such an extent that a few merchant ships were diverted to Singapore.
Compensation claims in relation to spill response operations, including hull cleaning, were submitted to the shipowner’s P&I Club.

Oil tanker fires and pollution in North America (Burgos, Mexico; Aframax River, USA)

On 24th September, around 13 km off the Mexican port of Boca del Rio, the oil tanker *Burgos*, carrying 38,800 m^3 of diesel and petrol, suffered an explosion followed by a fire which lasted several days. Cracks appeared in the structure and the estimated 5,400 m^3 of petrol which escaped burnt spontaneously.

Earlier that month, on 6th September, the oil tanker *Aframax River* (unladen at the time) collided with an unspecified "object" in the Houston Ship Channel (Texas, US). The crash caused a crack in one of the fuel tanks and a fire broke out. An estimated 300 m^3 of low sulphur diesel was released, an unspecified proportion of which – but probably the majority according to the US Coast Guard – burnt spontaneously. The shipping traffic in the incident area was suspended for 14 hours.

Offshore non-persistent oil spill (Clair rig, North Sea, Scotland)

On 2nd October, a technical incident, of unspecified nature and cause, occurred on the Clair platform operated by BP in the North Sea, resulting in a spill of around 100 m^3 of unspecified oil some 75 km west of the Shetland Isles (Scotland).

No response actions proved necessary, as the relatively modest volume of oil released was not a threat to the coastline. It spread and dispersed naturally at sea (by evaporation and dispersion), as confirmed by the aerial observations conducted by BP and by satellite images. This decision not to implement response operations, supported by the minimal risks of impact on marine fauna, was the outcome of discussions between the platform operator, experts from specialised companies working for the oil industry (Oil Spill Response Limited, OSRL) and representatives of the relevant government agencies and departments in the UK (in particular the Department for Business, Energy and Industrial Strategy) and the Scottish Government.

Diesel spill: medium-sized spill, high sensitivities (*Nathan E. Stewart*, Canada)

On 13th October 2016, the tug *Nathan E. Stewart* (owned by Kirby Corporation), en route from Alaska to Vancouver, ran aground at around 1:00 am on a reef in the Seaforth Channel, not far from the coasts of Athlone Island, near Bella Bella in British Columbia (Canada). The vessel began to take on water at a higher rate than could be handled by the pumps onboard, and the ship sank 8 hours later, in waters 9 m deep, after offers from a Canadian Coast Guard vessel (*Cape St. James*) to pull the tug off the rocks had been declined.

At the time of the grounding, the tug was pushing a nearly 90 m-long oil barge (*DBL 55*), unladen, and its tanks contained around 220 m^3 of diesel. These tanks were cracked, releasing part of their contents into the coastal waters, later estimated at around half of the diesel transported (i.e. around 110 m^3). These leaks led to sheen which spread across the water surface from the *Nathan E. Stewart*, of which only the bridge could be seen emerging from the water, and extended along the

[4] In the event of major pollution in Malaysia, the response organisation however requires operations to be conducted under the auspices of the Ministry of Transport's Marine Department, under the coordination of the Department of Environment which oversees crisis management.
[5] The terminal has a capacity of over one million m^3, including light fuels (petrol, kerosene, diesel, etc.), heavy refined products and biofuels.

inshore waters, contaminating foreshores in places.

The Canadian Coast Guard was in charge of supervising response operations and had several assistance vessels on site within a few hours of the grounding.

In compliance with Canadian regulations, the operator's contingency plan, which was immediately activated, stated that a preselected spill response contractor should be mobilised. The Western Canada Marine Response Corporation (WCMRC) sent equipment and vessels on site from its Prince Rupert base in British Columbia, with notably: 1 specialised vessel (containment and mechanical recovery), 2 lighter vessels for boom deployment (over 750 m), 1 service vessel, 1 tug, 1 barge, as well as 3 trucks loaded with various response products and equipment.

Laying booms around the submerged Nathan E. Stewart *(Source: WCMRC)*

To compensate for the equipment transport times (around 20 hours according to press sources), WCMRC commissioned a local company (Shearwater) to immediately deploy booms around the *Nathan E. Stewart*. The tribal authorities of Heiltsuk First Nation were also involved in this initial response action (see below).

Containment system broken loose due to adverse sea and weather conditions (Source: Heiltsuk Nation)

Response actions at sea – mainly containment and recovery – were slowed by the remote location of the site (not easily accessed from the shore) and adverse sea and weather conditions, which caused operations to be suspended at times over the first days following the incident (furthermore, the extensive spread of this light product in this open environment hindered, if not prevented, the recovery of significant quantities on the water).

This was also the case for the high priority operations to plug the bunker tanks and remove their contents, operations conducted by the Resolve Marine Group. While the leaks were plugged 2 days after the incident thanks to intervention by divers, the fuel removal operations were completed some ten days after the spill and resulted in the recovery of half of the initial volume.

Although relatively minor in quantity, this spill occurred at a highly culturally sensitive site, as it was within the traditional territory of Heiltsuk Nation, which comprises 5 indigenous tribal groups whose relationship to this land and marine environment is "ancient, complex and sacred". Furthermore, the affected area is home to beds of bivalve molluscs (several species of clams, razor clams, oysters and scallops in particular) which are harvested (culturally and commercially) by members of the tribal community[6]. This site is also home to emblematic marine species (such as killer whales) and, more widely, is part of the Great Bear Rainforest, a temperate rainforest protected since 2016 by the Government of British Columbia against industrial logging and endorsed by the Queen's Commonwealth Canopy. Given these sensitivities, this incident attracted considerable media coverage, as well as strong criticism (some founded, some not) of the response at various levels (local to federal), in particular concerning implementation times, efficiency and coordination.

What's more, this incident happened to occur against the backdrop of a bill to introduce a moratorium[7] on oil tanker traffic along the north-west coast of British Columbia, under preparation since 2015 by Transport Canada and instigated by Canada's Prime Minister. As a reminder, the Canada Shipping Act, 2001, restricts access to the Inside Passage (coastal shipping route in the Pacific Ocean along the south-east coast of Alaska and the north-west coast of British Columbia) to tankers with a capacity of less than 40,000 tonnes. On 12th May 2017, the Canadian Government introduced a bill for first reading in Parliament (Bill C-48, "Oil Tanker Moratorium Act") aiming to prohibit oil tankers carrying over 12,500 tonnes of crude oil cargo from stopping, loading and

[6] Indeed, the day after the spill, Fisheries and Oceans Canada issued a temporary fishing ban in the area affected by the sheen.

[7] Developed by the Canadian Government as part of the $1.5 billion Oceans Protection Plan, aimed at simultaneously meeting aims relating to "maritime safety, economic development and coastal protection".

unloading in ports and marine terminals between the northern tip of Vancouver Island to the south and the border with Alaska to the north. This area[8] includes the spot where the *Nathan E. Stewart* incident occurred and the bill concerns a number of derived heavy products (dilbits, synbits, etc.)[9], however it is worth noting that neither the tug nor the type of barge it was pushing (around 9,000 DWT) fall within the scope of this act.

The Canadian Transportation Safety Board (TSB) opened an enquiry into the causes of the grounding of the tug, which was refloated and towed away on 14th November 2016.

• Past spills

Houston Ship Channel spill: fines and safety improvement measures

On 22nd March 2015, in foggy weather, the oil barge *Kirby 27706* collided with the cargo vessel *Summer Wind* in Houston Ship Channel (Texas City, US), causing a leak, from one of the damaged tanks, of around 640 m^3 of its cargo of IFO 380 in this particularly busy shipping channel (which runs between the Gulf of Mexico and the oil terminals in south-east Texas) (see LTML n°39). The oil pollution soon reached the shoreline near to the spill site (Galveston Bay), but also affected remote and ecologically sensitive sites (including the protected site of Matagorda Island, less than 200 km away), and caused the channel to be closed to ships for no less than 3 days.

