CENTRE OF DOCUMENTATION, RESEARCH AND EXPERIMENTATION ON ACCIDENTAL WATER POLLUTION

715, Rue Alain Colas, CS 41836 - 29218 BREST CEDEX 2, FRANCE
Tel: +33 (0)2 98 33 10 10 – Fax: +33 (0)2 98 44 91 38
Email: contact@cedre.fr - Web: www.cedre.fr

Sea & Shore Technical Newsletter *n°33*

2011-1

Contents

- **Spills**

Crude oil spill from an offshore pipeline (Mumbai Uran Trunk Pipeline, India)

On the morning of 21st January 2011, 80 km off the coast of Bombay (India), the rupture of a submarine pipeline (Mumbai Uran Trunk Pipeline) belonging to the Indian Oil & Natural Gas Corporation (ONGC) caused a spill of around 4,500 to 5,000 m^3 of crude oil into the eastern waters of the Arabian Sea.

This spill, which occurred in the country's largest offshore oil and gas field (Mumbai High Basin), was caused by the anchor of a service barge catching on the line connecting an ONGC production well to the oil facilities in Uran (Bombay).

The incident was immediately reported to the Indian Coast Guard (ICG) which, after activating the Regional Contingency Plan, deployed its marine response resources, i.e. several vessels including the recent spill response vessel *Samudra Prahari.*

The first surveys were carried out at sea in the hours following the spill, by two ICG patrol vessels which happened to be close to the site at the time of the incident: the resulting pollution spread over a distance of 35 km, but the risks of the oil reaching the coast were considered low by the ICG from the onset, given that the winds were pushing the oil out to sea. Alongside containment and recovery operations (not detailed in our information sources), response at sea appears to have mainly consisted in spraying chemicals dispersants by helicopter, in order to accelerate the dispersion of the surface pollution offshore. Dispersant spraying was stopped the following day, once the ICG and ONGC had calculated that natural dispersion should break down the slicks within 48 hours, without a risk of the coasts being reached. No impact was observed following this spill and no consequences on fishing activities were reported – apart from a ban in the area where response operations were being conducted at sea.

Heavy fuel oil spill in ice-covered waters: grounding of the *Godafoss* (Hvaler-Fredrikstad, Norway)

On 17th February 2011, the grounding of the Icelandic container ship *Godafoss* (17,000 DWT) in the Norwegian Hvaler-Fredrikstad archipelago (within the Ytre Hvaler marine nature reserve, not far from the mouth of the Glomma in the Oslofjord) led to a spill of 110 to 120 tonnes of IFO 380 bunker fuel in ice-infested waters, around 10 km from the Swedish border.

The vessel, travelling from Fredrikstad to Denmark, was carrying 555 tonnes of bunker fuel and 439 containers (none of which were lost overboard in the incident) when it hit a marked reef for an unknown reason (an enquiry was opened).

Immediately after the incident, the Norwegian Coastal Administration (NCA or *Kystverket*) conducted an emergency assessment of the vessel as well as aerial surveys, by both planes and helicopters, to determine the presence of any pollution at sea. From the first hours, leaks of bunker fuel were identified, and it was soon established that they were coming from 4 damaged tanks (each with a capacity of 250 m^3).

Two rows of floating boom were immediately placed around the *Godafoss* to contain as much of the oil as possible. Assessment teams identified the leak points and the day after the incident the leaks were plugged. Operations to secure and salvage the vessel were rapidly initiated, starting with the removal of the remaining bunker fuel, the first attempts at which resulted in the recovery of a limited volume (123 tonnes) of fuel oil, which had become highly viscous as the heating system had broken down. It was also estimated that 112 tonnes of IFO 380 were spilt during the first hours.

Containment booms deployed around the grounded Godafoss (Source: Kystverket)

Recovery operations at sea involved the mobilisation of NCA resources – specialised vessels and tugs – while, from the first hours of response, the risk of transboundary pollution caused the Swedish Coast Guard (*KBV*, or *Kustbevakningen*) to contribute significantly, in particular through the involvement of 3 specialised vessels equipped with Lamor integrated recovery systems[1] (*KBV 001 Poseidon*, *KBV 050* and *KBV 051*), one specialised patrol vessel and one surveillance plane[2].

Despite relatively favourable sea and weather conditions, calm seas and winds helping to stop the oil from reaching the shore, recovery operations were conducted in difficult circumstances due to low temperatures and ice-infested waters.



Aerial view of trails of heavy fuel oil spilt in ice-infested waters (left); deployment of a double row of floating boom (middle); "density" of blocks of ice in containment pockets (right) (source: Kystverket)

At sea, the efficiency of containment operations was dependent on the resistance of the available booms to the heavy strain exerted by the blocks of ice, liable to cause them to rip and/or be submerged.

Sandvik industrial steel belt oil skimmer (source: Kystverket)

Fuel recovery itself was also complicated by the presence of ice, which penalised the skimmers' performance; the very low atmospheric temperatures (-20°C), by "congealing" the IFO 380 (already viscous by nature), were a challenge for the pumps used. Within this context, various types of skimmers were deployed (including steel belt skimmers, designed for more industrial purposes). The oleophilic brush skimmers equipped with spray systems which, by causing the ice to melt and decreasing the oil's viscosity, showed the best performance.

Another original aspect involved clusters of weathered fuel oil, mixed with large quantities of ice and contained using floating booms or sweeping arms fitted to vessels, often being recovered using grabs before being stored in temporary storage tanks on the decks of the recovery vessels.

While this overcame the above-mentioned weather-related constraints, limiting skimming and pumping options, this method proved to be of moderate selectivity (large amounts of ice recovered) and raised difficulties related to the management of the volumes recovered: availability of temporary storage capacities, increased settling time due to the time required for the ice to melt[3].

Recovery using a grab (source: Kystverket)

In general, the freezing temperatures were a source of many problems in terms of maintaining the equipment and infrastructures deployed (e.g. connections, pipes; machine cooling systems, etc.) and the advantage, or even necessity, of heating systems was fully illustrated throughout response operations.

