# The *TK BREMEN* Incident. Surfwashing Operations as a Clean-up Strategy to Prevent Oil Entering a Small Estuary, the Etel Ria (France)

Loïc Kerambrun and Gérard Cariou
Cedre, Brest, France
Loïc.kerambrun@cedre.fr

Franck Laruelle
ITOPF, London, UK

## Abstract

On 15th December 2011, due to heavy winds and swell during a severe storm in the south of Brittany (France), the cargo ship *TK BREMEN* dragged her anchor at night and drifted towards the shore where she grounded on a sandy beach with 190 MT of IFO 120 and 40 MT of diesel oil on board. Her hull suffered a crack and part of her bunker fuel was immediately released, polluting the nearby shoreline. Spring tide currents resulted in the oil affecting a small estuary housing oyster farming beds 2 km upstream. The oil spill occurred just before the Christmas and New Year festivities, a key period for the oyster farming business in France. Part of the oil settled high on the upper part of the beach at the mouth of the Ria and given the macrotidal regime, this heavy oil deposit was an obvious threat of recontamination for the estuary. In order to prevent the oil polluting the estuarine environment again, a preventive strategy was proposed consisting of implementing surfwashing (also known as sediment relocation) operations in accordance with the geomorphological characteristics and meteo-oceanographic conditions in the area. A specific operational plan was defined including windows of opportunity in relation to the tide, currents, winds and sea state, together with an innovative oil recovery system composed of a series of anchored fine mesh nets. The oiled sand layers were scraped, and moved towards particular storage points away from the mouth of the estuary, until the appropriate time and conditions to be pushed towards the sea for washing. A few thousand cubic metres of oily sand was treated accordingly.

## 1 The Incident

On 15th December 2011, storm Joachim was forecast for the coming night in the Bay of Biscay on the southern coast of Brittany, France. Météo France placed the department (administrative territorial subdivision) of Morbihan under orange alert: violent winds, with strong waves liable to cause coastal flooding. In preparation, the French land authority (the 'Préfet of Morbihan') activated the operational civil protection mechanism (the Departmental Operational Centre).

The Maltese-registered cargo vessel *TK BREMEN*, which had just unloaded its cargo of 5,300 tonnes of sunflower seeds in the port of Lorient (Morbihan), left the port in the evening. As a result of a misunderstanding between the Master of the ship and the Port Authority with respect to the berth availability (according to the inquiry report), the captain considered it preferable to be moored at sea, downwind of Groix Island.

The weather conditions very rapidly deteriorated.

On land, the storm uprooted hundreds of trees, mobilising over 1,000 firefighters involved in more than 400 incidents; the power was cut off to over 80,000 homes overnight.

At sea, the unladen *TK BREMEN* began to drag its anchor (only one was used while 2 anchors would have been necessary - according to the inquiry report) and gradually drifted out of its shelter area. In 110 km per hour winds, attempts were made to steer the ship to another anchorage but in vain. Veering out of control, it drifted unrelentingly towards the

Kerambrun, L., G. Cariou, and F. Laruelle, The TK BREMEN Incident. Surfwashing Operations as a Clean-up Strategy to Prevent Oil Entering a Small Estuary, the Etel Ria (France), Proceedings of the Thirty-seventh AMOP Technical Seminar on Environmental Contamination and Response, Environment Canada, Ottawa, ON, pp. 713-720, 2014.

coast; it was inevitably set to run aground. At 02:00 am, the *TK BREMEN* stranded on Erdeven Beach, approximately 10 nautical miles from its initial anchor point.

The French authority in charge of managing the event at sea (the 'Préfet Maritime ') informed the land authority (the 'Préfet of Morbihan') of the grounding and launched the rescue operation for the crew still on-board the wreck, beaten by breaking waves: the 19 crew members were evacuated by helicopter.