In September 2016, Kirby Inland Marine agreed to pay $4.9 million (around €4.35 million) in civil penalties, according to the terms of an agreement established with the Department of Justice and the US Coast Guard. The company also committed to investing in a programme designed to improve the safety of the services provided by all of the fleet, in terms of equipment, personnel training and requirements for the Automatic Identification Systems of the hundreds of tugs it owns (for instance, complete tow dimensions, including both towboat and barges, should be entered before embarking on every transit).

The US Government alleged that the operator was liable for this spill under the Clean Water Act, when it became clear that its towboat (pushing 2 oil barges at the time) had detected the nearby presence of the bulk carrier *Summer Wind* but had dismissed it and, a few moments later, had attempted to cross the channel in front of it, resulting in the known outcome.

The cost of these penalties and preventive measures came in addition to costs already incurred by the company for spill response operations (or their reimbursement to the relevant federal and Texan agencies) and for compensation paid out to civil parties having filed claims for the damages caused by the spill. According to the Environment and Natural Resources Division of the Department of Justice, the settlement sends a clear message on the responsibility of ship operators in terms of water pollution prevention. The Coast Guard highlighted this case as an illustration of the inherent risk in transporting oil and HNS along the US' waterways.

Timor Sea offshore well blowout, 7 years on: proceedings and class action against the operator

In August 2016, 13,000 Indonesian seaweed farmers filed a class action with the Federal Court in Sydney to claim over €130 million (200 million Australian dollars) in compensation from PTTEP Australasia for damages believed to be caused by the pollution from the blowout in August 2009 in the Timor Sea, from the well drilled by the West Atlas mobile rig in the Montara offshore oil field (some 230 km off the north-west coast of Australia, see LTML 27-28).

Based on the allegations of various impacts (e.g. loss of seaweed production and fish stocks, skin diseases due to the presence of chemical dispersants...)[10], this was the first court case against the operator and was followed by a second lawsuit filed in May 2017 by the Indonesian Government

[8] (in addition to the voluntary Tanker Exclusion Zone set up in 1985)

[9] The government mentions the following products: "partially upgraded bitumen, synthetic crude oils, pitch, slack wax and bunker C fuel oil". Light oil products ("liquefied natural gas, gasoline, naphtha, jet fuel and propane") are not included in this moratorium.

[10] And with financial backing from Harbour Litigation Funding, based in the UK.

seeking nearly €1.78 million (US$2 billion) in compensation for environmental damage.

At the time, the spill response conducted at the surface, at the same time as leak control operations (completed 10 weeks after the beginning of the blowout)[11], was considered a success given that no oil was reported on the shoreline. Nevertheless, from the first weeks of the incident, while slicks were drifting towards Indonesian waters, Australia had informed Indonesia of the presence of a few weathered and fragmented slicks drifting towards its EEZ[12]. At that point, NGOs began to share concerns over the effects on various aquaculture resources (fish, seaweed) in Indonesia, in particular in the province of East Nusa Tenggara, around 200 km away and one of the country's poorest provinces. However, the complaints by fishermen and seaweed farmers filed by the Indonesian Government against PTTEP were rejected by the oil company due to a lack of scientific data supporting the accusations.

In spring 2017, the Indonesian Government, in addition to having instated a moratorium on issuing exploration and exploitation permits to PTTEP until the company "resolves the problem concretely", registered a lawsuit with the Central Jakarta District Court to claim a substantial sum in compensation.

The operator stated that they had launched a broad environmental impact assessment and monitoring programme instigated by the Australian Department of the Environment, Water, Heritage and the Arts (DEWHA). This programme, approved in 2009 by DEWHA, comprised 12 scientific studies whose results (summarised on the website http://www.environment.gov.au/node/18259) did not reveal evidence of significant impact on Australia's waters, reefs and shorelines in the vicinity of the spill. Based on the finding that according to the slick drift data available at the time (aerial and satellite observations; trajectory modelling) an estimated 98% of the oil never left Australian waters and that no oil was observed on the shoreline (either of Australia or Indonesia), PTTEP stated that they were confident that adverse effects on the Indonesian coasts were unlikely. This smaller spill attracted less media attention than the Macondo spill in the Gulf of Mexico a few months later and was perhaps less controversial in terms of response operations (partly as they were more "conventional" by comparison), and yet it was followed by a vast scientific programme. This oil well blow-out is still the focus of enquiries and lawsuits in terms of environmental impacts. To be continued...

[11] The main well was intercepted in early November 2009, after 4 unsuccessful attempts, after the injection of 540 m^3 of heavy mud to plug the leak. The well was definitively capped at the end of the month by pumping cement over 1,500 m down the relief well.

[12] Slick containment/recovery operations were conducted by Australia within the Indonesian EEZ.

• Review of spills having occurred worldwide in 2016

Oil and HNS spills, all origins (Cedre analysis)

• Volumes spilt

In 2016, Cedre recorded 38 spills involving volumes greater than or equal to 10 m^3, for which sufficient information was available for statistical analysis. These events occurred most often at sea and in ports (each representing around 37% of incidents), followed by inshore waters (around 20% of cases). Approximately 5% of these spills occurred in estuaries (Fig. 1).

The number of incidents recorded in 2016 is slightly higher than the annual median expressed for the 12 previous years (29 incidents for the 2004-2015 period). The total quantity of oil and other hazardous substances spilt, around 172,800 tonnes, is far higher than the median estimated using the same method for the previous 12-year period (around 28,400 tonnes) (Fig. 3). Nevertheless, this total is skewed by the inclusion of one major spill (loss of a vessel and its cargo of 160,000 tonnes of coal in Madagascar in January 2016; see LTML n°42-43). Aside from this exception, 2016 was punctuated by spills distributed around a median of around 30 tonnes (and would appear to fit with the overall downward trend in estimated annual volumes reported since 2012) (Fig. 3).

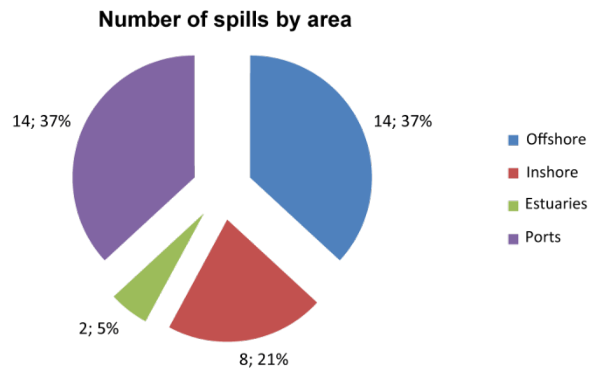


Figure 1

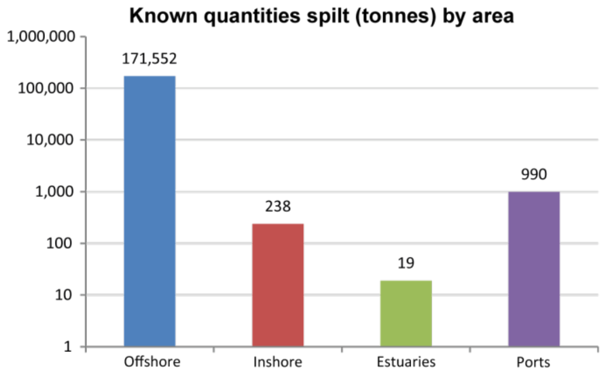


Figure 2

The quantities spilt in 2016 were mainly released at sea (Fig. 2), largely due to: the above-mentioned spill of coal in the coastal waters of Madagascar; the rupture of a pipeline at an oil terminal in the Niger Delta[13] in January; and the explosion which occurred onboard the oil tanker *Burgos* a few nautical miles from the Mexican coasts in September (see above).

The remaining quantities spilt were mainly released in ports, largely from oil facilities (refinery in Italy in April, see LTML 42-43, and an oil terminal in the Port of Aqaba in August - see above), and a cargo vessel stranded in a Japanese port in January[14].