The resources deployed, in terms of (i) remote sensing (in particular the *SECurus*/*OSIRIS* system[4], used from vessels for IR detection and slick quantification, mapped in real time), (ii) oil drift tracking using surface buoys (the Norwegian firm AADI in particular[5]), and (iii) recovery, allowed operations to be carried out around the clock during the days following the incident. The NCA announced the

---

[1] Brush skimmers.
[2] Note that assistance from the Swedish Coast Guards was greatly facilitated by the "Agreement concerning co-operation to ensure compliance with the regulations for preventing the pollution of the sea by oil" (regional agreement between Denmark, Finland, Norway and Sweden, signed in Copenhagen on 8th December 1967).
[3] In this context, vessels equipped with ad hoc heating systems were particularly useful.
[4] By the company *Aptomar*; *Cf*. LTML 25
[5] *Cf*. LTML 31-32.

recovery at sea of half of the oil spilt (55 m^3; *Cf*. figure below) after 4 days of response – a satisfactory result despite the technical difficulties encountered.

On land, oil washed up on the shore during the days following the incident, sporadically along a total of 200 km of coastline towards the south. Here once again, clean-up operations were confronted with the problem of recovering oil (i) deposited on – or mixed with – ice and snow, or (ii) frozen into the ice in inshore waters.

Inshore area: IFO 380 frozen into the ice (source: Kystverket)

In the case of the second scenario, while visual surveys initially led teams to suspect that large quantities of oil had been trapped in the newly formed ice, tests showed that the oil content was in fact minor (according to the NCA, the equivalent of 1 litre of fuel oil in a volume of 250 m^3 of ice[6]), and its recovery was therefore not considered appropriate. On the other hand, clusters of fuel oil mixed with ice or snow were collected using excavators placed on barges, and the mixtures recovered contained 3 to 5 % oil.

Where possible, deposits of fuel oil on the shore were recovered mainly manually, a highly selective technique suitable for the generally scattered and sporadic nature of arrivals, but also probably due to a lack of alternative strategies in the given geomorphological context (jagged coastline, possibly difficult to access) and climate conditions (limited possibility of pumping for instance).

Aerial view of fuel oil, mixed with ice, being pushed towards a jagged, rocky coastline (left); Fragmentation (tar balls) of the shoreline pollution (middle); Manual collection of unpumpable clusters of heavy fuel oil (right) (source: Kystverket)

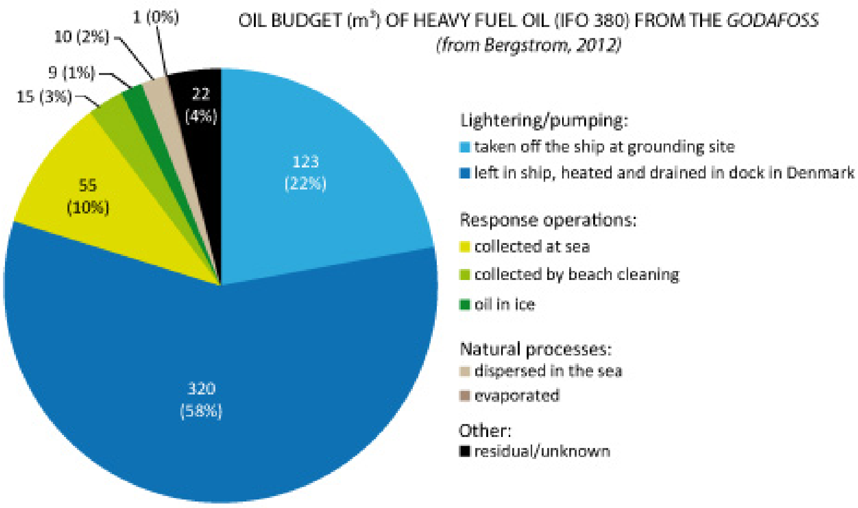
From this point of view, the low winter temperatures and the oil's high viscosity facilitated its collection by preventing its penetration into cracks and crevices on the characteristic rocky coasts in the region affected.

In addition, surveys of potentially oiled sites were organised in order to postpone or finalise clean-up in less severe spring conditions, also less risky for responders.

Most of the shoreline operations, which resulted in the recovery of around 15 m^3 of heavy fuel oil (Cf. figure below), were finished in the spring, followed by a few clean-up operations in late autumn 2011 (or even spring 2012 for one popular beach).

Spring 2011: surveying localised oiled areas (note the fluidification of the heavy fuel oil) (source: Kystverket)

[6] Estimations of 1 litre of IFO 380 recovered for 1,000 m^2 of 25 cm-thick ice (Bergstrøm, 2012)



In terms of environmental sensitivity, this spill brought with it strong concerns, as it occurred within Norway's only marine nature reserve (created in June 2009), covering a surface area of 354 km^2 and potentially home to over 6,000 marine species, of which 220 feature on Norway and Sweden's lists of endangered species. The observations made by the assessment teams commissioned by the NCA initially focused on the oiling of over 500 birds, mainly eiders; no capture or care operations were considered appropriate given the particularly difficult climate conditions during the days following the incident. A study report available online[7] indicates that around 1,000 eiders died following the spill. Over and above bird populations, no significant environmental impact was reported, no doubt due to the rapidity and relative efficiency of recovery at sea.

As for the ship, it was refloated and towed in early March 2011 to Odense (Denmark), for removal of the 320 tonnes of IFO 380 remaining in its bunker tanks and for repair, not without stopping off at the port of Grenå (east coast of Jutland) after oil was detected in its wake.

For further information:
Bergstrøm R., 2012. *Lessons learned from the Godafoss accident in Feb. 2011: Oil spill recovery at -20°C*. Interspill 2012, 13-15 March 2012, London.
http://www.kystverket.no

Spill in an isolated region: grounding of the *Oliva* (Nightingale Island, Tristan da Cunha)

On 16th March 2011, during a storm, the Maltese-registered bulk carrier *Oliva* (40,170 GT, 225 m, travelling from Brazil to Singapore) ran aground on a rocky headland on Nightingale Island, polluting part of the shoreline of the Tristan da Cunha archipelago, located on British overseas territory in the southern Atlantic and including the world's most remote inhabited islands.

