# ANALYSIS OF OIL RECOVERY VESSELS USED WORLDWIDE

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**ABSTRACT:** *Before considering any possibility of increasing her capacity to combat an oil spill offshore, the French Navy asked CEDRE to inventory the different types of vessels used worldwide, and more especially in Europe, to recover oil spilled offshore.*

*Two types of ships can be differentiated:*

- *those which were specifically conceived for recovering oil,*
- *and those which have been adapted or used for this mission.*

*In the last case, we can also make a distinction between vessels which are only, or mainly, used for antipollution combat and those which are normally used for commercial activities, e.g., dredgers or coastal tankers.*

*Except for Germany, the only country to have ships that were specifically conceived for recovering oil offshore, most countries make use of dredgers or supply vessels. Storage capacities for recovered oil are generally between 500 and 1,000 $m^3$, except for dredgers which may have storage capacities of 6,000 $m^3$ and even more. The oil recovery devices associated to these vessels generally combine oil containment and recovery and are deployed alongside. Most of them are mechanical weir skimmers and use high-capacity transfer pumps.*

*Taking into account the conditions of intervention off the French coastline, the comparison of the different solutions pointed out numerous advantages of supply vessels having large storage capacity inboard, even if improvements are still needed to increase the capacity of controlling a large oil spill with bad sea conditions.*

Studies carried out by the French Navy, with assistance from CEDRE, on equipment available in France for an intervention at sea following a spill involving several thousand tons of oil have revealed that France is insufficiently equipped with adapted vessels. In this light, the French Navy has requested that CEDRE look at vessels which could be obtained to develop a more complete pollution response fleet similar to those of other nations. Referring to earlier studies made by CEDRE on the use of dredgers and coastal tankers, the Navy requested that the current study involve existing, specifically designed, pollution-response vessels but also nonspecialized vessels that could be adapted for use in pollution response.

The study was therefore to consider the advantages and disadvantages of various existing solutions—whether or not they involve specialized vessels—and the possibility of adapting these solutions to French needs. To fulfill these objectives, the work was accomplished in two parts: First a review of all the existing vessels and an evaluation of these pollution-response means were made; then the possibilities of adapting foreign solutions to French needs were considered.

A study of existing skimming vessels involved several approaches including a review of detailed information obtained from several sources:

- National organizations were asked to provide information regarding the characteristics and functioning of available high-sea vessels in their countries (about 15 nations were contacted).
- The builders and suppliers of oil recovery vessels or large-scale skimming devices which could be adapted for use on nonspecialized vessels were contacted (about 40 companies).
- Other data were found through a detailed search of specialized magazines.

The analysis made as a result of these contacts and documents were complemented by visits to observe the pollution-response vessels and equipment used in Germany, the Netherlands, Denmark, and Norway.

An analysis and summary of all the collected information were made to discover the salient features of the response means and economic and political considerations which might explain the choices made in other countries and therefore help in evaluating the possibility of adopting these means in France.

Considerations for adopting certain ways and means in France, as well as the inherent interest in using certain solutions, included what already exists in France and the reasons which led to these previous choices. The analysis of what is missing and the specific nature of what is needed in France led to proposals which would significantly improve the French capacity for pollution response at sea.

## Examination of existing means for recovering oil at sea

**Classification of existing vessels.** Developing a national system for recovering oil spills at sea can be accomplished in three, often complementary, ways:

- by building vessels specifically designed around a skimming system;
- by converting existing vessels—adapting these vessels often involves significant changes whereby the skimming function becomes the vessel's principal, and perhaps only, function;
- by using vessels which are multifunctional or which can combine several functions—some existing vessels, by use or form, and with few modifications, can be easily converted for temporary use in oil spill recovery.

According to the choice, vessels can be specifically designed for use in oil spills, can be permanently converted for use, or can be temporarily converted for use. The study used these general classifications.

**Inventory of naval means currently in use.** The information obtained from the various sources previously mentioned from personal contacts, visits, and from technical documentation, enabled us to prepare a detailed inventory of the naval means used in some nations for recovering oil spills at sea. The inventory of vessels is presented in Table 1, arranged by country and by the previously defined classification for the vessels.

Certain important points have been brought out in this inventory:

- Few countries have set up real naval means for skimming oil spills at sea (involving confinement, skimming, and storage): only nine countries are listed. With the exception of Japan, the countries are neighbors on the North Sea or the Baltic Sea (including the U.S.S.R. whose pollution defense system must include its entire seaboard).
- Only one nation, Germany, has built specifically designed skimming vessels. They have four for use at sea plus others designed for work in estuaries or ports.