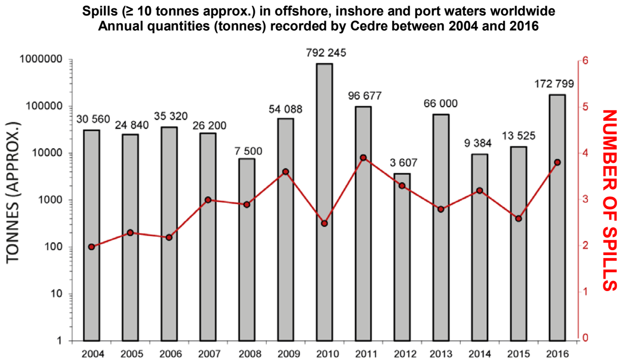


Figure 3

By comparison, inshore waters and estuaries were less affected by the quantities spilt in 2016 (quantities which it is important to remember, as for previous years, are probably underestimated due to sometimes inaccurate information).

[13] On 14th February, in Nigeria, a pipeline rupture at an oil terminal caused a spill, off the Niger Delta, of a few thousand m^3 of crude oil. The operator deployed the equipment and personnel required to implement response actions at sea (aerial surveys, containment and mechanical recovery, etc.) and on the shoreline, with support from the oil industry cooperative Clean Nigeria Associates.

[14] Incident involving the cargo ship *City*; See LTML 42-43

• Spill locations

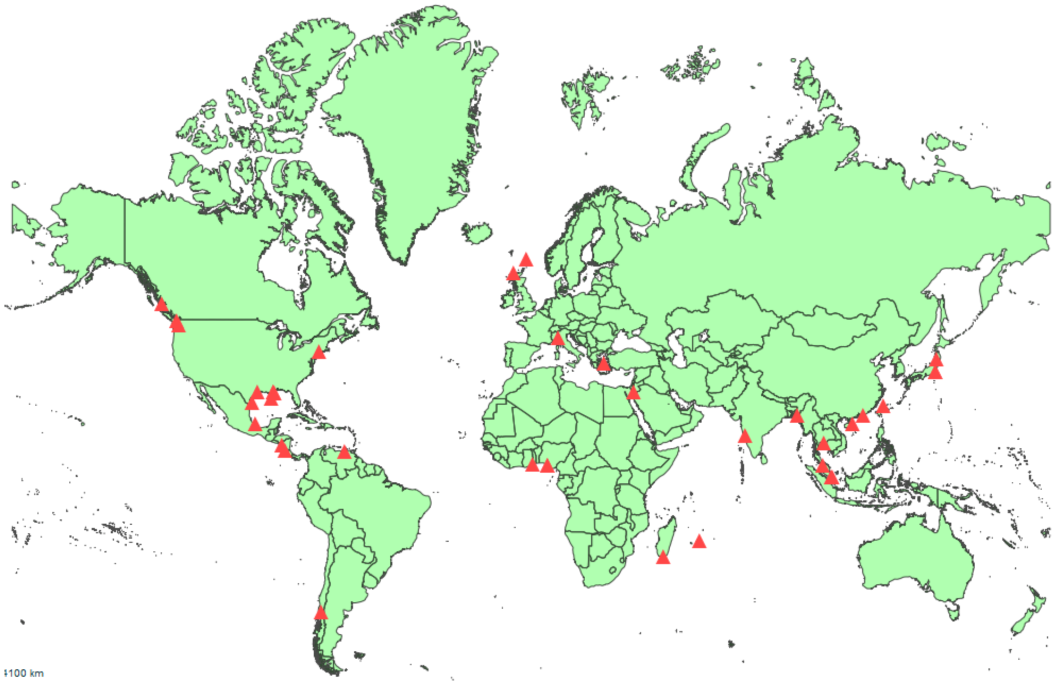


Figure 4 *Location of the main oil and HNS spills offshore and inshore in 2016 (recorded by Cedre).*

• Incidents leading to spills

The majority (over 80%) of the incidents in 2016 were due to **breaches or ruptures** in various structures:

- In terms of frequency, nearly a quarter of these incidents resulted from ship **groundings** (Fig. 5), which represented the vast majority (around 90%) of the total volume spilt in 2016 (Fig. 6). Over and above the 160,000 tonnes of coal released when the *New Mykonos* ran aground in the coastal waters of Madagascar, 3 moderate spills stand out (between 100 and 120 tonnes), following groundings in Asia (the cargo vessel *City* in Japan, the container ship *TS Taipei* in Taiwan)[15] and Canada (case of a tug in British Columbia – see above).
- **Ship collisions** (with other ships or structures) were involved in the same number of cases, three quarters of these cases being due to collisions with other ships (Fig. 5), but only represented a very small proportion of the total quantity spilt in 2016 (<1 %; Fig. 6). This interpretation should however be balanced against the lack of precise information on the extent of the spill for half of all cases.
- **Loss of integrity** of various structures, most often offshore or onshore oil facilities (from pipelines or storage facilities in particular), represented nearly 20% of incidents in the **breaches and ruptures** category in 2016. They nevertheless contributed only marginally (less than 1%) to the overall total, given the generally low volumes (from around 10 to 50 m^3). To the best of our knowledge, only one incident exceeded the 100 m^3-mark (a leak from a gathering line between a production well and an offshore platform in the United States in May)[16].
- Spills triggered by **explosions/fires** and **structure ruptures** then come in at roughly equal levels, both in number and quantity, with around 5,900 tonnes mainly related to two incidents: an explosion aboard an oil tanker in the United States[17] and a pipeline rupture in Nigeria.

The incident having caused the spill was not described in 13 % of the cases listed. Based on the

[15] See LTML n°42-43
[16] See LTML n°42-43
[17] See above.

information available to us, none of the other types of incidents stood out in the 2016 analysis, either in terms of frequency or of their share in the overall total (Fig. 5 and 6).

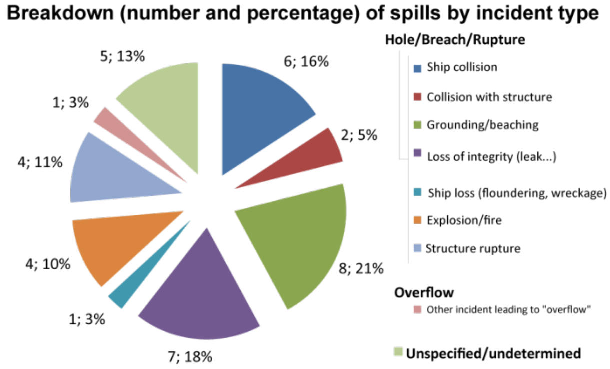


Figure 5

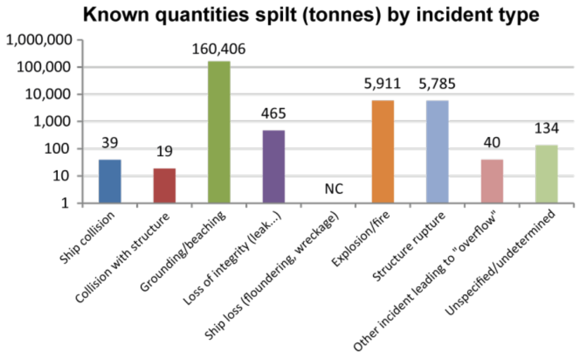


Figure 6

• Spill causes

The analysis of causes shows that they are **undetermined or unspecified** in our information sources for three quarters of incidents identified (Fig. 7). These incidents were the main contributors (>90 %) to the total volume spilt (Fig.8), largely due to the grounding of the bulk carrier the *New Mykonos*[18] whose cause is unknown.

