# The *Prestige* Oil Spill Response on the Sandy Beaches in France

Loïc Kerambrun and Natalie Beau
Cedre
Brest, France
Loic.kerambrun@cedre.fr

**Abstract**

In mid-November 2003, the tanker *Prestige* sank off the northwest coast of Spain, spilling large amounts of oil that in a few days hit and severely affected the Galician coastline. For several months, part of the continuously released oil from the wreck drifted northwest, polluting the northern coast of Spain and then the French coastline. The affected French coast consisted mainly of long sandy dunes. Except for some slicks in the first days, most of the fuel deposits consisted of patches and tar balls scattered along the shore and often mixed with various floating debris that usually drifted in the Biscay bay area.

Different recovery and cleanup techniques were used on the polluted beaches, ranging from manual recovery to mechanical screening and drumming as well as surf-washing or using nets anchored at one end. The response team was constantly looking for ways to deal with the oil, which arrived continuously for several months and was buried on the beaches, and the unique geomorphology conditions, such as sediment transit and debris.

## 1 Introduction

In France, the *Prestige* spill primarily affected the sandy shores of the Gironde and the Landes rivers. To the north of the Gironde, shorelines that had been heavily oiled by the *Erika* in December 1999 were affected much later on, to a much lesser degree, and even then only locally. The widespread nature of the spill coupled with the lack of financial resources restricted the response operation to manual collection, so that most of the oil was washed by wave action in the areas that were eventually oiled.

The hardest-hit areas were the Aquitaine coastline and from the Gironde river estuary to the Spanish frontier, with constant beachings of patches, small patches, and tar balls of oil over a six-month period. As a result, most of the response operation, i.e., collection and cleanup, was conducted in these areas.

The coastline in Aquitaine is mainly sandy, straight, low-lying, and made up of an almost continuous stretch of dunes about 250 km long, broken only by Arcachon Bay and a few small rivers. This sedimentary structure is interspersed with rare rocky outcrops of anthropic origin, e.g., spits and breakwaters or man-made structures, such as quaysides and wharfs.

Further south, beyond the Adour River, the Basque coastline is much more craggy and rocky and stretches almost 30 km to the Spanish border. Sandy beaches alternate with more rocky structures consisting of boulders and pebbles where the oil was trapped, sometimes to a considerable depth.

Kerambrun L. and N. Beau. The *Prestige* oil spill response on the sandy beaches in France. Proceedings of the twenty-eighth AMOP Technical Seminar, Environment Canada, Ottawa, ON, pp.539-547, 2005.

## 2 Shore Response: Influencing Factors

Before the *Prestige* spill, the generally accepted opinion was that compared to rocky and craggy shorelines as in Brittany, for instance, the long sandy coastline in Aquitaine should, at least initially, be easier to manage and clean. Things turned out much differently and can be explained by a number of parameters.

To begin with, constant beachings of oil compounded the way the response was eventually organized. It was difficult to forecast where and when the oil would land. Available human resources were scarce. There were three main differences from the *Erika* cleanup: far less firefighters were available, even less soldiers as compulsory national service had just been phased out, and fewer volunteers. Volunteers either did not come forward or they were not called on due to the two major problems during the *Erika* spill, namely that the oil was very toxic and it was uncertain who would be liable. The Polmar strike teams were thin on the ground and could only muster a few Civil Defence squads (*UIISCs*). The fact that private contractors were called in very early did not offset this deficit.

Furthermore, the response was hampered by the makeup of the shoreline, which is heavily beaten by wave action. In areas where long waves tended to reach the beach, difficulties were created for the responders and massive and sudden sediment displacement occurred so that oil was quickly covered and buried and tar balls formed. Typically, beaches were strewn with anthropic waste such as nets, drums, cans, and bottles, in addition to items such as branches and uprooted trees mainly washed down to the sea from the Pyrenees and sometimes very cumbersome to deal with. The quantities were so enormous that systematic and regular waste collection campaigns had to be organized for a number of years in the Landes. Such waste had to be collected immediately to keep the amount of oiled material down and facilitate movements of the beach cleaners and screening machines.