The Préfet of Morbihan immediately activated the departmental contingency plan ('Polmar plan'). At 02:30 am, the fire brigade set up an incident command post near the ship. A strong smell of fuel oil arose during the night: the pollutant was escaping from the cracked hull; the volume in the ship's bunker tanks was estimated at 190 tonnes of intermediate fuel oil (IFO 120) and 40 tonnes of diesel.

## 2 The Sensitivities

The wreck was located at the mouth of the Ria d'Etel (Fig. 1), known for its near-shore sand bank (the 'barre d'Etel') which is constantly moving and makes access to the port of Etel dangerous, or even impossible at certain times according to the tide. The Ria is also reputed for its oyster farms, which constitute one of the major economic activities in the area, especially during the festive period. The *TK BREMEN* incident occurred at the busiest time of the year for the oyster farming business.

The Ria d'Etel is also ecologically sensitive to oil. It forms a small, sheltered, inland bay, scattered with islets, whose banks are composed of different types of shores (rocks, mud, sand and heterogeneous gravel). Its environmental characteristics have earned it classification as a "*Natura 2000*" area (EC network composed of Special Areas of Conservation - SAC - under the Habitats Directive and Special Protection Areas - SPA - under the Birds Directive). The dune system on which the *TK BREMEN* was now sitting also comes under this initiative.


**Figure 1 Location map: Ria d'Etel and the TK Bremen on the Erdeven Beach.**

At sunrise, initial surveys confirmed the fears: the pollutant (fuel oil and oiled seaweed) had spread several kilometres up the Ria. Six of the forty-odd oyster farms in the

Ria had already been hit. The pollution accumulated in the port of Etel, oiling many pleasure boats.

## 3 The Oil Spill Response

During the night, the Préfet of Morbihan requested supplementary resources from outside the départements from the Western Defence Zone (WDZ, which comprises 20 départements): containment booms, from the public response equipment stockpile, to attempt to protect upstream oyster farms and clam beds in the Ria, and extra personnel (110 firefighters and 50 military personnel) arrived the same day from the départements of the WDZ.

The priority actions focused on: (i) food safety in shellfish harvesting areas (ban on shellfish harvesting, collection and sales), (ii) protection of oyster farms (laying of light floating booms in the Ria immediately next to them, and heavier boom in a J-shape configuration at the Port of Etel), (iii) management of communication on the sale of local oysters (to reduce media impact on the brand image), (iv) clean-up of oiled areas, (v) removal of the fuel from the casualty and (vi) refloating of the ship if possible, or if not dismantling.

The greatest accumulations of fuel oil, oiled sediment and oiled seaweed, liable to be carried away by the tide and wind, were recovered by the 250 firefighters and military personnel deployed each day, on the beach and in the Ria (estuary and rivers): after 5 days, 780 $m^3$ had been collected.

In terms of the wreck, pending the arrival of resources from the ship owner, who had been ordered to take the necessary measures to reduce the pollution and its source, *CEPPOL* (the French Navy's Centre of Practical Expertise in Pollution Response) attempted to estimate the remaining contents of the bunker tanks and to pump off the fuel oil: this attempt was unsuccessful due to the hazardous nature of the wreck and the breaches in the hull which altered the levels. The Dutch company *SMIT Salvage* and *Bourbon – Les Abeilles International*, contracted by the ship owner's representative, France P&I, took over these operations on 18$^{th}$ December, with more appropriate resources and logistics. Approximately 270 $m^3$ of oil and oily water was removed from the casualty in 4 days.

In terms of shoreline clean-up, the ship owner also took over field operations management, under the expertise of ITOPF (International Tanker Owners Pollution Federation), on Christmas Eve. A pollution response company, *Le Floch Dépollution (LFD)*, was called upon. Around 20 small clean-up sites were gradually set up in the Ria.

## 4 The Specific Case of Substantial Residual Pollution on the Upper Beach

The part of the beach located between the wreck and the mouth of the Ria was the first to be affected by the pollution, at the height of the storm: the pollution was sprayed onto the upper beach, a level only reached by the sea during storms or spring tides (semi-diurnal tide regime with maxi tidal height 5.5m).