**Table 1. Inventory of oil recovery vessels used worldwide**

| Nation | Specifically designed | Permanently reconverted | Temporarily convertible—multi-function | | | |
|---|---|---|---|---|---|---|
| | | | Dredgers | Supply ships | Sea trucks | Others |
| Denmark | | | | *Gunnar Thorson*<br>*G. Seidenfaden* | *Mette Miljo*<br>*Marie Miljo* | |
| Finland | | *Hylje (Ro/Ro)* | | | | |
| Germany | *Eversand*<br>*Bottsand*<br>*Westensee*<br>*MPOSS* | | *Nordsee* | *Mellum*<br>*Scharhorn* | | |
| Japan | | | *Seiryu Maru* | | | |
| Netherlands | | *Small agt*<br>(land fill carrier) | *Cosmos*<br>*Hein*<br>*Rijndelta*<br>*Geopotes 14*<br>*Cornelia*<br>*Lesse* | *Volans* | | *Mitra*<br>(oceanographic research vessel) |
| Norway | | 4 trawlers | | 25 | | 6 coastal oil tankers |
| Sweden | | | | | *TVO45*<br>to *TVO51* (7) | |
| United Kingdom | | *Forth Explorer*<br>(Ro/Ro)<br>*Clean Seas*<br>(trawler)<br>*Seaspring* (land fill carrier) | | | | |
| U.S.S.R. | | *Svetlomor* | *Professor Gorjunov*<br>*General Vaidaghubsky* | 10 | | |
| Total | 4 | 10 | 10 | 40 | 9 | 7 |

The solution most often adopted is that of multipurpose or multiple function vessels; in other words, vessels that can be easily converted for oil spills in the event they are needed. These vessels can be divided into two major categories:

- vessels which usually have the job of assisting, surveying, or filling—e.g., supply types or sea trucks. The supply ship category is by far the most used.
- vessels that have a specific economic role necessitating a large bulk transport capacity which can, on occasion, be used to store recovered oil—e.g., dredgers or coastal tankers.

**Specific vessels.** Research to design and perfect specialized vessels for oil skimming on water has been going on for a number of years in several nations. However, most of the working vessels, which were primarily developed by private enterprises specializing in port cleanup, are small-size units designed for use in port waters or, exceptionally, along a coastal area. These vessels are soon limited by their non-high sea characteristics; also, they only possess a limited storage capacity. We should note that Japan, the U.S.S.R., the U.S.A. and the Netherlands are among the nations with a well-developed fleet of pollution response equipment of this type.

As far as high-sea oil skimming is concerned, numerous projects have been proposed, some of which do not seem to be feasible. In most cases, the most realistic projects are still on the drawing board due to a lack of enthusiasm from both the public and private sector in terms of financing. In fact, only Germany has gone beyond the planning stage and has actually constructed specifically designed oil skimming vessels which can be used at sea (see Table 1).

Three systems have been built and put into use (see Table 2).

***The Luhring twin-hull system.*** This type of ship opens longitudinally, on a pivot point at the stern, to form an angle where the oil is confined before it flows into the ship itself through openings in the hull equipped with a weir. A powerful separator (Jastram) insures a water/oil separation and the water is returned to the sea. At the current time, there are four such vessels:

- *Thor* (1981) the prototype now used in inland waterways and along the coast.
- *Bottsand* (1984) and *Eversand* (1988) used by the German Navy.
- *Pemex 654* (1988), a twin of *Eversand,* which was purchased by Pemex and used in the Gulf of Mexico.

***The Sobinger system: mobil oil dike (MOB) catamaran.*** This catamaran is not self-propelled so requires a pusher. At the present time there is one example of this system, the *Westensee,* which has the main

**Table 2. Specifically designed vessels for recovering oil spills at sea**

| Type/recovery system | Name (date) | L × l × d (m)<br>swath (m) | Storage capacity ($m^3$) | Other functions |
|---|---|---|---|---|
| Twin-hull vessel | *Bottsand* (1984) | 46 × 12 × 3.1<br>42 | 790 | slops storage<br>de-ballasting |
| Luhring system (RFA) | *Eversand* (1988) | 48 × 12 × 3.5<br>45 | | diesel refueling |
| Non—self-propelled catamaran *Mobil Oil Dike* Sobinger system (RFA) | *Westensee* (1987) | 46 × 27 × 4.4 | 2,000 | none |
| Self-Propelled catamaran Multi-Purpose Oil Skimmer System KSR system (RFA) | *MPOSS* (1986) | 33 × 12 × 1.8 | 300 | port area cleaning |

advantages of a large storage capacity (2,000 $m^3$) and functioning according to simple principles, the natural separation of oil and water in settling tanks).

