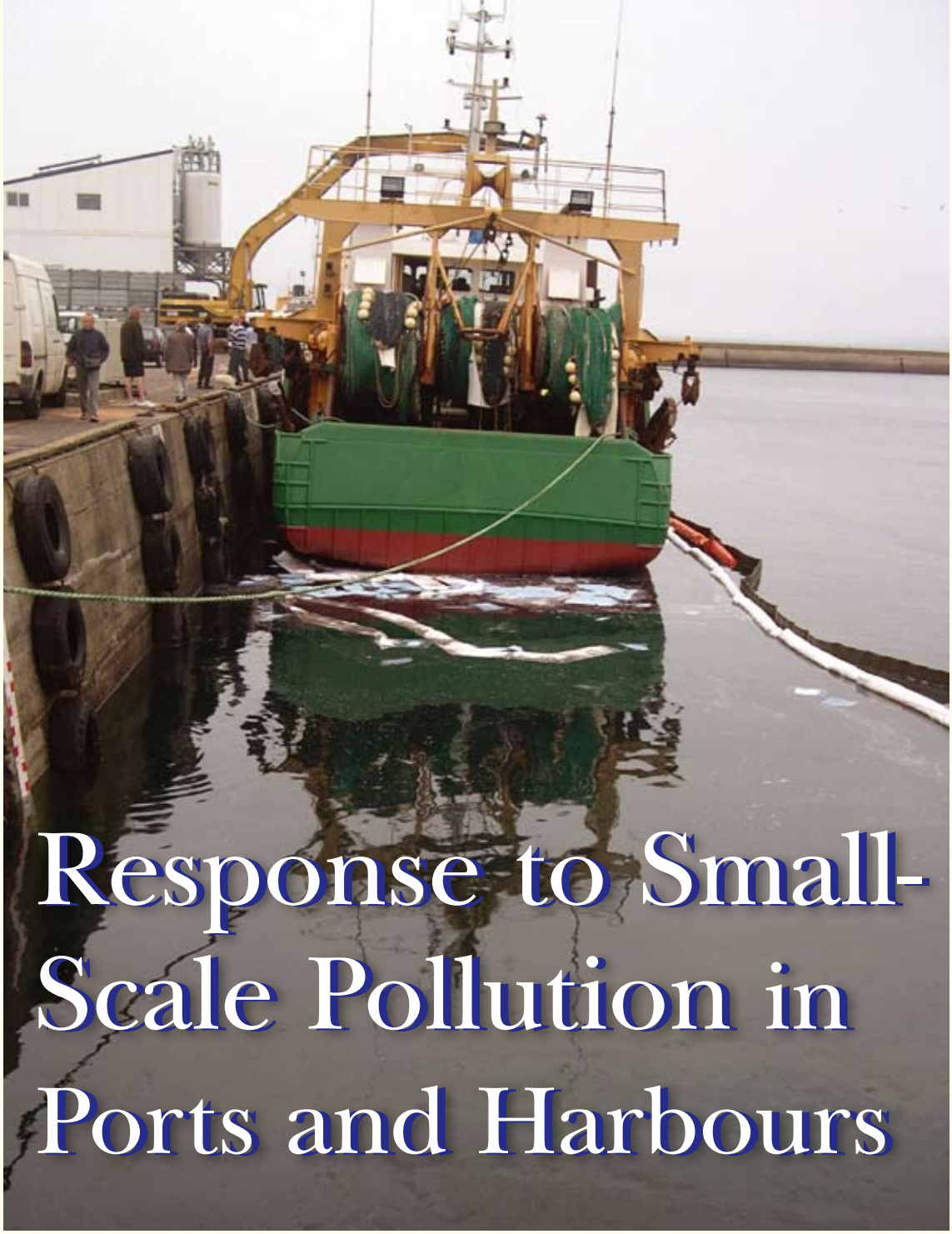

Response to Small-Scale Pollution in Ports and Harbours

OPERATIONAL GUIDE

Cedre

Cover photo: containment of a diesel spill around a fishing boat
Source: Cedre

Response to Small-Scale Pollution in Ports and Harbours

OPERATIONAL GUIDE

This guide was designed and written by *Cedre* with financial support from the French Ministry of Transport and the Ministry of Defence.

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Translated and adapted from the French version published in January 2007 by Sally Ferguson.

Purpose of this guide

Many ports, harbours and marinas are relatively poorly equipped to respond to small spills which may occur on land or on jetties or piers and pollute their channels and basins. River ports, military ports and waterways also present similar risks. Response means are often limited and the knowledge of efficient techniques to combat such pollution incidents could often be improved.

These incidents vary greatly in origin and type. Particular reference can be made to spills caused by bunkering, deliberate or accidental discharge of bilge water, pollution due to shipping accidents, spills caused by failure of industrial installations or port infrastructures (storage facilities, pipes...) or road or rail accidents, solid waste due to activities near water bodies, and run-off from sewer systems or drainpipes into water basins.