Access was a problem because the beaches are backed by extensive forests where the public is not allowed access due to tree-felling operations or the existence of sanctuaries or Ministry of Defence premises. The coastline is not built up much, with only a few scattered villages. The facilities are primarily low-key amenities, open to the public only in summer when population figures soar because of the camping grounds. Roads are rare and access paths to beaches are few and far between and even then require substantial detours.

## 3 Shore Response: Principles and Resources

The *Prestige* response operation (Cedre, 2004) was based partly on the same technical principles as those used to cope with the *Erika* spill two years before, which involved a spill of HFO (Kerambrun and Laruelle, 2001). With the *Prestige* spill, however, the response effort was aimed primarily at the sandy beaches and only the innovative or exceptional items are mentioned here.

The characteristics of the spill and the shoreline led to mechanical screening especially for the biggest beaches. Screening machines specially built for the dry, sandy beaches and used extensively to deal with the *Erika* spill (Guena, 2002) were tested and modified to suit the circumstances of the *Prestige* spill. Drumming machines were developed in addition to the beach cleaners for use on wet, sandy beaches.

Two other techniques were used a great deal during the *Prestige* response effort. Surf-washing was used to clean the bulk of the sand. More importantly, during the fine-

Kerambrun L. and N. Beau. The *Prestige* oil spill response on the sandy beaches in France. Proceedings of the twenty-eighth AMOP Technical Seminar, Environment Canada, Ottawa, ON, pp.539-547, 2005.

tuning at the end of the cleanup operation and as an alternative to screening, the oil was captured in nets anchored at one end before it reached the beaches.

Waste and unoiled flotsam and jetsam were collected with heavy-duty machinery such as road maintenance and farming equipment which scooped up material for collection using perforated buckets and grabs or piled them up with rakes. From the outset, the unoiled materials were gathered for collection at the top end of the beach out of the reach of waves and then gradually evacuated to appropriate treatment centres in the Landes or incinerated on the beaches in the Gironde. The operation had to be conducted regularly to deal with repeated beachings of oil in both areas.

### 3.1 Capturing the Oil at Sea Just Off the Beach

It was decided to set up lines of fine mesh nets, called "mop nets", along the shore to catch the drifting patches of heavy oil before they reached the beach. This technique was developed to manage the *Erika* spill in addition to surf-washing to clean the bulk of the sticky oil coating the pebbles. The nets are simply tied to a sinker on the foreshore and mobilized by a digger. The sinker consisted of a stone or large bag full of sand or pebbles. The nets ranged from 5 to 20 m long and 1.5 to 5 m wide and their mesh size varied depending on the type of net or the configuration of the shoreline. The nets were placed above the mid-high tide mark, with the height depending on the tidal range.

During the *Prestige* spill, netting material used to catch juvenile eels were used initially and then replaced for financial reasons with nets used by scaffolding companies or to protect windows from hail. Eel netting is still the most efficient because it is more resilient and the mesh aperture doesn't change much in waves whereas other nets tend to twist. These nets are very effective on viscous HFO, whereas with light crude oils they tend not to do as well because adhesion isn't as good and especially due to self-adhesion. They fare even worse in relatively exposed areas. With the *Erika*, the nets worked relatively well on short jobs of one or two days as they were easier to place depending on tidal conditions at the time.

Using these nets over the long term as a protective device was not effective as shown by tests conducted during the *Prestige* spill. In view of this, the effort required to maintain the nets on an ongoing basis, e.g., replacing oiled nets and repositioning them depending on fluctuating tidal ranges and checking they are securely fastened, seems rather disproportionate especially if the nets are to be used on a large scale and may not be particularly effective in terms of trapping sizeable amounts of floating oil. Used preventively, the technique must be part of the on-shore response that will invariably involve other techniques and in particular collection manually and with machines.

### 3.2 Screening

As was the case with the *Erika* spill, large and small screening machines were used extensively. Cedre and one of the major contractors modified one of the larger screening machines to limit fragmentation of tar balls and patches and improve selectivity. Some of the changes were recommended in the '80s by Cedre and integrated into a Rolba type beach cleaner and other changes were also suggested during the *Erika* spill response. The modifications consisted primarily of the following: placing the beach cleaner's grid rotation axis off centre to increase vibration efficiency and speed up the screening process; installing a rubber "blade" on the leading edge of the grid to reduce sand build-up and improve selectivity; and replacing the hooks of the

Kerambrun L. and N. Beau. The *Prestige* oil spill response on the sandy beaches in France. Proceedings of the twenty-eighth AMOP Technical Seminar, Environment Canada, Ottawa, ON, pp.539-547, 2005.

pick-up, which otherwise tends to break down the oil patches, with either linear or multi-linear metal or stiff rubber blades.