16th March: the Oliva *grounded at Spinners Point (source: www.tristandc.com)*

On 17th March, the 22 crew members were safely evacuated[8] from the grounded vessel, which broke in two the following day, due to violent swell, to soon release its cargo of 65,000 tonnes of soybeans and the contents of its bunker tanks, i.e. around 1,400 m^3 of IFO 320 and 70 m^3 of diesel.

Immediately, the vessel's insurance called upon its technical expert, the International Tanker Owners Pollution Federation (ITOPF), to assess the spill response options and coordinate the response.

From the outset, the geographical context of the incident raised a logistical challenge, due to the low response capacity available locally and the obvious remoteness for the delivery of any additional personnel and equipment and in terms of the distance from other infrastructures (e.g. airports, ports, waste treatment facilities etc.).

At sea, the lack of suitable resources meant that response was not possible, an option that was in

[7] http://www.kystverket.no/PageFiles/9101/Fugl%20Godafoss%20endelig%20rapport.pdf
[8] Transferred onto the fishing boat *M/V Edinburgh*

any case compromised by unsuitable sea and weather conditions.

Rockhopper penguins oiled by IFO 320 (Source: www.tristandc.com / T. Glass)

On land, heavy fuel oil was washed up on the shores close to the incident site, requiring clean-up operations to be organised, especially given that strong local ecological sensitivity was rapidly identified, in particular due to the presence on the shoreline of thousands of Northern Rockhopper Penguins (*Eudyptes moseleyi*), an endangered species (listed in the International Union for Conservation of Nature's red list of threatened species) whose almost entire world population reproduces in the Tristan da Cunha archipelago. Furthermore, the incident occurred at the end of a moulting period during which the penguins do not feed at sea, and are weak and more vulnerable to arrivals of oil on the shore[9].

Under the supervision of the P&I Club, two vessels – a tug from the company Svitzer (Singapore) and a Russian icebreaker (*Ivan Papanin*) – were sent to the island from Cape Town (South Africa)[10] to deliver the equipment and personnel required for wildlife rescue operations, on 7th April, and shoreline clean-up, on 12th April.



Left: Collecting oiled penguins; Middle: Cleaning a penguin; Right: Penguins in the rehabilitation pool before being released (source: www.tristandc.com)

Bird rescue operations, considered as a priority given their heritage value, were coordinated by the Southern African Foundation for the Conservation of Coastal Birds (SANCCOB), contracted by the insurance company. SANCCOB, experienced in this field[11], set up a rehabilitation centre on site, comprising the facilities required for washing and rehabilitating the some 3,700 penguins captured and cleaned, before releasing the surviving 10 % in June.

Restricted by the inaccessibility of sites, shoreline clean-up efforts focused – initially according to photographs – on relatively sheltered, localised areas of fuel oil accumulation, identified as moulting areas for penguin populations.

Operations were carried out, under the technical supervision of ITOPF, by contractors commissioned by the insurer – one French contractor (*Le Floch Dépollution*), the other South African (*Drizit*) – and with support from a locally recruited workforce.

23rd March: oiled site frequented by bird populations (source: ITOPF)

[9] Not to mention the ethology of these penguins which, as capable swimmers, move awkwardly on land, where sliding, for instance, is one of their methods of locomotion, thus further increasing risks of oiling.

[10] The closest continent, some 2,800 km – and around 6 days by sea – from the incident site.

[11] Since its creation in 1968, SANCCOB has worked on many spills (http://www.sanccob.co.za/wildlife-response.html) for instance that of the *Treasure* in June 2000.

Clean-up site: rinsing and effluent containment operations (source: ITOPF)

Recovery of the oil involved manual collection, low pressure rinsing and pumping (possibly with skimmer heads) – operations which were completed, where appropriate, with high pressure washing of the remaining oil.

It is worth noting that, given the sites' high self-cleaning potential (strong hydrodynamics) and sensitivity[12], the primary objective was to minimise the risks of contact between fauna and the oil as quickly as possible, by rapidly recovering the bulk of the oil.

In some cases, the sites' inaccessibility and sensitivity (Inaccessible Island, nature reserve listed as UNESCO World Heritage Site) caused any response to be considered inappropriate (or even made reconnaissance impossible) and self-cleaning to be prioritised.

Delivery of equipment by helicopter (source: ITOPF)

We note that the presence of a helicopter on board the icebreaker *Ivan Papanin* proved to be a determining factor for conducting aerial surveys, transporting response teams and equipment to shores often inaccessible by sea and evacuating waste (liquid and solid oiled waste transported to South Africa by the icebreaker – in plastic bags placed in a specially prepared area on board – for treatment).

Left: Inaccessibility of a polluted site (circled); Right: storage area for bags of waste on board the Ivan Papanin (source: ITOPF)

In socio-economic terms, the spill affected fishing activities, in particular lobster fishing, which was preventively banned in several areas (Inaccessible Island, Nightingale Island).

In autumn 2011:

- inspection of the wreck by divers confirmed its dislocation, as well as the absence of visible oil leaks. Nearby, residual deposits of soybeans were reported in natural depressions on the rocky seabed and locally reduced densities of sea urchin populations were, as an initial assumption, put down to their being covered by the cargo during the weeks following the incident. In this respect, impact assessments, supported by the vessel's insurance company, are understood to still be in progress.
- a few dredging operations to recover accumulations of soybeans were conducted in areas where lobster pots were used (south-west coast of Nightingale Island), where its decomposition generated a potential risk of hypoxia[13]. The possible impact of the soybeans on crustacean populations around the island was being studied in late 2011, with catches appearing to be lower than normal in areas where decomposing residues were observed on the pots. Lobster fishing was reopened in certain areas (Inaccessible Island), but with a preventively lower quota for the 2011/2012 season, and remains to be banned around Nightingale Island, until further results relating to the potential impact of the pollution on the youngest age groups are obtained.