Although the information available lacks accuracy, the main causes of significant spills in 2016 can be tentatively ranked based on their frequency. The most prominent causes thus appear to be **external interference** (8 % of cases in total, in particular in the **sabotage/terrorism/piracy/war** category which accounts for over 5,000 tonnes) and **human failure** (also around 8 %), followed by **technical failures** (around 4 %, due in equal parts to **defectiveness/dilapidation** of facilities and **ship engine failure**). Their shares in the total volume are difficult to determine due to the lack of accurate data.

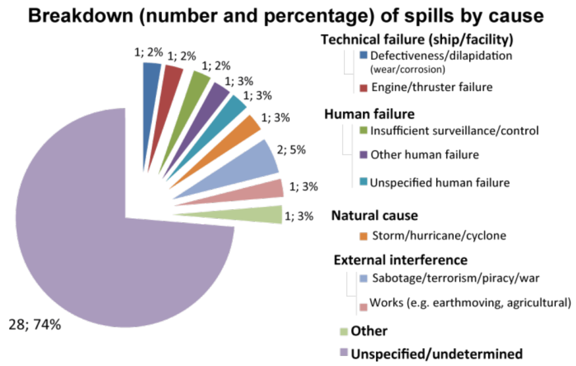


Figure 7

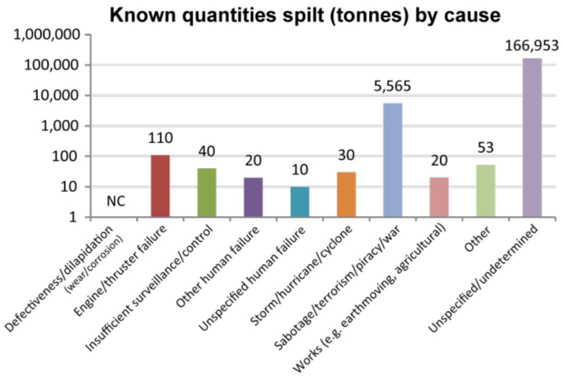


Figure 8

• Substances spilt

The significant spills in 2016 all involved oil (Fig. 9). In terms of spill frequency, we note the prevalence of **light refined oil products** (most often diesel, involved in almost 30% of cases), followed by **crude oils of unspecified density** (approximately 25% of cases). These 2 categories account for the largest shares of oil products in the annual total (Fig. 10).

This is followed by **heavy/intermediate** products of unspecified IFO grades (involved in approximately 16% of cases) and **heavy** (IFO≥380) and **intermediate** (IFO 180) refined products, which are associated with 5% and 3% of incidents respectively. In 15% of cases, the type of oil is **unspecified or unknown**. The shares of the latter 4 categories in the total volume spilt in 2016

[18] See LTML n°42-43

appear low, in comparison to those of crude oils and light refined oils.

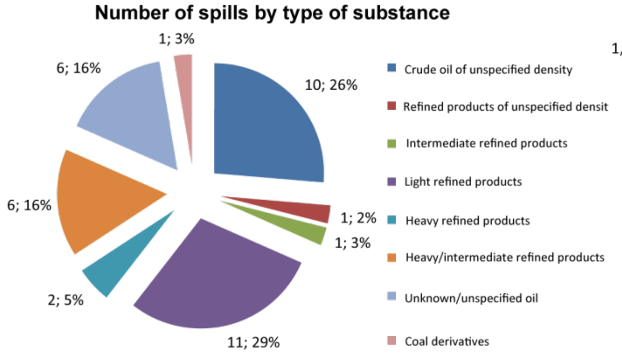


Figure 9

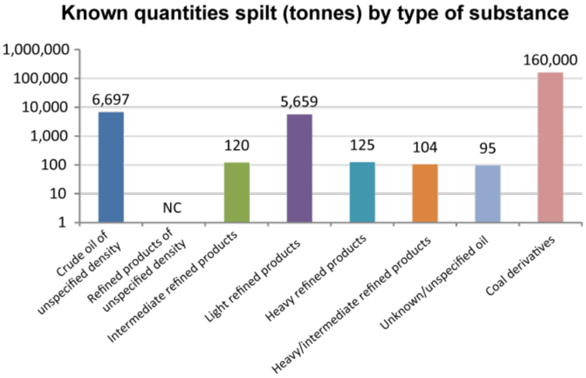


Figure 10

Despite a single occurrence involving the loss of a cargo of coal by the bulk carrier *New Mykonos* in the coastal waters of Madagascar, the **coal derivatives** category represents the overwhelming majority of the 2016 total (Fig. 9).

Ship-source oil spills in 2016: ITOPF statistics

At the end of 2016, the analysis by the International Tanker Owners Pollution Federation (ITOPF) on ship-source oil spills once again confirmed the downward trend of major spills from ships observed since the 1970s.

In 2016, ITOPF reported only one large spill (over 700 tonnes according to ITOPF's terminology), which was a spill of a light fuel into the Gulf of Mexico in September, following an explosion and fire onboard an oil tanker[19]. By way of comparison, the federation reported 2 large spills in 2015, 1 in 2014 and 3 in 2013. ITOPF also reported 4 medium-sized spills (7-700 tonnes category) in 2016, a modest figure, down slightly from the previous year (6 cases in 2015).

According to ITOPF, the total volume of oil spilt in 2016 worldwide due to oil tanker incidents was approximately 6,000 tonnes. This figure is similar to the previous year (around 7,000 tonnes) and is within the range of values recorded since 2008 (generally between 1,000 and 7,000 tonnes per year).

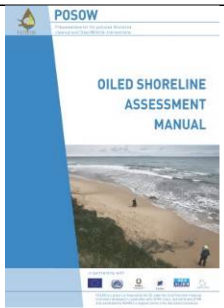
For further information:
http://www.itopf.com

• Response preparedness/(inter)national strategies

It’s a wrap for POSOW II: new training materials now available

The POSOW II project (Preparedness for Oil-polluted Shoreline Cleanup and Oiled Wildlife interventions) launched on 1st January 2015 under the coordination of Cedre and funded by the civil protection mechanism (DG ECHO) drew to a close on 31st December 2016.

This project was a sequel to the POSOW project conducted in 2012 and 2013 and again involved REMPEC (Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea, Malta), ISPRA (*Istituto*



[19] Doubtlessly, although it is not named, the *Burgos* incident (see above).

Superiore per la Protezione e la Ricerca Ambientale, Italy), FEPORTS (*Instituto Portuario de Estudios y Cooperacion de la Comunidad Valenciana*, Spain), AASTMT (Arab Academy for Science, Technology and Maritime Transport, Egypt) and DG-MARINWA (General Directorate of Maritime and Inland Waters, Turkey). The main aim of this project was to improve knowledge and skills in the countries bordering the Mediterranean Sea by developing training materials and manuals as well as running training courses.

POSOW II was thus the opportunity to expand the collection of training materials developed during POSOW I on 6 themes: volunteer management, shoreline assessment, shoreline clean-up, the role of fishermen, wildlife response and waste management. This collection now comprises 6 instructor manuals and 6 field manuals in English, Arabic and Turkish, as well as 16 posters and 17 PowerPoint presentations available in English, Arabic, Croatian, Spanish, French, Greek, Italian, Slovenian and Turkish.

All of these documents are available for free download from the website www.posow.org.

Mediterranean: 11th ratification of the Prevention and Emergency Protocol of the Barcelona Convention

As a contracting party to the Barcelona Convention[20], the Algerian Government ratified the “Protocol Concerning Cooperation in Preventing Pollution from Ships and, In Cases of Emergency, Combating Pollution of the Mediterranean Sea” in November 2016, with entry into force in December 2016.

The ratification by Algeria of this Protocol, adopted by the Conference of the Plenipotentiaries held in Malta in 2002, comes in addition to its ratification by Cyprus, Croatia, Greece, Israel, Italy, Malta, Monaco, Morocco, Slovenia, and Spain, i.e. half of the contracting parties to the Barcelona Convention who thereby commit to cooperate to implement international regulations in order to prevent, reduce and control pollution of the marine environment from ships, and to take all necessary measures in cases of pollution incidents.