The smaller beach cleaners worked well during the *Erika* spill and were put to use again during the *Prestige* spill for collecting residual fragmented tar balls at the bottom of the dunes and on very busy beaches. The only significant change made to these beach cleaners was to replace the 5-mm mesh screen with a much finer one, as small as 1 mm in some places where dune sand was very fine and dry.

In view of the enormous stretches of beach that were eventually oiled and striving to focus resources appropriately, large and small screening machines were often used in tandem for several kilometres at a time. As was the case with the *Erika*, all available machines were mobilized where needed, but there were not enough of them. As a result, the Polmar Authorities had to secure other sourcing channels such as:

- offering beach cleaners from the Polmar stockpile for use (about a dozen or so large and small cleaners were made available);
- preferring outright purchase by the local authorities at a very good price thanks to subsidies from government or county authorities;
- organizing lending agreements with neighbouring local authorities that were not affected by the spill or with other regions in France (approximately 20 machines and occasionally operators were made available) and in Tunisia. The Polmar authorities organized the logistics and transport and reconditioned the beach cleaners before returning them; and
- requisitioning the resources of private companies during the first few months of the response by organizing tenders afterwards. Companies agreed to help and provided existing resources and equipment or bought new equipment to comply with the call for tenders issued by the Polmar authorities.

Cedre provided training sessions for beach cleaner operators on the machines and local environmental conditions to improve selectivity and throughput (blade adjustments, screen operating speeds, and tyre pressures) and to raise awareness about the potentially enormous ecological impact of the use of beach cleaners such as erosion and destruction of dune vegetation.

On some beaches where the sand was coarse grained (in front of the breakwaters, for instance), large patches of HFO were quickly covered by varying thicknesses of sand that exceeded a metre in some places. The larger beach cleaners are definitely recommended for use on this kind of beach. To collect oil patches selectively, even when they were covered by thick layers of sand, a caterpillar-type front-end loader was used, fitted with a bucket complete with a tightly packed row of small prongs on the leading edge. This enabled the clean, coarse-grained sand to fall freely to the ground. The caterpillar cleaner initially removed the bulk of the surface oil and afterwards was put back into action to deal with the buried oil.

## 4 Oleophilic Drums

Beach cleaners do not do a good job of collecting HFO tar balls on wet sand. They can't sift wet sand properly as it tends to be very compact and hard so that the tar balls get squashed. During the *Prestige* response operation, an innovative collection method was tried out on this kind of pollutant. It consisted of either one or a pair of drums pushed by an operator or by a tractor with the bigger model lined with a geotextile, netting, Bidim®, or Enkamat® that the tar balls stick to when they are fresh.

Kerambrun L. and N. Beau. The *Prestige* oil spill response on the sandy beaches in France. Proceedings of the twenty-eighth AMOP Technical Seminar, Environment Canada, Ottawa, ON, pp.539-547, 2005.

The tar balls are subsequently removed by scrapers and conveyed into a storage tank. The linings of the drums are interchangeable and can be replaced when saturated and subsequently disposed of by incineration. These drums are an adjunct to the beach cleaners as they are very effective where the others do not fare quite so well and vice versa.

### 4.1 A Forgotten Concept

Unknown to the public at large and unavailable at the time of the *Prestige* spill, the drumming concept has been around for quite some time. Cedre developed a prototype of this kind from 1981 to 1984 (Pasquet and Denis, 1983). It was a metal cylinder connected to a tractor power take-off with a conveyor belt system to evacuate the collected materials. The drum was lined with a kind of carpet but other linings were also tested, including rubber grommets and geotextiles. The prototype fared very well during trials but was never developed by the industry as there was no potential market and a very narrow scope of application, i.e., HFO deposited on wet sand.