[12] Meaning that no chemical washing agents were used during operations.

[13] This risk of the impact of an organic cargo spill, following the natural processes of its bacterial degradation, reminds us of the grounding of the grain carrier *Fénès* in the Lavezzi Islands nature reserve (Corsica, 1996), spilling its cargo of wheat. The smothering effect of this wheat, together with the release of hydrogen sulphide and oxygen depletion generated by its decomposition, caused a localised destruction of Posidonia seagrass beds, justifying the removal of the wreck and the gradual release of the wheat in the open sea during towing (http://www.cedre.fr/en/spill/fenes/fenes.php).

- the initiation of annual penguin population counts appears to suggest a relatively low impact on populations.

Local accumulation of soybeans decomposing at depths of 20 m (source: www.tristandc.com)

In late December 2011, using a vessel equipped with various types of seabed investigation equipment (sonar, remotely operated vehicle) the *Oliva*'s insurer commissioned a control, by experts, of the state of the wreck and the residual soybean deposits on the seabed. The campaign confirmed the dislocation of the structure (and its colonisation by flora and fauna) and reported the absence of soybean accumulations.

For further information:
http://www.tristandc.com/
Laruelle, F., 2012. Responding to Spills in Remote Locations: *GULSER ANA* (Madagascar) & *OLIVA* (South Atlantic). Proceedings of the INTERSPILL 2012 Conference.

Sinking of a grain carrier and organic pollution in the Port of Chittagong (Bangladesh)

On 6th April 2011, shortly before midnight, the North Korean grain carrier *Hyang Ro Bong*, transporting nearly 13,500 tonnes of rice from Pakistan, sank as it was entering the Port of Chittagong (Bangladesh), after having collided with a moored vessel (*M/V Banga Lanka*).

Damaged by the collision, a leak broke out in the grain carrier's machine room and the vessel rapidly began to list and then sink. The day after the incident, in the hope of salvaging the ship, attempts were made for several hours to remove the cargo, under the coordination of Chittagong Port Authority (CPA) and in cooperation with representatives of the owner (Fortune Shipping). These attempts were unsuccessful, given the impossibility of operating the equipment on board (e.g. crane) due to an electric black-out.

The ship, three-quarters underwater, was abandoned and in the end sank with its cargo and the undetermined contents of its bunker tanks. Furthermore, strong currents hindered attempts by half a dozen divers contracted by Fortune Shipping (ordered to eliminate the pollution risk and to present a wreck refloating plan to the authorities) to plug the heavily damaged wreck. In the end, thousands of tonnes of rice were spilt, in addition to a leak of propulsion fuel which, as soon as it was detected, triggered a spill response effort (mainly by chemical dispersion) by CPA.

An investigation was jointly conducted by CPA, the Bangladesh Coast Guard and the Bangladesh Navy, as well as the Mercantile Marine Department, into the causes of the collision, whose results have not been released as far as we know.

Not far from the Port of Chittagong, this incident was followed, on 4th June, by the sinking of a small oil tanker (*Moon*) in the estuary of the river Karnaphuli, after 150 to 180 tonnes of an unspecified oil had been loaded onto the vessel. This incident, for which little information is available (unspecified cause, although overloading is suspected), led to the release, through a vent, of an again unspecified volume of oil, forming a 10 km^2 slick, and resulting in the mobilisation of 3 vessels by CPA (*Kandari 10* for salvage, and *Cleaner 1* and *2* for spill response). On 6th June, official estimations indicated that 45 tonnes of oil had been recovered at sea.

Heating oil spill in a port in Saint-Pierre (Louis Hardy depot, Saint-Pierre-et-Miquelon)

On 30th May 2011, in the Port of Saint-Pierre (Saint-Pierre-et-Miquelon archipelago, French overseas territory), a handling error at the island's oil depot led to the release, from tanker truck filling valves, of around 100 m^3 of heating oil. The leak occurred in a closed hut (also containing the valves feeding into the storage tanks); the hut was filled with oil, which overflowed out of the door and windows, and ran down the slope and into the sea at the port's deep-water dock.

Site layout: right (orange) hut where the valves and pipes for filling tanker trucks are located. The heating oil ran down the slope, under the road, then through the riprap (source: DTAM 975)

Rapidly alerted by the operator, the Polmar correspondent (DTAM 975) arrived on site, then notified the stockpile and sent a buoy tender to assess the extent of the pollution (as Saint-Pierre-et-Miquelon archipelago has no aerial observation means). *Cedre*'s emergency response duty team was called upon for technical recommendations in terms of clean-up, as well as for an oil slick drift prediction.

The results of the numerical model activated by Météo France indicated the potential drift of the oil towards Newfoundland, and the Canadian authorities were informed of the spill.

The first boom was laid 2 hours after the alert, and pumping began in the afternoon, once containment had proved efficient. The equipment and personnel involved were from the Polmar stockpile and the lights and beacons department; the company responsible for the spill organised waste management, and accepted to reimburse the costs of response by State services and of the supplies used.

Containment and recovery at the foot of riprap (source: DTAM 975)

Meanwhile, the Canadian authorities carried out an aerial survey, which resulted, the day after the incident, in the detection of a leak from the containment set-up (which was reinforced with sorbents 2 days after the spill), and the spread of the pollution in the port. The quantities involved however appeared to be low.

A week after the incident, when it was confirmed that this was indeed a small-scale spill, although visible at the water surface from the foot of the riprap – naturally rinsed by rain – the Prefect banned water pumping and fishing in the Port of Saint-Pierre. These bans were lifted respectively on 24th June and 10th August. On 8th June, the Prefect ordered the depot operator to take the necessary measures to stop the pollution, in particular by contracting a specialised company for site clean-up and waste treatment, and by providing a clean water supply to fish tanks using seawater from adjacent areas.