***The ERNO-KSR: multipurpose oil skimming system (MPOSS) catamaran.*** This catamaran is self-propelled and functions according to a more sophisticated skimming system where the surface layer is separated, skimmed and then pumped. The only operational example of this system is destined for interventions in ports and estuaries.

**Converted vessels.** Relatively few vessels have been permanently converted for oil skimming work at sea (see Table 3). The goal is generally to combine a large storage capacity with possibilities for assuming additional functions—which remain in the framework of pollution response, such as, preventive operations (collecting slops), cleanup (dispersion, cleaning), and assistance (carrying other equipment). The original construction design varies: These vessels may be former oil tankers, land fill carriers, roll-on/roll-off ferries, or fishing boats (trawlers).

**Convertible multifunction vessels.**

***Dredgers.*** A total of ten dredgers were adapted for skimming oil at sea. That more than half of them are found in the Netherlands is explained by the large dredging work which exists in this country and by the fact that the dredging work is done under the authority of the Dutch public works department (Rijkswaterstaat) which is also responsible for pollution response interventions. This dual responsibility for the dredgers avoids any conflict of interest and facilitates the dredgers availability in the event of a pollution response. A contract for immediate availability by the same administration is able to supersede a previous contract made with a private company.

These vessels present two main advantages:

- rapid availability since they can instantly dump their load in the estuaries where they work, and need only a quick stop to be equipped with a skimming mechanism if such a mechanism has not already been installed on board
- a large storage capacity that enables a simple settling process to separate the oil/water mixture and that allows a nonselective high-flow-rate skimming system to be used.

Among the equipment found on board the inventoried dredgers (see Table 4), were two skimming systems:

- the Sweeping arm equipped with an easily used submersible pump that insures a flow rate of 500 $m^3/h$.
- the Soopress system which requires a more complicated installation (the hull must be cut into) but which then no longer requires a transfer pump since the oil slick flows directly into the dredger's tank.

The use of other skimming systems with this type of vessel seems less effective since there is little need to consider storage limitation once the oil/water mix has been skimmed.

Finally, using a dredger presupposes that the safety regulations have been observed for the dredger to be considered an oil recovery vessel. Certain security modifications need to be installed. For example, the Dutch dredgers that are appropriately equipped to be used in oil spill response all possess a manual specifying all the steps to be followed to short-circuit dredging operations and to work in full safety by putting the anti-incendiary systems into operation.

***Coastal tankers.*** Despite a large storage capacity, equal to or greater than that of the dredgers, only one nation uses coastal tankers. They are much less easily available due to their economic function and require a longer preparation time since they must be unloaded and their tanks must be gas-freed.

***Supply ships.*** Vessels designed to supply offshore drill rigs and platforms are often used for oil spill response at sea (see Table 5). These vessels have several advantages:

- easily available, good compatibility with the various other functions which they fulfill (help, rescue, towing, marking, survey, supply, research) and, because of these other functions, the ships are often found close to the high risk areas for oil spills
- large work area on the rear deck enables these vessels to carry the equipment necessary for confining and skimming oil and to facilitate putting this equipment to work
- high maneuverability and the possibility of working at reduced speeds