The protocol has been approved by France and the European Union and adhered to by Montenegro, Syria and Turkey.

South-East Asia: marine spill response exercises including HNS

As part of a bilateral cooperation programme, under the auspices of the Malaysia-Singapore Joint Committee on the Environment, the Malaysian National Environment Agency (NEA), the Marine Department of Malaysia (MDM), the Johor Department of Environment (DoE) and the Maritime and Port Authority (MPA) of Singapore jointly organised a major HNS spill response exercise in the second half of 2016.

This exercise was based on a commonly occurring scenario in this heavy shipping area, involving a collision between two ships: a chemical tanker and a cargo ship. The chemical tanker suffered structural damage, leading to the immediate release of around 30 tonnes of styrene (product that floats and evaporates) off the port of Pasir Gudang, at the eastern end of Johore Strait which marks the boundary between these 2 states. The aim was to test the Joint Emergency Response Plan (ERP) developed by the states, as well as the communication between operational and environmental agencies in Malaysia and Singapore. Supervised by MDM, the at-sea response involved the large-scale deployment of equipment (4 vessels) and personnel (40 responders) from the MPA of Singapore. The NEA was in charge of monitoring atmospheric and seawater contamination, in association with the Johor DoE.

[20] United Nations Environment Programme Mediterranean Action Plan

For further information:
http://www.nea.gov.sg/corporate-functions/newsroom/news-releases/malaysia-and-singapore-jointly-conduct-exercise-to-tackle-a-chemical-spill-at-sea

Also a signatory party to OPRC 90 and OPRC-HNS 2000, Hong Kong (People's Republic of China) once again conducted an annual marine pollution response exercise in October 2016. Two parts, referred to as Oilex and the Maritime Hazardous and Noxious Substances Exercise, related to spills, one oil and the other HNS.

Based on a scenario involving a collision between an oil tanker and a container ship, the exercise included an onshore and offshore spill response component, following the release of part of the oil tanker's cargo, control of the leak, as well as addressing the issue of a port of refuge and the management of a potential HNS spill (with 5 leaking containers of phosphoric acid being lost overboard). The following operations were thus simulated: salvage of the damaged oil tanker (plugging and transfer of the contents of the leaking tanks), containment and mechanical recovery at sea (Hong Kong's preferred strategy), as well as spraying of chemical dispersants from ships[21]. The leaks of phosphoric acid, a water-soluble product, from drifting containers were treated by spraying water onto the sea surface, to accelerate dilution (we note that the same strategy was applied for the previous year's scenario, which was fairly similar except that it involved the loss of containers of ammonium nitrate, also a soluble product).

In compliance with the national Maritime Oil Spill Response Plan, the operations were coordinated by the Marine Department's (MD) Pollution Control Unit. This large-scale exercise included the participation, alongside the relevant public agencies, of service providers funded by the oil industry (Hong Kong Response Ltd).

EMSA: renewal of the fleet of oil spill response vessels in the Black Sea

In early 2017, the European Maritime Safety Agency (EMSA) completed a public procurement procedure launched in 2016 for chartering an oil spill response vessel in the southern Black Sea area, replacing the contract which expired the previous September.

The contract was awarded to Cosmos Shipping (Bulgaria), whose oil tanker *Galaxy Eco* will be fitted out with remote sensing and oil containment and recovery equipment, in particular suited to oils with a flash point below 60°C. This tanker, with a storage capacity of 3,000 m^3, is expected to enter into operational service by mid-2017.

For further information:
http://www.emsa.europa.eu/operations/pollution-response-services.html

• Decision support

Norway: field data banking and access tool to support operations

The Norwegian Coastal Administration (NCA) recently developed a set of software tools designed to optimise the time taken to assess oiled shorelines and consequently reduce the delay in implementing clean-up operations. This optimisation effort focused on data input, transmission and integration processes for data obtained from spill surveys (spread, distribution, form, etc.) into an IT platform which provides an evolving overview of the situation (Common Operating Picture concept).

The project focused on developing a mobile application to directly enter survey data in the field, in standardised format (via forms). The data is georeferenced and automatically transferred to a server from which it is fed into a detailed geographical information system, through regular syncing, meaning that it is updated in real time for use by decision-makers.

Led by NCA, this system was developed in cooperation with the oil operators cooperative NOFO, building on feedback from the *Full City* spill (2009; LTML n°27 & 28) and the *Godafoss* spill (2011; LTML n°33) in particular. While the pre-existing service Kystinfo (NCA's online mapping service) was able to scan and integrate field data (pollution, operations), the advantage of being able to directly enter standardised data was also identified, in particular when, in addition to the time

[21] Dispersant spraying is generally only a second resort, if there is a risk of the oil slicks affecting aquaculture facilities, water intakes or certain industrial facilities, or sites with a special status (e.g. Special Scientific Interest Sites).

required to transcribe and enter handwritten notes into an IT system, surveys are limited by daylight hours (winter, case of the *Godafoss*).

Source: http://kystverket.no/

Furthermore, the need was also felt to optimise the system's capacity to integrate detailed/precise data. In response to these needs, NCA and NOFO worked together to develop a mobile app (for smartphones, tablets, etc.) dubbed *Strandappen*, to collect data via standardised forms (as well as photographs, videos, etc.) and quickly upload them to a geographic information system which compiles all the spill surveys (on foot, from aircraft, at sea, etc.) and the different types of operations implemented.

In operational terms, the expected benefits of this tool are to facilitate response operation planning through the early definition of clean-up priorities and the appropriate techniques. One of the aims of compiling this accurate information (pollutant volumes, surface areas, lengths of contaminated shoreline, etc.) is to determine the quantities of logistical and human resources required and allocate them more appropriately, as well as to better anticipate costs.

Offshore pollution risks: decision support system SpillWatch

The Norwegian company StormGeo, specialised in weather forecasting, is offering offshore industry players decision support systems for operations which are heavily dependent on metocean conditions.

Their solution dubbed OceanWatch is designed to support oil and gas industry operations by continuously tracking and forecasting conditions and currents in real time. The SpillWatch module can be activated to supplement the features of the host software by using sensors and models in order to track and predict the fate of oil spills. The trajectory model included was developed in cooperation with SINTEF and is based on the OSCAR model. Users can choose between different scenarios, based on the type of oil and the spill characteristics (surface spill vs. subsea blow-out, leak rate, etc.).

For further information:
http://www.stormgeo.com/offshore/oceanwatch/

Sunken oil: technical review and API operational guide

The year 2016 saw the release of two new American Petroleum Institute (API) publications on the issue of sunken oil detection:

- The first, Sunken Oil Detection and Recovery, aims to review the current state of knowledge, drawing upon past incidents in marine and freshwaters, in terms of potentially appropriate techniques and equipment for sunken oil detection (sounders, subsea cameras, divers, samplers, ballasted sorbents, detectors, etc.), containment (air curtains, silt curtains, gabion baskets) and recovery (dredging, pumping/suction, sorbents, remobilisation, etc.). It also proposes research and development opportunities for a number of techniques identified as promising in this field, or conversely due to gaps being pinpointed, without forgetting the issue of management of the waste generated by these techniques (e.g. sediment dredging).
- The second is an operational guide which aims to provide decision support in terms of implementing response operations for sunken oil, by weighing up the advantages and disadvantages of each method (e.g. operational limitations, logistical prerequisites, etc.)

Intended more for application in, and based on feedback from, incidents in inland waters, this issue is also of interest for offshore and inshore environments, where spills of heavy oil such as bunker fuel are not uncommon and where submersion processes (in particular due to sediment load with weathered clusters of oil in inshore waters for instance)[22] may lead, in the longer term, to issues comparable to the response to sunken pollutants.

For further information:

American Petroleum Institute, 2016. Sunken Oil Detection and Recovery. *API TECHNICAL REPORT 1154-1*, 126 pp.