The rapidity of response, the proximity of the Polmar stockpile and the quick reaction time and good preparation of personnel – following a Polmar exercise conducted in 2008 with support from Cetmef and *Cedre* – enabled rapid and efficient containment of the oil, and recovery of 12 m^3 of oil from the water surface by pumping. This point proved important given the archipelago's limited capacity to rapidly replenish its stockpile of sorbents, of which a large part was used for this incident, due to its geographical remoteness,.

In June, a Canadian firm was contracted to analyse the polluted soil and treat it by biorestoration (adding nutrients and regularly ploughing).

High-profile incidents on offshore drilling rigs (Penglai oil field, Bohai Sea, China)

On 4th and 17th June 2011, two spills occurred in the Bohai Sea (China) in the offshore oil field Penglai 19-3, generated by the drilling activity of platforms B and C respectively, operated jointly by the Chinese subsidiary (ConocoPhillips China, COPC) of the US firm ConocoPhillips and the China National Offshore Oil Corporation (CNOOC).

The first incident, reported the same day by COPC to the Chinese maritime authorities (CNOOC did not confirm it until July), is believed to have involved 18 m^3 of crude oil, from seepage along a crack that appeared in the reservoir at the base of the rig. To the best of our knowledge, the precise cause of this crack has not been clearly explained, either by an official source or by the press (in which the event was confused with the subsequent spill): it is believed to be have been due to a faulty control of pressure in the well. Very little information has been divulged on any pollution response operations, although in terms of the leak, COPC did indicate that the majority of the seepage was stopped on 2nd July thanks to (i) the construction and deployment of a containment and pumping system and (ii) the adjustment of the production activities of surrounding rigs to reduce pressure in the reservoir. The containment system was repositioned in August to prevent any new leaks; residual seepage estimated at a few litres per day temporarily caused minor surface sheen.

The second incident was detected following upwellings of oil at the surface near platform C during drilling (3 km from platform B). The leak, for which little detail was provided on the cause, is believed to have involved a little less than 100 m^3 of crude oil and around 400 m^3 of drilling mud containing mineral oils, following an unexpected problem of excess pressure of fluids in the reservoir. According to COPC, an emergency cementing procedure was implemented, stopping the leak within 24 hours; the well was thereby stabilised, plugged and abandoned. The efficiency of these measures was assessed close to the seabed, resulting in the observation of residual upwellings (gas bubbles and oil), justifying operations to gradually recover the contaminated mud through a dive programme. At the surface, the response implemented by COPC mobilised technical means provided by CNOOC, joint operator of the offshore field, with the deployment of 3,000 m of boom (sorbent and floating) and around 30 vessels (specialised vessels but also supply boats, fishing boats and tugs), under the supervision of the State Oceanic Administration (SOA).

On 5th July, i.e. over a fortnight after the second incident, the SOA reported surface pollution covering a cumulated area of 840 km^2, then 4,240 km^2 by mid-July, while CNOOC reported a "controlled" spill reduced to a 200 m-long slick at sea. Sketchy and sometimes contradictory information appeared, before a press release was issued by COPC estimating, in July and following the discovery of new polluted sediments on the seabed, that the total volume of oil spilt (i.e. from the two incidents together) "could exceed 250-300 m^3 or even 500 m^3".

In mid-July, the SOA notified COPC, identified as responsible for the pollution, to promptly suspend the production of platforms B and C, until all risks had been eliminated and response operations completed. In early September, the Chinese Government placed a total ban on the oil field's production (which represented an average of around 9,000 m^3/day in 2010); the company was accused of deficiencies, both in terms of its operations and its response, which was believed to have exacerbated the pollution.

On the shoreline, weathered tar balls a few centimetres in diameter, attributed according to SOA to the two incidents, began to wash up on the shoreline in the last week of July on various beaches in the Suizhong district (Liaoning province) and close to the Port of Jingtang (Hebei province). For weeks and months to come, allegations were made of impacts on bivalves (scallops in particular) and fish, as well as on fisheries.

In January 2012, the two companies (ConocoPhillips and CNOOC – whose CEO resigned) came to an agreement with the Chinese Ministry of Agriculture, guaranteeing the ministry the payment of a US$160 million fund in response to compensation claims by public and private parties (in particular fisheries and fish farms), for the impact caused. In November 2012, new negotiations resulted in ConocoPhillips paying SOA an additional $US191 million (with a US$76 million contribution from CNOOC), of which $173 million was to compensate for potential impacts (tourism, aquaculture, etc.) and $18 million to "support environmental initiatives in Bohai Bay" (clean-up, restoration, scientific studies). Production resumed in 2012 but only partially (by November).

• Response preparedness

Reinforcement of the EMSA spill response fleet

Contracted in late 2010, the Cyprus-registered oil tanker *Alexandria* became an operational part of the European Maritime Safety Agency's (EMSA) spill response fleet in August 2011, after having been duly fitted out with the equipment required to carry out its oil recovery duties at sea. The vessel, based in the Port of Limassol (Cyprus), reinforces the response capacity in the Eastern Mediterranean.

In November 2011, 4 new vessels were chartered, including 3 oil tankers – located in Denmark (*OW Copenhagen*, Copenhagen), Malta (*Balluta Bay*, Valletta) and Spain (*Monte Anaga*, Algeciras) – and 1 supply vessel based in Bulgaria (*Enterprise*, Varna), to enter into operational service in the first term of 2012 (after technical adaptation and fitting out).

Meanwhile, a new set of sweeping arms has been added to the stockpile of equipment available for chartered vessels based in Cobh (Ireland; i.e. *Forth Fisher*, *Galway Fisher* and *Mersey Fisher*), while, in the autumn, the oil tanker *Aktea* (port of Piraeus, Greece) was equipped with a new offshore high-capacity skimmer *Noren* (*NorMar 250 TI*, with hose reel).

A new chartering procedure was launched in 2012, in addition to or to replace current contracts, with the contracting of 3 oil tankers at the end of the year, respectively based in Ferrol (Spain), Sines (Portugal) and Malta.