The bulk of the oil was removed from the beach during the first few days; very rapidly, due to an increasingly slow collection rate with decreasing selectivity, the presence of responders was no longer justified in this area, and they were moved to other sites.

This residual pollution – located on the widest part of the beach, with a convex form characteristic of beach accretion was nevertheless relatively substantial: it appeared in the form of scattered tarballs (at the surface or buried due to high pedestrian and vehicle traffic during the first few days) or thin layers of buried fuel oil (around 5 to 10 mm thick, due to a concomitant supply of clean sand brought by the storm waves on the night of the incident).

This residual pollution immediately next to the Ria mouth constituted a clear source of potential contamination for the Ria environment and economic sensitivities during the following spring tides, at flood tide, in particular in rough seas.

Kerambrun, L., G. Cariou, and F. Laruelle, The TK BREMEN Incident. Surfwashing Operations as a Clean-up Strategy to Prevent Oil Entering a Small Estuary, the Etel Ria (France), Proceedings of the Thirty-seventh AMOP Technical Seminar on Environmental Contamination and Response, Environment Canada, Ottawa, ON, pp. 713-720, 2014.

In order to anticipate this risk, Cedre identified the possible solutions: self-cleaning (or natural clean-up), mechanised screening, off-site sediment washing facility, or surfwashing – also known as sediment relocation (Owens and Sergy, 2003).

The beach was an exposed shore as shown by the near-permanent presence of a surf zone. On this type of beach, in the event of oil pollution, the strong hydrodynamic exposure means that the sediment is regularly shifted by wave action, releasing the oil trapped in the sand. Thus, the sea would ultimately clean the whole of the beach perfectly. In the case in hand, this option however had a number of drawbacks:

(i) self-cleaning of the upper beach would occur in conditions liable to cause oil to enter the Ria d'Etel – i.e. during rising spring tides – on a massive scale, as the whole of the dune ridge was concerned;
(ii) the possibility of recovering the oil released was limited (preventive recovery systems using nets and sorbents cannot recover all the oil), or even impossible to implement, in the case of very rough seas and strong currents (as is the case at the mouth of the Ria at spring tides).

The use of beach cleaners (screening machines) was not practicable either due to:

(i) the low viscosity of the pollutant: it was a mixture of sand and fluid fuel oil, not consistent tarballs;
(ii) the high disturbance of the beach surface due to traffic of heavy vehicles (deep ruts, oily agglomerates buried up to 40 cm below the surface in places).

The other solution, which consisted in temporarily removing the polluted sand from the beach in order to subsequently wash it off-site using a mobile sediment washing facility, did not appear suitable either due to:

(i) the substantial volume of sand to be removed and the subsequent risk of erosion which the dune could incur in the event of a storm,
(ii) the logistics required, and the traffic implied which could potentially damage the site, both on the beach and the back-dune,
(iii) the lack of nearby availability of a non-sensitive area large enough to set up the washing facility and all related logistics,
(iv) the quality of clean-up obtained (residual traces of pollutant and washing agents) which could preclude the cleaned sediment from being returned to its original location (reminder: in the case of the ERIKA, the sand washed using this technique could not be returned to the beach due to pressure from NGOs, local inhabitants and councillors who considered that the remaining oil content presented a health risk).

The remaining option was the so-called surfwashing technique. This technique consists in removing the layer of polluted sand from the upper beach and depositing it on the mid-foreshore in piles or berms, in the surf zone where the waves churn up these piles and thus release the pollutant trapped in the sand. The pollutant released into the water is then partly collected using fine-mesh nets, laid near the sand deposit (or surfwashing) point prior to the operation.