**Table 3. Vessels permanently converted for oil spill response at sea**

| Type of vessel | Quantity | Name<br>Nation<br>Date<br>Converted | Storage capacity ($m^3$) | Oil skimming equipment | Other functions | Dimensions<br>L × l × d (m)<br>Limits for use |
|---|---|---|---|---|---|---|
| Land fill carrier | 2 | *Small Act*<br>Netherlands<br>1977 | 440 | 2 Sweeping Arms (13 m)<br>1 separator | | 54 × 9, 5 × 3,5<br>swath: 35 m<br>sea state: 4 |
| | | *Seaspring*<br>U.K.<br>1976 | 600 | Spring Sweep<br>(troilboom) | Oceanographic research | 60 × 12 × 4 |
| Oil tanker | 1 | *Svetlomor*<br>U.S.S.R.<br>1980 | 8,000 | Direct flow into hull<br>SWRBS system<br>heated tanks<br>separator<br>boom | Cleaning tanks and motors of other vessels<br>Deballasting<br>Collecting slops | 150 × 18 × 8,4<br>wave limit: 2 m |
| Roll-on/roll-off | 2 | *Forth Explorer*<br>U.K.<br>1981 | 1,580 | 2 Vikoma skimmers<br>Thune Eureka pump<br>Heated tanks<br>Crane<br>Small dingles<br>Vikoma boom | Pollution response<br>dispersion,<br>transportation of amphibious equipment | 76 × 13 × 4<br>wave limit: 3 m |
| | | *Hylje*<br>Finland<br>1981 | 860 | Direct flow into hull<br>Heated tanks<br>Separator | Transportation of heavy loads<br>Collecting slops<br>Deballasting | 50 × 12,5 × 3<br>wave limit: 1 m<br>wave limit: 10 kt |
| Purseine | 4 | —<br>Norway<br>— | Not specified | Not specified | Not specified | L: 45 to 60 m |
| Trawler | 1 | *Clean Seas*<br>U.K.<br>1981 | 200 | Spring Sweep<br>(troilboom) | Not specified | 39 × 8 × 35 |

**Table 4. Dredgers temporarily converted for oil spill response at sea**

| Nation | Quantity | Name<br>Date converted | Storage capacity ($m^3$) | Oil skimming equipment | Dimensions<br>L × l × d (m)<br>Limits for use |
|---|---|---|---|---|---|
| Germany | 1 | *Nordsee*<br>1983 | 5,400 | 2 Sweeping Arms<br>(22 m) | 132 × 23 × 7<br>Swath: 61 m |
| Japan | 1 | *Seiryu Maru* | 1,500 | 2 Cyclonet<br>2 Mitsubishi | 95 × 16 × 5,5 |
| Netherlands | 6 | *Cosmos*<br>1980 | 6,300 | 2 Sweeping Arms<br>(20 m) | 113 × 20 × 7,5<br>Limits: wind: Force 6<br>wave: 1,5 m<br>Swath: 55 m |
| | | *Rijndelta* | 3,550 | 2 Sweeping Arms<br>(13 m) | 113 × 18 × 8 |
| | | *Cornelia* | 6,400 | 2 Sweeping Arms<br>(20 m) | 113 × 20 × 7,5 |
| | | *Geopotes 14*<br>1984 | 6,600 | | 124 × 20 × 7,6 |
| | | *Lesse* | 1,540 | 1 Sweeping Arm | 70 × 13 × 5 |
| | | *Hein*<br>1982 | 2,860 | 2 Sweeping Arms<br>(13 m) | 78 × 13 × 5<br>Swath: 35 m |
| U.S.S.R. | 2 | *Professor Goryunov*<br>1986 | 4,700 | Soopress system | 110 × 20 × 6,5<br>Swath: 60 m<br>Limits: wave: 3 m<br>wind: 15 m/s<br>current: 2 kts |
| | | *General Vayda Ghubsky*<br>1986 | 8,000 | Noas U-shaped boom and Framo ACW 400 skimmer | 132 × 22 × 8,5 |

- good transit speeds
- large integrated storage capacity—1,000 $m^3$ or more.

***Sea trucks.*** In Denmark and Sweden, sea trucks are the main type of vessel in the pollution response fleet. Their main advantages are:

- good maneuverability (bow thrusters)
- large enough work space to enable a storage of equipment and room to set up the equipment and put it to work
- able to function in shallow waters and dock to unload equipment.

However, these vessels have a relatively small storage capacity (60 to 120 $m^3$) even when portable tanks are installed on deck.

## Inventory of skimming equipment used for oil spills at sea

Most equipment is a boom-skimmer system in which a boom element concentrates the slick before it is skimmed by a device at the rear of the boom. The skimming device is generally composed of a pump that moves the oil towards a storage capacity. Suction may occur in a weir whose sill limits the thickness of the surface to be pumped. This type of skimmer is used in France (Sirene 20), in the U.S.A. (Sock, Skimming Barrier), in Great Britain (Weir Boom, Spring Sweep), in Holland and Germany (Sweeping arm), and in Norway (RO-FI oil trawl, Transrec).

Boom-skimmers offer many advantages:

- a large sweeping width concentrates thin slicks for easier pumping
- flexibility enables them to remain effective even when the sea is choppy
- powerful pumps adapted to the viscosity of a given spill can be used.