American Petroleum Institute, 2016. Sunken Oil Detection and Recovery, Operational Guide. *API TECHNICAL REPORT 1154-2*, 36 pp.

• Containment

Spills during transfer operations: VikoSeal Boom

The British manufacturer Vikoma has launched a containment and protection system baptised VikoSeal, designed to set up an oil containment area between ships, or between a ship and the dockside. Its primary purpose is to ensure safe cargo loading and unloading operations, bunkering operations – either in dock or at sea, etc.

It is composed of 3 sections of floating boom which, when deployed, form an H-shape. The two lateral bars of the H form a seal against the ship hull or dockside, creating a containment area with the crossbar, which also acts as a spacer.

According to the manufacturer, the device has high abrasion resistance and high tensile strength (in particular resistance to towing and compression) – vital given the conditions in which it is used – thanks to its vulcanised neoprene. The draught of this boom is around 10 cm.

View of the VikoSeal deployed between a ship and the dock (Source: https://www.vikoma.com/)

The Vikoseal comes in 2 sizes, approximately 3 m and 4.5 m wide. In addition to its preventive role, as described above, the manufacturers claims that this device can be used in emergency response as a spacer for conventional booms deployed for instance around a grounded, leaking vessel (in order to provide a recovery/skimming area for floating substances).

In either case (risk of operational or accidental release), Vikoma emphasises the fact that this system is quick to deploy, which is an important factor given that when a spill occurs in inshore areas – which are often sensitive environments – the effectiveness of containment is often a key factor in ensuring a successful response.

For further information:
https://www.vikoma.com/Oil_Spill_Solutions/Booms/VikoSeal.html

Emergency offshore containment: HARBO Technologies disposable boom project

The Israeli company HARBO Technologies is developing a disposable floating boom concept, the T-Fence Boom™, especially designed to be (i) compact and lightweight for easy storage, (ii) quick to deploy, encircling the slick by deploying the boom from a lightweight boat, and (iii) effective in the open sea, in particular through the floats' capacity to sit firmly on the water surface even in heavy swell.

Deployment of this boom is designed to be simple, requiring few operators and no specific training: a push button is pressed to inflate the small buoyancy chambers, packaged in "cartridges"[23], and linked together as the boat moves forward, while simultaneously injecting seawater into the ballast chambers.

[22] On this point, a report was published in 2015 by the U.S. Geological Survey (USGS) presenting the state of knowledge on the formation and fate (transport, sedimentation, resuspension, etc.) of oil-particle aggregates (OPA) in various environments (marine, coastal, estuarine, lakes, etc.) See **Fitzpatrick, F.A., Boufadel, M.C., Johnson, Rex, Lee, Kenneth, Graan, T.P., and others, 2015**. Oil-particle interactions and submergence from crude oil spills in marine and freshwater environments—Review of the science and future science needs: U.S. Geological Survey Open-File Report 2015–1076, 33 p., http://dx.doi.org/10.3133/ofr20151076.

[23] (comparable, according to the manufacturer, to the deployment method used for inflatable life rafts)

Prototype of the HARBO T-Fence Boom™ being tested at OHMSETT (source: HARBO)

This system aims to effectively contain a floating oil spill thanks to its seakeeping performance in swell. Its performance appears to have been proven in the test conditions used in late 2014 at the OHMSETT facility[24] during the concept development phase (although we note that these tests did not cover the deployment manoeuvres).

This lightweight, disposable boom is designed to be pre-positioned at high risk offshore sites (oil installations) and is intended not as a substitute for conventional offshore booms but rather as an initial emergency measure, pending the mobilisation and deployment of more substantial equipment.

Following the trials conducted on the boom itself, HARBO announced that it was then working on the development of its deployment set.

For further information:
http://www.harbo-technologies.com/

• Floating waste/debris

Floating debris and seaweed: the Elastec Beach Bouncer

The manufacturer Elastec recently launched a new model of barrier, the Beach Bouncer, initially developed to protect beaches against seagrasses such as Sargassum, which is relatively invasive and which washes ashore in massive amounts in the Caribbean where it has been known to occasionally affect tourism from Mexico to Florida.

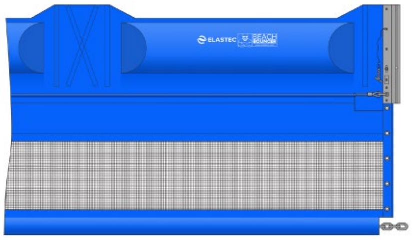


Diagram of the components of the Beach Bouncer (source: https://www.elastec.com)

In this respect, the Beach Bouncer was designed as a boom for floating debris, and it can also be used to contain (or deflect) litter, in the same way as other models proposed by the manufacturer such as the Brute Boom[25].

It is composed of permanent floats (Ø 30 cm foam cylinders) in a PVC casing, with a longitudinal steel load-carrying cable and, below, a 90 cm-high net, with an approximately 3 mm mesh. This net is ballasted with a galvanised steel chain along the bottom of the skirt to keep the boom upright.

The 30 m-long boom sections can be combined using standard ASTM connectors and feature mooring points every 7.5 m.

For further information:
https://www.elastec.com/products/floating-boom-barriers/invasive-aquatic-plant/beach-bouncer/

• Recovery at sea

Storage at sea: tank heating using the multi-nozzle system *PARAT Halvorsen*

Norwegian firm *PARAT Halvorsen* markets a tank heating solution to be technically capable of pumping oil from the tanks of ships tasked with storing oil emulsion recovered at sea. Various versions of this steam heating solution exist, ranging from a system that can use the hot water loop already in place and implemented only to heat the tanks when the vessel is storing liquid oil waste, to a more comprehensive integrated system, providing hot water for the ship's daily use and combined with the tank heating system when activated.

These systems are designed based on a multiple nozzle model, designed to optimise heat distribution throughout the tanks while requiring only a single insertion point (preferably close to the draining/pumping point), bearing in mind that the creation of additional insertion points is costly,

[24] Tests conducted in calm waters, rough waters, static mode and towed mode.

[25] Heavy duty permanent containment boom with reinforced steel screen.

complex and liable to increase the number of technical failures (risk of leaks from numerous connections, seals, valves, etc.).

For further information:
http://www.parat.no/media/165798/Tank-Heating-Solutions-web.pdf

Containment and recovery: Mobimar FinnSweep integrated systems

In its range of workboats, the Finnish naval engineering firm Mobimar markets trimarans equipped for oil recovery on water. These boats, which go by the name of CORS (Continuous Oil Recovery System), come in 2 models (21 m and 30 m) and have a Mobimar FinnSweep system integrated in their hull. This system is composed of two linear oleophilic brush skimmers, one on each side of the hull, with a nameplate capacity, according to the manufacturer, of 100 m^3/hour, together with two 300 m sections of inflatable boom (Hi-Sprint booms by Vikoma) to funnel the oil, held in sweeping position by beams. It is worth noting that two auxiliary boats able to pull the booms with around 3 ton bollard pull each are needed to set up the system. The recovered oil is stored in 25 m^3 flexible floating tanks, although the type used is not specified by the manufacturer.

The Finnish Coast Guard has equipped its specialised vessel *Turva* with a FinnSweep system, although this version differs in that the beams and booms are deployed from the onboard vessel itself via a command post which requires only one operator.

For further information:
http://www.mobimar.com/oil_recovery_systems
https://www.youtube.com/watch?v=7Zu2H4cpkBQ

• Response on the shoreline

Cleaning rocky substrates with loose sorbents

In Norway, the cleaning of hard shoreline substrates by spreading and recovering loose sorbents is a strategy perceived to be an efficient alternative to manual collection in certain conditions (jagged shores, difficult access sites, etc.).

Given this context, the Norwegian manufacturer Henriksen made a recent addition to its catalogue: FoxMix, a specially designed machine developed in collaboration with the Norwegian Coastal Administration (NCA). After using the FoxBlower to spray the sorbent, the FoxMix is used to optimise sorbent yield by promoting contact with the oil, before recovering the oiled sorbent by vacuuming[26].