Surfwashing is a commonly used technique both in France (AMAZZONE, 1988; ERIKA, 1999; PRESTIGE, 2002) and abroad (SOLAR 1, 2006; HEBEI SPIRIT, 2007;

Deepwater Horizon, 2011, etc.). It can be used to rapidly treat a large quantity of sand, while keeping the sand on the beach and therefore avoiding aggravating the dune erosion process.

In this case, this process in fact amounted to anticipating the work that the sea would naturally perform during the following spring tides. The aim was therefore to control the drift of the released pollutant as far as possible, and especially to prevent the oil from entering the Ria. To do so, the most appropriate place for depositing the piles of contaminated sediment (the surfwashing point) had to be identified, i.e. the point at which the sea and weather conditions (wind, tide, current) would naturally entrain the pollutant away from the Ria, and where sediment drift would ensure that the washed sand stayed within the beach's sediment system.

Three days after the incident, Cedre carried out an initial test, which involved depositing around 5 m3 in three different locations on the beach. The surfwashing point was identified during this test which was also used to check the feasibility of the technique (oil/sediment separation and pollutant weathering) as well as to ensure that the mechanical equipment was suitable for the site's characteristics (ground bearing capacity both in the upper and the lower foreshore).


**Figure 2 Map of operation site**

This initial test meant that this option could be put forward to the authorities that very evening, and resulted in an initial action plan:

- Surfwashing point (cf. Fig. 2): this point was located on the boundary between the two juxtaposed systems on Erdeven Beach, at the transition between the section of beach erosion and that of beach accretion.
- Window of opportunity: the operation could only be implemented in certain sea and weather conditions (presence of moderate to strong wave action; north or north-westerly winds) and tidal conditions (during the first three or four hours of the ebb tide – from HT+1/2 to HT+4).

- Pollutant recovery system: an innovative system for recovering oil in the water was developed (cf. Figure 3). It consisted of three ropes (each 60 m long), parallel to the water line, and offset by half the rope's length in the direction of the drift. These ropes were moored to the mid-foreshore using big bags (1 $m^3$) filled with sand and ~~sunk~~ buried into the beach. Fine mesh nets (8 m x 2 m) were attached by one end to each rope every 7 m. The system was set up immediately downstream from the surfwashing point in order to trap the pollutant as soon as it was released. As the tide went out, once the upper rope had emerged, it was removed and the surfwashing point was shifted downshore and in the direction of the drift.
- Logistics: heavy, tracked vehicles were required such as tracked bulldozers (to form piles and transfer sand) and excavators (to remove and deposit sand in the water).