During the *Erika* spill, an inventor noticed that oil adhered well to the Bidim type geotextile and built a drum fitted with a Bidim® continuous belt which was then mounted on a quad. The drum consisted of an axle fitted with 5 low-pressure tires. When moving forward, the Bidim® belt rotated around three triangulated axes and was scraped as it passed above the storage tanks. In pusher mode, the quad avoided squashing the oil before it could be collected and, in pulling mode, the quad tractor improved the mobility of the device and enabled very quick deployment. This prototype was being developed when tar balls were becoming rarer and was consequently not used.

When the *Prestige* spill occurred, the concept was reinvented. This time, the device consisted of a simple fine mesh net mounted on a garden roller. The process has proved suitable and very effective for the job at hand and the concept was well accepted. It was now feasible to develop such a device because the spill lasted for quite some time. Furthermore, the authorities requisitioned and organized calls for tender very quickly, as the cleanup operation was relying on these drums. This explains why at least 5 companies developed a drum and more than 500 drums were available in less than 2 months.

### 4.2 Machines Used

Two types of drums were suggested, a wide-based drum connected to the front end of a tractor or a front-end loader and a smaller drum pushed by small caterpillar-type machines operated by hand.

**Afimex Drum** - The Afimex drum is fixed to the front fork of a tractor and is made up of two drums, 220 cm wide with a diameter of about 60 cm, arranged one behind the other and fitted with an oleophilic lining of 2 or 3 layers of polyethylene netting with a mesh of 8/3. The second drum provides the finishing touches. Two 200-L storage tanks located in front of the drums are fitted with scrapers and hydraulic jacks. The device travels at 3 km/hour. A heavy-duty loader is required to empty the storage tanks and transfer the recovered materials to a storage facility.

Kerambrun L. and N. Beau. The *Prestige* oil spill response on the sandy beaches in France. Proceedings of the twenty-eighth AMOP Technical Seminar, Environment Canada, Ottawa, ON, pp.539-547, 2005.

**SLPF Drum (Société Les Pierres de Fontenac)** - The SLPF drum is mounted on a Fiat Hitachi or Volvo L 120 front-end loader and consists of a drum, 4 m wide and 1.60 m in diameter, with a protective geotextile lining and a scavenger geotextile made up of polyamide monofilaments (Enkamat® 7220); a storage tank fitted with a comb; and a wheel stabilizer to fine-tune the pressure exerted by the drum.

The device, which moves at 4 to 5 km/hour, is effective on very wet and damp sand. The lining tends to become heavily laden with sand, however, so that the drum must be rinsed regularly at sea. Even then, only the sand is dislodged from the drum even with wave action. It takes two people to replace the lining when it is too heavily oiled or damaged.

On dry sand, the device has also proven its capacity to collect tar balls thanks to the use of a stabilizer that avoids squashing the oil and enables the device to be used on dry and wet or very wet sand. The other devices tend to sink into the beach.

**LFD Drum (Le Floch Dépollution)** - This is a three-drum arrangement that can be folded away on a tractor. It consists of a middle drum, 2 m long and 60 cm in diameter, and two side drums, 1 m long and 60 cm in diameter, which can be stowed using hydraulic jacks. The drums are lined with oleophilic geotextile with 2 or 3 layers of Bidim® and netting, plus 100-L storage tanks fitted with scrapers and mounted in front of the three drums. The device has a 4-m span with the side drums extended. The operator can select the swath width depending on how heavily oiled the beach is and the side drums can be lowered if required.

As with a number of drums that have been tested and/or used, sand tends to stick to the drums and the operator has to go to the water's edge regularly to rinse them so as to continue collecting the tar balls and avoid clogging the geotextile entirely. The device moves forward at about 4 to 5 km/hour. Beyond this speed, tar balls tend to adhere less, particularly if the oil is heavily laden with sand or has dried to some extent.

**Bataille Drum** - This company has marketed a hybrid device consisting of a beach cleaner and a drum in a pull-push configuration. The idea was to be in a position to deal with fresh beachings of oil at the water's edge using the drum, while also using it to clean the sand at the top end of the beach. This hybrid cleanup concept was adopted by the companies involved in the call for tenders for beach cleanup. Mounted on a tractor, the device is made up of two components: a drum 2.36 m long and 80 cm in diameter, a sorbent lining, and a polyethylene net; and a 350-L storage tank.