Powered by a small 4-stroke engine, a rotating head with interchangeable brushes, selected according to the type of substrate to be treated (pebbles, wave-cut platforms, etc.), mixes the sorbent particles (fibres, shavings, granules, etc.) with the oil.

Shoreline clean-up by bulk sorbents: spraying (FoxBlower, left) then mixing (FoxMix, right) of particles (Source: www.hhenriksen.com)

This is a compact, lightweight system that can be operated by a single operator and transported across beaches with limited access. This device is reminiscent, in terms of its form and purpose, of the MOSE (Mechanical Oil Spill Equipment) developed a few years ago through the research and innovation programme Oil Spill Response 2010[27], and since manufactured and marketed by MOSE Innovation.

For further information:
https://www.hhenriksen.com/spillrecs/shoreline

[26] The provisionally named FoxVac is a vacuum system currently under development by the manufacturer to complete this range.
[27] Launched in 2009, in partnership with the Norwegian Coastal Administration (NCA) and the Norwegian Clean Seas Association for Operating Companies (NOFO). See LTML n°36.

• Sorbents and gelling agents

Crude oil spill in the Arctic: gelling agent allowing recovery and compatibility for refining

In the United States, the Department of Materials Science & Engineering at the University of Pennsylvania has developed i-Petrogel, a polymer derived from oil compounds that is able to absorb 30 to 40 times its weight in oil. Over and above this performance, oil treated with this gel floats and can be mechanically recovered then reused. This gives it a high potential with a view to allowing refining, using the regular refining process (no pretreatment).

This project, funded by the Bureau of Safety and Environmental Enforcement (BSEE), ran from September 2014 to March 2017 and aimed to develop and assess a new spill product designed for practical application in the Arctic waters of Alaska for containment and mechanical recovery operations involving Alaskan North Slope (ANS) oil. This project was divided into two phases, and its results and conclusions have recently been released by BSEE:

- The first phase consisted in formulating and developing a gelling agent with a high absorption capacity for ANS crude oil, before producing samples whose absorption performance was assessed in the laboratory. This performance (absorption capacity, kinetics) was then validated at mesoscale (in 3 m x 3 m experimental tanks at the OHMSETT facility) through tests on various formulations during which the skimming and pumping of the gelled oil were also tested.
- the second phase aimed to establish a production process to manufacture larger quantities of the gel, in the form of flakes to enable it to be applied by aircraft, and to conduct new tests (application, efficiency, skimming using oleophilic drum skimmers, etc.) in operational conditions close to those expected in the Arctic, at the OHMSETT facility.

*Mesoscale tests: spreading i-Petrogel flakes on crude ANS (**left**); skimming with an oleophilic drum skimmer (TDS Elastec, **right**) (Source: OHMSETT)*

According to the reports recently published by BSEE, this technology is looking promising. Based on the preliminary results of tests conducted on ANS, the agency concluded that i-Petrogel has a high absorption capacity, as well as other advantages including:

- low weathering of the crude oil reported in the trial conditions
- good "recoverability" of the gel/oil mixture at the water surface (dependent on the gel's formulation, in particular the ratio of rigid to soft polymers)
- low water content in the recovered mixture (dependent on the selectivity of the skimming equipment used)
- the possibility of refining the collected oil as regular ANS.

For further information:
https://www.bsee.gov/sites/bsee.gov/files/osrr-oil-spill-response-research//1034aa.pdf
https://www.bsee.gov/sites/bsee.gov/files/osrr-oil-spill-response-research//final-project-report.pdf

• Dispersion

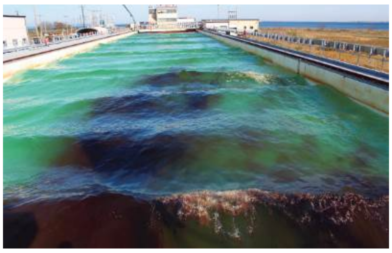
Dispersant effectiveness comparison according to environmental conditions: tank testing procedures

Again in the United States, a study into the respective effectiveness of 5 dispersants on the U.S. Environmental Protection Agency's National Contingency Plan Product Schedule is currently in progress using large-scale test procedures developed at the OHMSETT facility.

This project is funded and led by the Bureau of Safety and Environmental Enforcement (BSEE) which, as part of its oil spill preparedness functions, had identified a need for comparative studies in controlled environments, sufficient in size to allow agitation conditions which would be (i) repeatable and (ii) perceived as close to those of operations, referred to as "pseudo-field conditions".

The dispersants tested[28] were spread on slicks of HOOPS blend (a crude oil from the Gulf of Mexico) using a mobile spray bar simulating the advancement of a spraying vessel.

The dispersant effectiveness was estimated according to the oil distribution, after treatment, between the 2 phases, i.e. the residual slick and the water column. The droplet size distribution was also measured using Laser In-Situ Scattering and Transmissometry (LISST).



Large-scale evaluation of the effectiveness of approved dispersants in warm water and wave conditions (source: BSEE)

These assessments, intended to be complementary to – and in no way a substitute for – dispersant approval procedures, are similar to those developed during a previous EPA project on dispersion in the Arctic. The results of this project, released in 2016, were considered as relevant information for ranking the chemical formulations approved in the US on their effectiveness in cold waters.

This second project, this time in warm waters (to be applied in the Gulf of Mexico), is currently in its final phase and is due to be completed by the end of 2017. In connection with this type of comparative study on dispersion, for which we easily understand how they benefit from well managed experimental parameters, we note that between 2015 and 2016, the OHMSETT facility underwent major renovation work, including the replacement of its wave generator. These renovations were followed by detailed measurements of the waves created by this generator, using acoustic Doppler velocimeters, ultrasonic sensors, altimeters, etc. This analysis determined the ranges of wave characteristics (average height, wave length, period, energy, etc.) according to the chosen settings. It also assessed the potential benefit of equipment modifications (for instance wave energy dissipation systems to control reflection phenomena) with a view to future improvements of this tool which belongs to the federal government, or for trials implemented with particular specifications for example.

For further information:

OSRR-1016-AA: Steffek, T., Bittler, K., & Guarino, A. (2016). Comparative Testing of Corexit EC9500A, Finasol OSR 52, Accell Clean DWD, and ZI 400 at Ohmsett in a Simulated Arctic Environment. Sterling, VA: BSEE.

Aerial spraying of chemical dispersants: new oil industry capability *Boeing 727-2S2F* (RE) and developments in progress for the *Boeing 737-400* in the UK

In the second half of 2016, the industry-funded cooperative Oil Spill Response Limited (OSRL) completed the replacement of its *L-382G Hercules* (civil equivalent of the military C-130 also built by Lockheed), a fixed-wing aircraft fitted with an Airborne Dispersant Delivery System (ADDS Pack), which had previously been chartered from the Irish company Air Contractors.

As part of a Joint Industry Project (JIP) launched in the wake of the *Deepwater Horizon* spill, OSRL sought to expand its dispersant spraying response capability, with a plane capable of flying further and faster.

The British firm T2 Aviation won the tender issued by OSRL to select, modify and certify an aircraft which would meet these requirements. The chosen aircraft, 2 medium-haul Boeing 727-2S2F (RE) planes, now chartered by OSRL[29] were modified to accommodate 7 dispersant tanks (with a total capacity of 15 m^3), pumps and the newly developed Tersus Spray System. Spraying operations are implemented at around 40 metres altitude at a speed of 150 knots (similar to that of the Hercules plane).

(Source: OSRL)

Based in Doncaster (UK), the *G-OSRA* and the *G-OSRB* comply with specifications approved by the UK Civil Aviation Authority and by the European Union Aviation Safety Agency (EASA). These specifications include compliance of the spray system with current flammable fluid certification requirements (e.g. double-skinned tanks and pipework, the ability for the system to maintain

[28] Corexit EC9500A, Finasol OSR 52, Accell Clean DWD, Marine D-Blue Clean, and ZI 400

[29] Bearing in mind that T2 Aviation has AOCs (Air Operator's Certificates) to operate these aircraft worldwide.

structural integrity in a crash with forces up to 9g, etc.).