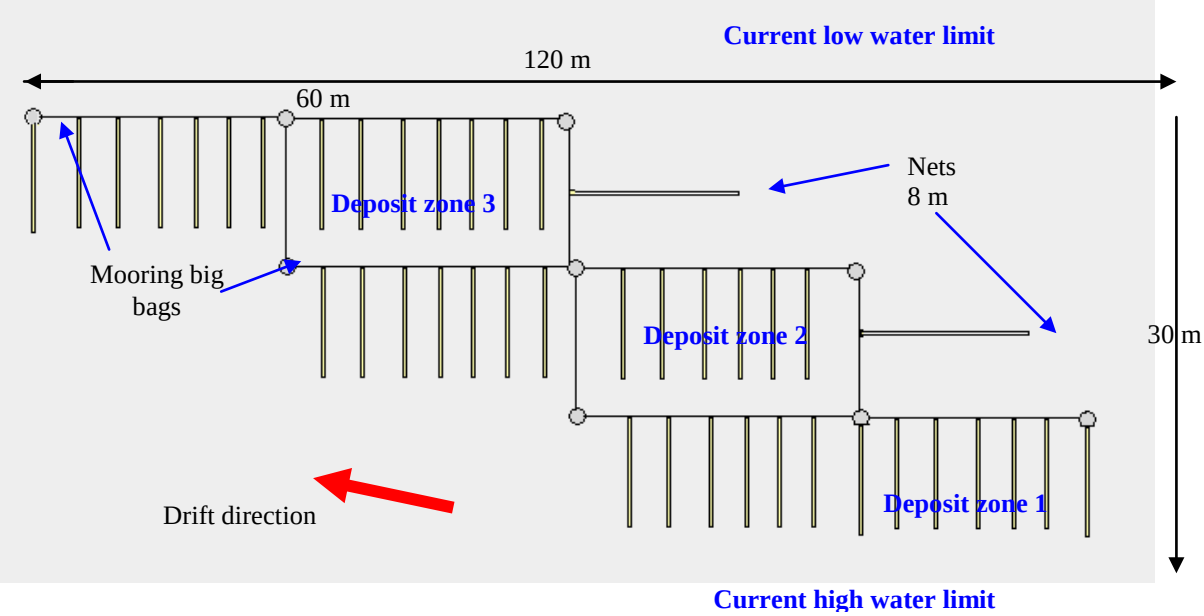


**Figure 3 Diagram of the initial oil recovery system**

Due to its fluidity, all the pollutant released was not collected by the nets: some of it escaped in the form of sheen which would ultimately evaporate or be naturally dispersed and broken down at sea.

Due to the economic and ecological sensitivities of the area, the agreement of all the parties concerned (Maritime authorities, State services, local councillors, site managers, sea professionals, ship owner representatives, etc.) was required before implementing further operation. The incident command, i.e. the Préfect of Morbihan gave its permission to continue operations on a larger scale, and provided additional resources.

Operations resumed during the following days but their efficiency was greatly hindered by mechanical failures and the long distances (300 to 700 m) between the collection points and the surfwashing point, with the sand being transferred by tracked bulldozers due to a lack of available 6x6 quarry trucks. Subsequently, the weather conditions, which were becoming too calm, prevented operations from continuing after 3 days. In total, less than 200 m3 of sand was treated.

These initial operations nevertheless confirmed that the pollutant released from the sediment by the surfwashing technique during the ebb-time did not spread up into the Ria during the rising tide (monitored for several hours), confirmed the feasibility of the technique, allowed it to be explained visually and enabled the surfwashing procedure to be validated and refined, as well as the innovative oil recovery system deployed in the water.

Resumption of operations was postponed until the next window of favourable sea and weather conditions. In the meantime, the most heavily oiled sand was concentrated into piles on the upper beach, out of reach of the sea – with the exception of a storm surge.

Several weeks passed before surfwashing operations resumed. Meanwhile, other operations in progress were attracting attention: the final clean-up sites in the Ria and the port, as well as the wreck removal on the beach. On 22nd December (with formal confirmation on 26th December), the decision was made to dismantle the ship; this operation was conducted by the Dutch company Euro Demolition (with support from French companies) and began on 6th January. The operation lasted only 20 days and resulted in 2,000 MT of scrap metal being removed. Electromagnetic sweeping and deep screening (-2 m) were conducted over the entire area to recover as many fragments of scrap metal as possible.

Surfwashing came back onto the agenda in late January, at the instigation of the ITOPF representative, who sought the resumption of operations and validated the procedure previously established by Cedre. Meetings and notes were nevertheless necessary to overcome the scepticism of certain local authorities with respect to surfwashing. Operations resumed in February with a specific organisation: they were supervised by ITOPF, under the control of CEPPOL, with technical coordination by Cedre and conducted by Le Floch Dépollution.

The procedure was slightly altered in order to optimise the set-up as well as to adapt to the logistical and weather constraints encountered:

- The recovery system on the beach was extended and reinforced: (i) the length of the 3 longitudinal ropes was almost doubled, and 5 perpendicular ropes were added, (ii) the length of the nets was also doubled (15 m) and the nets were attached by their middle.
- On the water, a mobile collection system was set-up, beyond the surf zone, in order to recover any floating clusters of oil: it was composed of 2 small boats equipped with scoop nets and sorbent booms for trawling.