**Djet Mini-drum** - The Djet company opted for smaller, lighter, and easier-to-handle machines made up of a self-propelled, caterpillar-type machine operating at a speed of about 3 km/h; a drum, 120 cm long and 40 cm in diameter, a 2- to 3-layer lining of fine geotextile, and 2 to 3 layers of polyethylene netting with a mesh of 3 to 5 mm; and a storage tank up front with a capacity of 110 L. The device comes as a kit, fits into a quad trailer, and is easy to move around. Only one operator is needed to steer, move, and dismantle the machine and a one-hour training session provided by the manufacturer is sufficient for the operator.

## 5 Surf-washing

During the *Prestige* spill, surf-washing was the third major cleanup technique used on the sandy beaches. The surf-washing concept is based on natural energy

Kerambrun L. and N. Beau. The *Prestige* oil spill response on the sandy beaches in France. Proceedings of the twenty-eighth AMOP Technical Seminar, Environment Canada, Ottawa, ON, pp.539-547, 2005.

provided by wave action releasing the pollutant trapped in the sand and the pebbles and washing sediment naturally. The technique consists of pushing the polluted sediment down to the water's edge where it is cleaned by the waves. Wave action eventually scatters the piles of sediment and redistributes them over the entire beach area. The released oil can then be recovered from the water surface with nets or at the top end of the beach with oleophilic drums or manual collection. Natural wave energy is used to clean the sand, pebbles, and boulders.

In the *Prestige* response operation, surf-washing was used during two main cleanup phases. During the bulk cleanup phase in the Pyrénées Atlantiques, it was used to clean piles of polluted pebbles at the top end of some coves. During the fine-tuning cleanup phase in the Landes and the Pyrénées Atlantiques, surf-washing was used as an alternative to beach cleaning to separate the sand from the tar balls that the beach cleaners could not handle.

Surf-washing operations were conducted methodically, beach section by beach section, and involved gradually removing layers, but limiting the number of passes on the beaches requiring cleanup. The following was the general operating method:

- gradual removal of the top layer of polluted sediment down to a predefined depth of 5 to 50 cm and locally even deeper, with the average depth of 20 cm;
- surface removal of polluted materials in rows 20 to 40 m long and 3 m wide parallel to the water's edge and forming a windrow perpendicular to the water's edge;
- further surface removal on the other side of the windrow; and
- removal of the windrow towards the bottom end of the beach to the mid-tidal range where wave action is stronger.

The general procedure varied from one work site to another and also depending on the appraisal of the OSC.

- The loader sometimes pushed the polluted materials directly towards the bottom end of the beach which is an attractive proposition for dealing with small quantities of sand but less so in the event of larger quantities due to vehicle movements on polluted beaches.
- For larger quantities, the windrows were removed directly by the loader or by a dumper.
- The piles of polluted materials that were deposited halfway down the foreshore were organized either at low tide or directly in the water.
- The polluted material was either deposited in piles or rows and the boulders and pebbles were scattered to avoid build-up.

The recovery method to be used was determined by the extent of the oiling. During cleanup phase 1, which was the case for the heavily oiled pebbles on the Basque coastline, fine-mesh nets, approximately 15 x 3 m in size, were anchored to the beaches with large bags of pebbles or sand. In this case and in rocky areas, the nets were attached to steel cables positioned across the beach and fastened to the rocks. Only slightly oiled sand was recovered mainly by hand and sometimes by drumming.

Surf-washing required prior and detailed reconnaissance of the beaches to determine levels of pollution and the physical environment and technical meetings to discuss implementation. Samples were taken to better characterize the extent to which the various areas were polluted and to determine whether they were amenable to surf-washing. If so, areas were defined that would require surface removal operations

Kerambrun L. and N. Beau. The *Prestige* oil spill response on the sandy beaches in France. Proceedings of the twenty-eighth AMOP Technical Seminar, Environment Canada, Ottawa, ON, pp.539-547, 2005.

(surface areas, volumes, and depths). The same areas were surveyed for sediment involvement and current patterns so as to define the best operating protocol for the job at hand, i.e., to deposit the sediment for washing on the foreshore depending on available wave energy and oil drift direction.