NorMar 250 TI skimmer on board the Aktea (source: EMSA)

For further information:
http://emsa.europa.eu/oil-recovery-vessels/vessel-inventory.html
Since April 2011, an interactive map indicating the location of the vessels in EMSA's spill response fleet is available at:
http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/#extent=-35.2_18.7_62.2_80.3&theme=themeSecurityAndSafety.subthemeRespVessel&=null

Spill response training institute in Korea

The Korea Marine Environment Management Corp. (KOEM, formerly the Korea Marine Pollution Response Corp. – KMPRC) announced the set-up in 2011 of a new infrastructure dedicated to conducting R&D but also practical training courses, in particular on spill response techniques and equipment; this new body, the Marine Environment Research and Technology Institute (MERTI), became operational in 2012.
This initiative by the Korean Government dates back to 2007, with $7,100,000 of public funding for the project, later raised to $14,300,000 following the *Hebei Spirit* spill in December of the same year (Cf. LTML 20).
MERTI, which, in addition to classrooms, has at its disposal man-made beaches and closed water basins (with tidal and current generators) enabling real oil spills, plans to provide oil spill response training courses in compliance with the international standard recommended by IMO (levels 1-3). More widely, this institute is perceived as a tool which should help to significantly reinforce international cooperation: both between East Asian countries and with international organisations and experts (e.g. implementation of the OPRC-HNS Protocol).

Man-made beach (pebbles) within MERTI's facilities (souce: Cedre)

• Conferences and exhibitions

International Oil Spill Conference 2011

The 21st edition of the International Oil Spill Conference (IOSC) was held in Portland (Oregan, US) from 23th to 26th May 2011, just a few months after the major spill in the Gulf of Mexico following the **Deepwater Horizon** (DWH) rig explosion (Cf. LTML 29-30), which no doubt contributed to its success, with a record-breaking number of participants (2,172, over half of which had been involved to some extent in operations, and 30% from outside the US), a vast and well-filled exhibition room and an extensive poster exhibition of over 100 posters.

While the opening and closing sessions and a specialised workshop were almost entirely dedicated to the Deepwater Horizon spill, only a quarter of the conferences dealt with this accident, thus overlooking many technical aspects (with the exception of in situ burning and dispersion) in favour of operational aspects, and mainly the Incident Command Structure (ICS).

CONFERENCES

With 4 sessions running in parallel, almost 130 conferences were presented, organised either by technical or operational themes, around a major incident (DWH, but also the Montara field[14] in Australia) or around a geographical location (Latin America, Arctic). Here we have chosen to make mention of the following points (non-exhaustive list)[15]:

Lessons from the Deepwater Horizon incident:

- The following points were emphasised: the overall success of operations, which reduced the amount of oil that washed up on a sensitive coastline; industry's quick reaction, good cooperation with the different parties involved and its feedback effort, with notably around twenty working groups set up to draw lessons from the incident.
- The US Environmental Protection Agency (EPA) has encouraged the consideration of worst-case scenarios in the preparation of this type of incident and, more generally, considered the existing US organisation (National Contingency Planning and National Response Plan) to be appropriate, with nonetheless lessons to be learnt in relation to the high demand for information from the public and the integration of potential widespread use of a given strategy in prior authorisations (in particular chemical dispersion). The EPA also proposed that subsequent efforts towards improving well response technologies (e.g. blow-out preventer) should also consider applications in the Arctic.
- According to representatives of the US Coast Guard (USCG), the public's expectations were not handled well and political pressure promoted excessive and sometimes inappropriate deployment of equipment (in particular booms inshore) at the expense of other solutions (e.g. skimmers on vessels of opportunity).
- In terms of strategic choices for offshore response, various discussions alongside the conferences lead us to believe that (i) the urgency and (ii) the extent of the incident led responders to use all available strategies (mechanical recovery, chemical dispersion, in situ burning) and to pursue their deployment when they proved technically feasible and efficiently contributed to reducing crude oil slicks (Cf. *Cedre* Information Bulletins n°28 and 29 for more details on chemical dispersion and mechanical recovery respectively)[16].

Characterisation, evolution and identification of pollutants, in relation to DWH but not exclusively**:**

- The USCG presented its work on the use of two-dimensional gas chromatography to monitor the evolution of a spill over 30 years[17].
- BP presented posters on the impact of weathering of the DWH oil on its fingerprinting[18] and the fingerprinting of oil sheens, slicks, and tarballs collected during clean-up operations[19].
- The methodology selected by the NOAA to calculate a mass balance for the DWH oil was also presented, highlighting the great sophistication of the equipment used given the extent of the spill and its subsea origin[20].

Models and other decision support systems

- France was present in this field with 2 posters, one produced by Météo France on the contribution of the MOTHY model, in particular the quality of wind predictions used, to risk assessments for sensitive sites[21], and the other on the *Migrhycar* project[22] of which *Cedre* is a partner.

[14] Cf. LTML 27-28
[15] Archives of posters and presentations mostly available at the address: http://iosc.org/papers_posters/search1.asp
[16] http://www.cedre.fr/fr/publication/bulletin/bull28.pdf
http://www.cedre.fr/fr/publication/bulletin/bull29.pdf
[17] #2011-428: *Tracking and modelling the degradation of a 30 year old fuel oil spill with comprehensive two-dimensional gas chromatography*
[18] poster #2011-372: *The impact of weathering on MC 252 oil chemistry and its fingerprinting*
[19] poster #2011-374: Fingerprinting of oil sheens, slicks, and tarballs collected in response to the MC 252 oil spill.
[20] #2011-161: *Computing mass balance for the Deepwater Horizon spill*
[21] poster #2011-37: *Use of ensemble prediction techniques to protect sensitive areas from oil spill*, by Pierre Daniel
[22] poster #2011-193: *Numerical modelling of oil spill drifts for operational management of risks in continental waters,* by Cedric Goeury (Saint Venant laboratory for hydraulics) et al.