The window of opportunity was the last before the spring tides of March. To save time, most of the sand to be treated was taken down close to the surfwashing point during the days preceding the operation. The volume to be treated was finally increased given that, as work progressed, new layers of oily sand (less heavily polluted) appeared which also needed treatment. The weather conditions were sometimes temporarily borderline (in particular early in the morning on the last two days): the waves and wind were dropping, but remained sufficient for the operation, especially as the conditions were set to deteriorate subsequently, thus ensuring the weathering of the sheen which otherwise tends to form at the water surface. The operations were carried out using 2 excavators and 3 tracked loaders. In order to reduce the sand transfer time, it was decided that the surfwashing point would remain in almost the same location, rather than shifting it gradually with the ebb tide, as the reinforced recovery system remained operational, thanks to favourable drift.

## 5 Conclusion

Surfwashing is a technique which has been widely used in France for several years in response to several spills (AMAZZONE, 1988; ERIKA, 1999 PRESTIGE, 2002 (Kerambrun and Beau, 2005); etc.) as well as in others countries (EXXON VALDEZ, 1999 (Owens et al. 1991); Lebanon oil spill, 2008 (Fichaut, 2008); Deepwater Horizon platform oil spill, 2010, (Owens et al., 2011); etc.). Initially used on pebbles, the technique also works well with sand.

In this specific case, the ecological and economic sensitivities of the surrounding area (Ria) meant that an appropriate procedure had to be defined, complying with specific

conditions in terms of the sea state, wind and tides in order to prevent further contamination of the Ria.

Often used at rising tide (for pebbles notably), this technique can also be used at ebb tide to enable better recovery of the released oil, which is collected shortly after it is released as the tide goes out, either in the form of tarballs (weathered heavy fuel oil) or adhering to recovery nets, as in this case.

Through these operations, all the residual pollution on the beach was able to be treated, i.e. 4,000 m3 of sand, in 5 days, just before the spring tides in March. The following tidal cycles finalised clean-up and gradually redistributed the shifted sediment towards its extraction site, i.e. striking a balance with the hydrodynamic characteristics prevailing on the site.

## 6 References

Fichaut, B. and B. Loubnan, "Massive Use of Berm Relocation and Surfwashing during the 2006 Jyeh Oil Spill (Lebanon): the Accurate Response for Beaches Cleanup", *in 2008 International Oil Spill Conference (IOSC) Proceedings.* 2008, 4-8 May, Vol.2008, N°1, pp. 331-338, API, IMO, IPIECA, MMS, NOAA, USCG, USEP, Savannah, Georgia, USA, 2008.

Kerambrun, L. and N. Beau, "The *Prestige* Oil Spill Response on the Sandy Beaches in France", *in Proceedings of the Twenty-eighth Arctic and Marine Oil Spill Program (AMOP) Technical Seminar*, Environment Canada, Ottawa, Ontario, pp. 539-547, 2005.

Owens, E.H., A.R. Teal, and P.C. Haase, "Berm Relocation during the 1990 Shoreline Cleanup Program following the « Exxon Valdez » Spill", in *Proceedings of the Fourteenth Arctic and Marine Oil Spill Program (AMOP) Technical Seminar*, June 12-14, 1991, Environment Canada, Ottawa, Ontario, pp. 607-630, 1991.

Owens, E.H. and G.A. Sergy, "Accelerated Attenuation of Oil on Beaches: Part 1 - Sediment Relocation', *in Proceedings of the 26th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar*, Vol. 2, Environment Canada, Ottawa, Ontario, 2003.

Owens, E. H., E. Taylor, A. Graham, and R.W. Castle, "Sand Beach Treatment Studies and Field Trials Conducted during the Deepwater Horizon-Macondo Response Operation", *in 2011 International Oil Spill Conference Proceedings*, 23-26 May 2011, Portland, Oregon. API, USCG, USEPA, IMO, IPIECA, USNOAA, BOEMRE, Vol. 2011, No. 1, abs 265, 9 p., 2011.