For further information:
https://www.oilspillresponse.com/services/member-response-services/aviation-resources/
http://www.2excelaviation.com/lines-of-business/t2/

Meanwhile, the American firm Waypoint Aeronautical has developed a removable dispersant spraying system designed for the Boeing 737-400, the world's highest-selling jetliner. Designed for an entirely reversible installation, this system with a capacity of approximately 15 m^3 was developed in collaboration with the British aviation services specialist RVL Group, through a project by the Maritime and Coastguard Agency (MCA) which is seeking an aviation service company capable of being mobilised across the UK's EEZ.

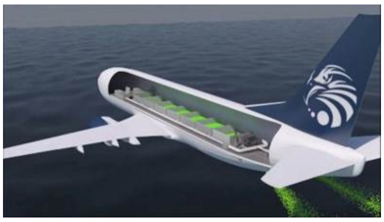


Diagram of the dispersant spray system from a Boeing 737-400 (Source: RVL Group)

In July 2016, this prototype, baptised the Oil Dispersant Spray System (ODSS), received a Supplemental Type Certificate, an authorisation delivered by the Federal Aviation Administration (FAA), to modify an aircraft or aircraft equipment with this system. This was the first step towards the certification sought by Waypoint Aeronautical and RVL Group in order to operate the ODSS on both sides of the Atlantic.

For further information:
http://rvl-group.com/rvl-group-reach-important-milestone-737-400-spray-system-project/
https://www.sell2wales.gov.wales/search/show/search_view.aspx?ID=FEB188404&catID=

• Controlled in situ burning

Industry initiatives: recent tests and publications

Held in Woods Hole (Massachussets, USA) from 24th to 26th September 2016, the fifth meeting of the Industry Technical Advisory Committee (ITAC) provided the opportunity for discussions between industry, response operators, representatives of scientific bodies (institutes, universities, agencies, etc.), as well as the chance to address the progress of various projects, from oil industry-funded Joint Industry Projects (JIPs) (including those launched following the Gulf of Mexico spill in 2010 which, led by IOGP/IPIECA and API, were reaching completion) to initiatives by industry or OSROs (in particular those belonging to GRN, the Global Response Network).

Among the themes addressed at the meeting, presentations were given and discussions held on in burning (ISB), with a review of recent publications and the general observation that this method still faces problems of acceptance (in particular due to burn residues, and their fate and potential effects in the atmosphere and in water).

In terms of publications, the following points can be noted:

- further to the Guidelines for the selection of in-situ burning equipment published in 2014, the Good Practice Guidelines in the series produced through Programme 3 of the IOGP-IPIECA OSR JIP5 were released in late 2016. Entitled "Controlled in situ burning of spilled oil" this guide is designed as a complement to the numerous industry-funded tasks, conducted under different projects including API JITF (Joint Industry Task Force) which has funded a large number of studies in recent years on the applicability of this strategy (admittedly in the Arctic in particular, but not only). This document aims to incorporate and promote the knowledge gained on ISB, from the NOBE experiment[30] to the lessons learnt from *Deepwater Horizon.* In addition to these documents, an information document, drafted by Cedre with support from Ineris, based on the available scientific literature and the results of burn tests – more specifically in relation to the residues (characterisation, persistence, etc.) potentially generated by ISB, was published online.
- the publication, in October 2016, of the revised version of the technical report "In Situ Burning: A Decision Maker's Guide" (the previous version dated back to 2005). Two additional API operational guides were also published recently (summer 2015) on ISB, one relating to upland

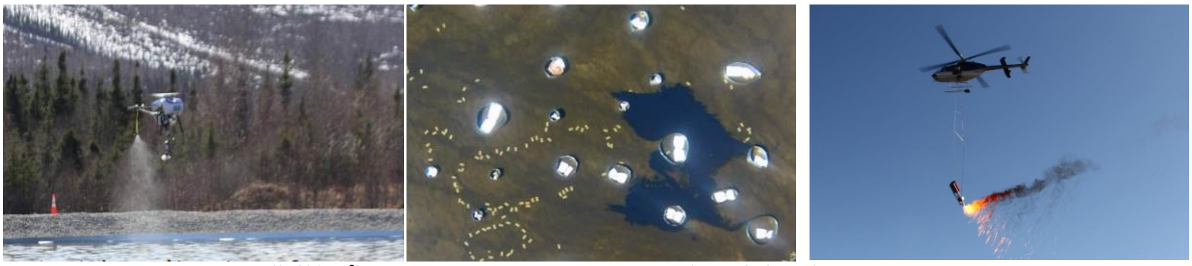
[30] Newfoundland Offshore Burn Experiment: an in situ experiment conducted in 1993 jointly by 25 North American agencies (Canada and US).

areas, wetlands and open water, entitled Field Operations Guide for In-Situ Burning of Inland Oil Spills, the other relating to surface waters (near-shore and open sea), entitled Field Operations Guide for In-Situ Burning of On-Water Oil Spills).

In terms of R&D, one of the current focuses is on the improvement of the method's applicability in the Arctic environment, in particular through:

- the use of herding agents to overcome the physical obstacle of ice on conventional containment and concentration techniques (e.g. fire-proof booms).
- its implementation by aircraft alone for fast implementation of ISB operations in remote and/or ice-infested waters which are difficult or dangerous to access (e.g. thaw) by boat.

A presentation was given on the work of the IOGP Arctic Response Technology JIP, which funded (late 2014) the construction of a test basin in Alaska (Poker Flat Research Range), under the supervision of SL Ross Environmental Research Ltd and the University of Alaska Fairbanks (UAF) which have since used this facility to jointly assess the effectiveness of aerial systems (helicopter, drones, spray system prototypes) in applying herding agents and igniting oil slicks.



*Trials in experimental basins (8,400 m^2) at the Poker Flat Research Range (AK-USA). **Left**: drones spraying herding agents; **centre**: aerial view of slick concentration/thickening operations; **right**: ignition by Heli-torch (source: SL Ross/University of Alaska Fairbanks)*

The development over recent years of these Arctic response techniques and their gradual validation as operational tools instils the industry with hope for their future approval by the relevant agencies.

A detailed report on this series of in situ experiments (Field Research on Helicopter Application of Chemical Herders to Advance In-situ Burning) was published in 2016 on the IOGP website http://www.arcticresponsetechnology.org.

• Research

ITOPF R&D Award 2017: virtual reality, exercises and training evaluation

In March 2017, the International Tanker Owners Pollution Federation (ITOPF) selected its 6th annual R&D Award winner. This year's funding went to the Virtual Reality Lab at Shanghai Maritime University's College of Transport and Communication.

The work supported by ITOPF aims to develop a platform called the Real Spill Response Game (RSRG). Based on the principle of online gaming, the purpose of the tool is to simulate a realistic crisis situation, requiring the involvement of several players/organisations in the spill response. The ultimate output will be an interactive training tool for multiple users. In addition to reducing the cost of training, one of the aims of the RSRG is to provide a way of analysing the results of spill response exercises. Currently geared towards an application in China, the R&D Award Committee also mentioned the possibility of extending the concept to other countries and regions of the world.

As a reminder, in 2016, the ITOPF R&D Award went to the Rosdam project (Remote Oil Spill Detection And Monitoring on ice-covered waters), conducted in partnership with the Centre for Signal and Image Processing of the University of Strathclyde (UK) and the Scottish Association for Marine Science (SAMS). With a more operational focus, it aimed to assess the potential applicability of hyperspectral imagery for the detection of oil spills in ice-infested Arctic waters.

For further information:
http://www.itopf.com/in-action/r-d-award/

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