From an ecological point of view, if used inappropriately, surf-washing can present a serious risk of sediment deficit because of sediment being transported out of the beach system. In the long term, this can lead to serious coastal erosion. In order to avoid harmful consequences, decisions were made in conjunction with representatives of the Ministry of the Environment, Cedre, and other geomorphological experts from academia and government institutions.

Surf-washing was used on a number of beaches during the *Prestige* cleanup operation. Major volumes of sediment were moved. Local authorities, the Polmar authorities, and amenity users have realized the effectiveness of this technique. In the Landes, the beaches in 7 local districts were treated by surf-washing. In a month, these operations involved more than 8 km of coastline, a surface area of 41 hectares, and displacement of more than 50,000 $m^3$ of sand and sediment.

## 6 Conclusion

The pollution response implemented to deal with the *Prestige* spill along France's sandy beaches enabled observers to appraise the advantages, performances, limits, and the complementarity of the main techniques used.

Collection nets were deployed during the first few days of the spill to prevent the oil from spreading. In a configuration such as this, the nets can turn out to be inappropriate if they cannot be suitably maintained. In this case, the drawbacks would be: net positioning is often inadequate because of tidal changes, nets tend to be buried under the sand, the pollutant is often carried away by wave action especially when oiled nets are not replaced, unsecured nets often drift away causing a hazard to shipping, and nets are often left untended.

Beach cleaners were used extensively to manage the *Erika* spill and they only required fine tuning and modifications.

For the first time, machines other than screening machines, namely oleophilic drums, were used to clean up a spill. These devices were extensively developed by a number of pro-active private companies because the beachings of oil were continuous. The large and small drums were used on a daily basis during the summer to clean beaches and especially the amenity beaches in addition to collecting large quantities of oil before it was buried or refloated out to sea. As with all dedicated machines, these could only be used with a very few types of pollutants, e.g., fresh viscous oil, sticky oil, and oil with a low sand content, and only in certain beach areas, e.g., fine grained sand, slightly damp to very wet sand, and even surfaces with no ridges with a slight slope and no waste or flotsam and jetsam.

Surf-washing was used extensively during the *Erika* spill (Fichaud and Fatal, 2002) and even more for fine-tuning during the cleanup operation for the *Prestige* spill as an alternative to beach cleaners. Once again it has been shown how useful this technique is in dealing with viscous oil. Apart from the fact that no sediment is removed, surf-washing is a quick method and clearly much less expensive than other options.

Kerambrun L. and N. Beau. The *Prestige* oil spill response on the sandy beaches in France. Proceedings of the twenty-eighth AMOP Technical Seminar, Environment Canada, Ottawa, ON, pp.539-547, 2005.

## 7 References

Cedre, "Nettoyage des plages", in *Archives Prestige*, CD-Rom Cedre (ed.), Brest, France, 2004.

Fichaut, B. and P. Fatal, "Marée noire de l'Erika : le surfwashing, une alternative à la mise en décharge des sédiments des plages", in *Proceedings of Safers Seas Conferences: les leçons techniques de l'Erika et autres accidents*, mars 2002, Brest, CD-Rom, Cedre (Ed.), 12 p., 2002.

Guena, A., "Les techniques de criblage utilisées pour nettoyer les plages souillées par le fuel de l'Erika : performances et limites d'utilisation", in *Proceedings of Safers Seas Conferences: les leçons techniques de l'Erika et autres accidents*, mars 2002, Brest, CD-Rom, Cedre (Ed.), 17 p., 2002.

Kerambrun, L. and F. Laruelle, "Erika Oil Spill: Some Innovations in the French Shoreline Response and Beach Cleanup Methods", in *Proceedings of the Twenty-Fourth Artic and Marine Oil Spill Program (AMOP) Technical Seminar*, Environment Canada, Edmonton, AB, pp. 671-677, 2001.

Pasquet, R. and J. Denis, "New Developments in Beach Cleanup Techniques", in *Proceedings of 1983 Oil Spill Conference*, USCG, API, EPA, San Antonio, TX, pp. 279-282, 1983.

Kerambrun L. and N. Beau. The *Prestige* oil spill response on the sandy beaches in France. Proceedings of the twenty-eighth AMOP Technical Seminar, Environment Canada, Ottawa, ON, pp.539-547, 2005.