However, boom-skimmer systems require a speed on the order of 1 to 2 knots to avoid oil leaks. This means they can only be used effectively with vessels able to function at reduced speeds—a difficult condition to fulfill except with specialized vessels such as supply ships. For this reason, it is often preferable to have a boom skimmer pulled by only one ship using a jib, rather than have the system towed by two or three vessels. In addition, this type skimming is poorly selective which means large storage settling tanks are needed.

This type of device can also be used with skimming ships where the pumping of a surface layer is replaced by a direct skimming ships where the pumping of a surface layer is replaced by a direct flow vessel via an opening in the hull. The opening may be located at the level of the water surface (Soopress in Norway) or several meters under the surface with a hose attached to a floating weir system (ESCA in France).

The advantage of this particular system is related to the absence of a pump. It will function equally well for light oils and for viscous, solid waste. However, this system must be used in conjunction with vessels having a large storage capacity (oil tankers, dredgers, large trawlers) which have been previously equipped with the hull-opening recovery system or have been specifically designed for the job (*Thor, Bottsand,* and *Eversand* in Germany).

A third type of skimming device uses the effect of a Vortex (or Cyclone) to concentrate the oil slick before pumping it from the water surface. These devices can be dynamic (Cyclonet in France) or static (Walosep in Sweden).

**Oleophilic skimmers.** For use at sea, these skimmers are generally divided into three categories according to the shape of the oleophilic surface: disks, drums or ropes.

The disk skimmers are designed for a semistatic use and only their size and the fact that they are used from a sea-going vessel allow them to be defined as high sea skimmers. The best known are the Norwegian devices (Framo and Thune-Eureka), the British (Vikoma Seaskimmer) and the American (Clean Sweep). It is advisable to use a confining boom in association with these devices. The performance of most of these skimmers can be improved if they are used in conjunction with a weir. This increases the rate of elimination of thick slicks but reduces the selectivity of the skimmer.

The Lori Brush System was designed to be integrated in the support vessel and associates a deflecting boom to increase its sweeping width.

The oleophilic drum skimmer Stopol (France) is more similar to the boom skimmers than to the disk skimmers described above.

## Possibility and advisability of adopting foreign oil spill response solutions in France

It is impossible to imagine that France would totally adopt a foreign nation's solutions since each nation has devised solutions that corre-

**Table 5. Supply ships temporarily converted for oil spill response at sea**

| Nation | Quantity | Name<br>Date | Storage capacity ($m^3$) | Oil skimming equipment | Other functions | Dimensions L × l × d (m)<br>Swath |
|---|---|---|---|---|---|---|
| Denmark | 2 | *Gunnar Thorson*<br>1981 | 315 | Ro boom<br>Destroil skimmer | Rescue<br>Towing<br>Oceanography<br>Fire<br>Marking | 56 × 12 × 4 |
| | | *Gunnar Seidenfaden*<br>1981 | | ACW400 Framo | | |
| Germany | 2 | *Mellum*<br>1984 | 1,040 | 2 Sweeping Arms (15 m)<br>1 ACW 400 Framo<br>1 Walosep<br>1 Jastram separator | Marking<br>sea lane surveillance<br>Rescue<br>Lightening | 71,5 × 15 × 5,8<br>41 m |
| | | *Scharhorn*<br>1981 | 580 | 1 Ro boom<br>2 Sweeping Arms (13 m)<br>1 Jastram separator | Fire | 56 × 14 × 4,2<br>36 m |
| Netherlands | 1 | *Volans* | 300 | 1 Sweeping Arm | Oceanography | 48 × 10 × 3 |
| Norway | 20 | *Nofo* | 1,000 | Transrec Nofo/<br>Framo system | Offshore supplying | Swath: 250 m |
| | 5 | *SFT* | 1,000 | Foxtail skimmer | Not specified | |
| U.S.S.R. | 6 | *B92*<br>1984–1987 | Being improved | Not specified | Towing | 81 × 16 ®x 4,75 |
| | 4 | *Svetlomor*<br>1988 | 625 | Ro boom<br>2 Destroil DS 250 | Fire<br>Rescue<br>Deep sea diving | 61 × 52 × 4,5 |

spond to its particular needs, constraints, and facilities. However, we can envision France's adoption of certain aspects of other nations' solutions whether it be the naval means or equipment used to recover oil spills at sea.

It is important to distinguish between the specifically designed skimming vessels and those which are permanently or temporarily converted for the job.