- A Malaysian university[23] presented a poster on the combined use of GNOME and ALOHA models to predict the trajectory and fate of a diesel oil spill in the Persian Gulf[24].
- Fisheries and Oceans Canada (DFO) presented a conference on modelling the long term fate of Oil-Mineral Aggregate (OMA) [25], from the DREAM model by SINTEF, in connection with the encouragement to use this approach to promote dispersion in the Arctic.
- In the field of inland waters, the University of Birmingham presented an oil travel prediction model for spills in rivers[26].
- The modelling of subsurface oil plumes was also the focus of a number of presentations, in connection with the issue of oil plumes dispersed in response to the DWH spill[27].
- In terms of operational decision support systems, several posters made reference to the use of Geographic Information Systems (GIS) and/or the internet, in particular for the organisation of aerial dispersant spraying in response to the DWH spill[28], the rapid dissemination of spill response data[29], and the management of second line response[30];

Surface and subsea dispersion

- Three sessions addressed this issue (2 of which were devoted to DWH). The main points can be summarised as follows:
  - A presentation (DFO) emphasising the need to consider natural dilution in tests on the biodegration of dispersed oil[31];
  - A presentation by OSR, drawing attention to the changes in Asia in terms of dispersant accreditation and approval protocols[32], several countries favouring locally manufactured products through their approvals;
- In the case of DWH, several conferences focused on aspects of the SMART protocol (Special Monitoring for Advanced Response Technology)[33], never before used to treat such a major long-lasting spill, so close to the coast. This protocol provided a large amount of field data, attesting to the efficiency of dispersion operations – a point which is all the more interesting as it is often overlooked in emergency situations, due to the difficulty of its implementation. Efficiency is monitored through:
  - SF-UV measurements at depths of 1.5 and 10 m;
  - georeferenced hydrological profiles, using CTD sensors.
  - monitoring of the dispersant concentration through the measurement of ethylene glycol, chosen as a marker (correlation between the total hydrocarbon content and ethylene glycol concentration at a depth of 1 m, which was no longer true at 10 m).
  - Furthermore, the monitoring in the water column of several chemically dispersed slicks suggested that complete dilution was obtained within 3 to 4 hours (concentrations below detection thresholds of the analytical equipment).
- Several posters also focused on dispersants outside of the context of DWH, including:
  - An explanation by Exxon of (i) the development of a new dispersant gel effective on cold, viscous oils[34] and (ii) the use of dispersants in calm waters[35];

[23] University Putra Malaysia
[24] poster #2011-242: *Trajectory and fate of diesel oil spill by combination of GNOME and ALOHA models in Persian Gulf*
[25] #2011-170: *Modelling the long term fate of Oil-Mineral-Aggregate (OMAs) in the marine environment and assessment of their potential risks,* by Haibo Niu.
[26] poster: *Hydraulic exponent for predicting oil travel time (OTT) in rivers: a case of pipeline river crossing*
[27] poster #2011-419: *Modelling subsurface oil transport and concentrations during response to the Deepwater Horizon Spill,* by Deborah French-McCay &Co of ASA (Applied Science Associates)
[28] poster #2011-268: *The role of GIS in aerial dispersant operations during the MC-252 Deepwater Horizon response,* by John LaCaze of O'Brien's response management
[29] poster #2011-77: *Web based GIS for rapid dissemination of spill response data,* by Judd Muskat of the California Government and Jamie Kum and Meomi Mustain of Ocean Imaging Corp.
[30] poster #2011-261: *Oil spill response management involving 2nd line emergency response setup with web-based technology,* by Soeren Petersen of DONG E&P
[31] #2011-245: *Lab tests on the biodegradation rates of chemically dispersed oil must consider natural dilution*
[32] #2011-144: *The nationalisation of dispersants accreditation and approval protocols in Asia: implications for response*
[33] in particular #2011-225: *Aerial dispersant monitoring using SMART protocols during the Deepwater Horizon spill response,* by NOAA
[34] poster #2011-109: *New dispersant gel effective on cold, viscous oils*, by ExxonMobil Upstream research company et. al.
[35] poster #2011-246: *Calm seas dispersant use,* ExxonMobil Upstream research company et. al.

- DFO presented a new way of assessing the efficiency of oil dispersion: FIR[36].

In situ burning (ISB)

- The theme of ISB was addressed by Spiltec[37], in connection with DWH. Further to the article in LTML 29-30, we note the following:
  - a total of 411 burns, of which 376 lasted over 10 minutes (with the longest burn lasting almost 12 hours). Overall, between 35,000 and 49,000 m^3 of crude oil were eliminated by burning, and several types of booms and ignitors were tested;
  - for the first time in the case of such a major real spill, the ISB alternative emerged as a first line technique;
  - the low cost ($20 to $40 per barrel) and the need for coordination of operations (helicopter, plane, command vessel) were highlighted;
- SL Ross[38] presented an overview of trials conducted since 2004 on the use of herders as part of ISB. These trials point to an interesting potential mainly in an Arctic context, where the use of fireproof booms is made difficult by the presence of ice. Research is in progress to develop a formula which could extend the potential applicability of such products to temperate areas.

Oil recovery at the water surface

Few conferences addressed this response option and the associated equipment, with the exception of:

- 2 presentations, one Norwegian[39] and the other Finnish[40], on recent and current research projects in Northern Europe to contribute to considerable improvements in this field.
- a presentation by Alaska Clean Seas on its involvement in DWH, in particular the development of an inshore recovery capacity based on vessels of opportunity (VOO[41]).
- the workshop on the Effective Daily Recovery Capacity (EDRC, established in 1993 through the Oil Pollution Act 90 set up following the *Exxon Valdez* accident), organised by the USCG, BOEMRE and API, which aimed to discuss the lessons drawn from the DWH spill[42] on the relevance of this criterion to assess the capacity to treat such a large spill by recovery at the water surface.
  - Due to EDRC, based exclusively on the expected performance of skimmers (values measured during tests or, simply, a certain percentage of the skimmer pump's flow rate) at the exclusion of other influential factors (or even containment, storage, transfer, guidance capacities etc.), expectations were not met in terms of the performances observed in relation to those predicted.
  - Discussions following presentations by the USCG on EDRC calculation methods addressed the fact that the perceived lack of efficiency is less a problem with a skimmer and more a problem of (i) input – the aim not necessarily being to increase skimmers' performance but rather to increase the encounter rate (as illustrated for instance by Ocean Busters during DWH) – and (ii) competition with other techniques (dispersion and ISB).
  - In terms of areas for improvement, a presentation by Genwest Systems of the Response Options Calculator[43] (ROC, Cf. also LTML 31-32) highlighted the potential contribution of the assessment of the performance of various recovery systems, according to their technical specificities and configuration, to this problem.
  - In response to the observed lack of accurate data on the results of recovery operations and on the efficiency of skimmers during DWH, the importance of trials at sea was emphasised during discussions. The importance of aerial guidance, preferably by helicopter, in the efficiency of recovery at sea was also addressed, based on the theory that "a moderate skimmer in a lot of oil is worth more than a good skimmer in little oil".

[36] poster #2011-379: *The fluorescence intensity ratio (FIR): a new way of assessing the efficiency of oil dispersion*
[37] #2011-194: *The Use of Controlled Burning during the Gulf of Mexico Deepwater Horizon MC-252 Oil Spill Response*, Spiltec.
[38] *Using Herders for Rapid In Situ Burning Of Oil Spills on Open Water*. SL Ross.
[39] #2011-344: *Spill response technology development through industry commitments – the Norwegian way,* by Jorn Harald S. Andersen, of NOFO
[40] #2011-189: *Mechanical oil spill recovery in ice; Finnish approach*
[41] #2011-407: *Hopedale Branch: a Vessel of Opportunity success story,* by Christopher Hall of *ACS*
[42] In particular in the final ISPR report *(Incident Specific Preparedness Review) BP Deepwater Horizon Oil Spill* of January 2011.
[43] http://www.genwest.com/roc

Other response techniques and products

In addition to presentations by *Cedre* referring to the use of washing agents, we note the presentation by ExxonMobil on a spreading agent designed to thin out thick slicks, to promote their evaporation and dispersion[44], an original strategy unless likened to dispersion.

EXHIBITION

The gaps detected during the conferences in terms of recovery at sea and shoreline clean-up were partially filled by a strong presence of equipment suppliers and service providers involved in these operations at the exhibition, however they were often lacking very precise feedback on the operations conducted and performances obtained. We note that the major sales of equipment during the DWH spill were pursued during the exhibition, which had rarely been expressed by manufacturers during previous editions. Despite the number of exhibitors, few real innovations were on show at this 2011 exhibition, on the whole marked by a strong presence of fireproof booms, alongside different models of skimmers and classic booms, some shoreline clean-up equipment and as usual a wide range of sorbents of all shapes and forms.

In direct connection with the pollution in the Gulf of Mexico, a stand presented the $1.4 million Wendy Schmidt Oil Cleanup X Challenge launched by the X Prize Foundation, with support from Shell, to inspire the emergence of more efficient recovery resources than those currently available, considered disappointing in the DWH response. The 10 finalists selected were announced at the IOSC: CRUCIAL, Elastec, PPR, Voraxial and Vor-Tek for the US, NOFI and Oilshaver for Norway, Lamor and Oilwhale for Finland, and finally Koseq for the Netherlands. The equipment entered into the competition[45] was to be tested in Ohmsett during the summer to demonstrate its capacities (the minimum objective being a recovery rate of 10 m^3/min with a water content of less than 30%).

Among the equipment[46] entered by the various manufacturers, we note:

- Communication by DESMI on its high-sea skimmer Giant Octopus (tested in Ohmsett), its fireproof boom PyroBoom – a necessity for DWH – but also on equipment developed for the Arctic (in particular the Polar Bear Arctic Skimmer System).
- The Norwegian firms Jason Engineering[47] and OP Oil Skimmer[48], which manufacture respectively dispersant spraying arms for vessels and a new skimmer barge.
- The dual-roller boom retrieval system, Boom Handler™[49] marketed by Seacor and Country Boy Environmental Services.
- Various surface trawl nets or devices other than those presented on the French stand, in particular the HORD, manufactured by Seacor.
- The MOS Sweeper concept, developed by the Norwegian firm MDG for recovery in rough seas[50], reminding us, on a larger scale, of the Dynapol device developed in France by EGMO over thirty years ago.
- The promotion of lobe pumps by Vogelsang USA, in particular in association with brush skimmers.
- The promotion by Elastec of its dispersant spraying system for confined areas by a towed boom, the NeatSweep oil spill dispersant spray system, as well as its grooved drum – and now disc – skimmers, not forgetting its American Fireboom and Hydro-Fire Boom; we note in particular the BP report issued in November 2010 which classed the latter as the most efficient boom during the DWH response.

[44] #2011-120: *Spreading agents provide a new oil spill response option,* by T. Nedwed (*ExxonMobil*)
[45] The equipment developed within this context and thereafter will be the focus of articles in the forthcoming Technical Newsletters.
[46] Which we will come back to, in part, in future Technical Newsletters.
[47] www.jason.no
[48] www.oil-skimmer.no
[49] http://sep.seacorholdings.com/products/booms/boomhandler.jsp
[50] Its promoters indicate that it is able to work in 5 m waves at a speed of 5 knots and covering 50 km^2 a day.

In the absence of tests conducted or supervised by Cedre, we cannot guarantee the quality or performance of the response resources mentioned in the Technical Newsletter; the parties (companies, journalists, authors of articles and reports, etc.) providing the information bear sole responsibility.

Any mention by Cedre of a company, product or equipment does not constitute a recommendation and Cedre does not assume any liability with respect thereto.

The articles contained in the "Spills" section are based on information from various sources, in printed or digital form (specialised reviews and publications, specialised or general interest press, technical/scientific conferences, study reports, releases from press or institutional agencies, etc.). When a website or document containing a large amount of relevant information is identified, explicit reference is made thereto at the end of the article, under the heading "For further information".