- Regarding the specifically designed vessels, without considering their limits for use at sea off the French coast, we should question whether or not these vessels are preferable to nonspecifically designed ships with permanently installed skimmers and having the same storage capacity. The converted vessels are often equal to the especially designed ships in terms of performance and limitation for use; however, they often represent a lower financial investment.
- Also the vessels built for oil spill response were designed for specific geographic and oceanographic conditions, in Germany and the Netherlands, for example. Unlike France, these nations have a relatively short coast line which would allow only one vessel—providing it were based at a strategic location—to cover nearly all that nation's territorial waters in a short time period.

For France, the extent of the coast suggests that the vessel should be based in the area statistically most threatened although the broken coast line and choppy seas (reefs, currents, swells, winds), could limit the specific vessel's ability to intervene effectively. It should be noted that the swells of the North Sea are smaller than those of the Channel and the Atlantic Ocean.

As far as the permanently or temporarily converted vessels are concerned, the difference between the two types is that the temporarily converted vessels are also used commercially while the permanently converted vessels are almost always limited to pollution response activities. The major problem encountered for the permanently converted vessels is that the economic investment cannot even partially be repaid by a commercial use. This will have the consequence of limiting this solution to medium sized ships having a subsequently lower storage capacity.

There may be a few exceptions to this if the converted vessels could also be used for commercial functions such as collecting slops. The regulations imposed by the Marpol Convention could lead to the use of oil spill pollution response vessels in port areas where there are insufficient land based slop treatment centers. It should be noted that this commercial function could also be accomplished by the specifically designed oil spill skimming vessels previously discussed.

Among the vessels which are permanently or temporarily converted, four main types can be distinguished: supply ship, dredger, coastal tanker or sea-truck.

**Sea trucks.** The major drawback of sea trucks is limited storage capacity; therefore, they cannot be relied upon for a large scale spill. However, they can be very helpful in association with one or more larger vessels if the spill is located in shallow waters or to unload equipment on islands or other areas that are accessible only by sea.

**Coastal tankers.** By definition, coastal tankers are the best vessels for carrying and storing oil (on condition that the vessels are equipped with heating tanks if the oil is extremely viscous). However, such vessels are not readily available if their primary mission is other than pollution response. When a tanker's primary function is commercial use, it will take one or two days before such a tanker is ready to be used for oil spills at sea. A two-day delay is acceptable in some areas where the oil slick will stay at sea, but this is not the case for an area such as the Channel. Also, to use vessels only temporarily, it is necessary that they be equipped with sufficient room for installing skimmers, and only vessels which regularly travel in a given area could be taken into consideration. Thus, it may often happen that these vessels cannot be used in the open sea; however, they could be helpful for a spill in the estuaries where they normally navigate.

Using coastal tankers for oil spills could be envisioned if they were permanently converted for this type of work, but this entails a high price for their use and maintenance which cannot be repaid through any other activity. The only use for a tanker is the storage and transport of petroleum products, and this function is incompatible with a need for almost immediate availability in the event of a spill. Also, the tanker is not a good support ship for the skimmers and for skimming activities. At the reduced speeds required for this activity, it must often be towed. So, it may be preferable to use self-propelled barges, which will be less expensive to purchase and run, or to orient the choice towards vessels with other functions than the recovery of oil slicks while also being easily adapted and quickly available for oil spill work.

**Dredgers.** As far as dredgers are concerned, foreign experience has confirmed that these vessels are useful for a rapid intervention near their normal working areas. In France, as elsewhere, using such vessels in estuaries could be possible under certain conditions—such as defin-

ing in advance the conditions which would enable the Navy to call upon the dredgers for assistance, and resolving the problems with regulations for oil transportation.

Current regulations are such that it is particularly impossible to use the dredgers functioning at this time for recovering and storing oil; however, it is also possible to plan to install the required equipment when new dredgers are built.

All the above considerations lead us to see that, of the four types of vessels which could be converted for oil spill response activities, supply ships generally seem to be the most advantageous, on condition that they possess adequate storage space and that pollution response to oil spills is defined as one of their main functions. Requirements formulated in Norway provide useful guidelines for equipping supply ships.

## Conclusion

The primary limitation in the current French pollution response system for recovering oil spills at sea is the absence of any vessels whose main vocation is pollution response and who possess a storage capacity of several hundred cubic meters of oil. An analysis of the various solutions adopted in other nations and the adaptability of these other solutions to the needs and limitations imposed in France has shown that, without considering the question of performance, a specifically designed vessel should be compared to one involving a converted vessel equipped for skimming floating slicks and for storing oil on board.

Among various vessels which could be converted, supply ships seem the most advisable provided that they possess adequate storage capacity and that their primary function becomes pollution response.

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