This guide aims to provide operational answers to all the questions which responders may have on the choice of response techniques and materials suitable for small pollution incidents in ports and harbours. It is designed for officers and agents working in ports, the fire service, technical support personnel for ports and harbours, oil depot personnel, crews of fishing boats, pleasure boats, military and commercial vessels...

It describes response procedures and techniques which can be implemented to combat pollution incidents, through scenarios and experience feedback. A list of the most suitable and commonly used equipment is provided.

This guide proposes options which can be considered, however it is important to bear in mind that the solutions presented are designed to be able to be rapidly and easily implemented, in order to respond to a relatively small volume of pollutant.

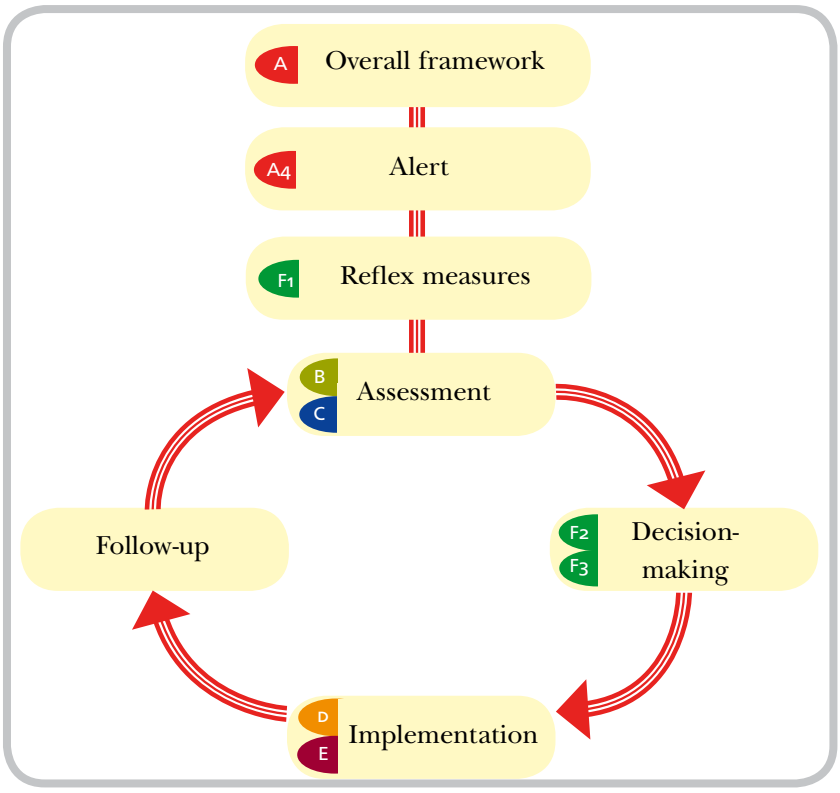
Contents

Introduction to pollution response in sea ports

A

Response in context

Response to small-scale pollution in ports and harbours is not restricted simply to the intervention phase. Although this is the core phase, it can only be carried out once all relevant bodies have been alerted, any "reflex measures" have been implemented, the situation has been assessed and research has been conducted on the behaviour and impact of the pollutant, the available response means, the sea and weather conditions and the protection of response personnel. This information is gathered during the assessment stage and is used to determine a suitable response strategy. Following response, the evolution of the situation must be monitored to establish a new assessment in order to fuel the decision-making process.



Experience of previous accidents has shown that operations to combat a pollution incident in a port or harbour can involve many participants from both public and private sectors. However, pumping operations are almost always assigned to industrial cleaning service companies equipped with sanitation trucks, or even companies specialised in pollution response operations.

The various actions which must be shared out between the different agents can be divided into:

- main actions
- secondary actions
- additional actions

A diagram illustrating the possible distribution of these different actions can be found in section A4.

Contingency plan or response procedures

A2

In the event of a spill, the execution of various activities in a port or harbour requires a quick and predetermined response. The port authorities should therefore possess a contingency plan or at least a series of procedures to respond to pollution. These plans or procedures should aim above all to ensure the safety and protection of personnel, the environment and equipment in terms of risks of fire, explosion or pollution and the toxicity of the hydrocarbons or chemicals spilled or of the vapours.

This contingency plan or these response procedures should outline at least the following:

1) Response organisation

- Scale of seriousness
- Emergency procedures and alert system
- Identification of pollutants and associated risks (toxicity, flammability, persistence...)
- Mobilisation of responders
- Mobilisation of means and possibility of increasing the resources available

2) Response strategies

- Reflex measures (safety, reduction of spreading...)
- Report and sampling (for technical and/or legal requirements)
- Protection, containment or trawling using booms
- Recovery using sorbents or by skimming and pumping
- Clean-up of infrastructures and polluted vessels
- Management of waste recovered
- Main pollution response equipment

Main actions	Secondary or joint actions	Additional actions and comments
Alert by the polluter or a witness, or reporting/ observation of the spill	• Closing, plugging, disconnection at the source as soon as possible	• Beginning of recording of the information • Activation of the contingency plan if there is one
Reporting/observation of the pollution on land or on the water	• Accurate identification of the pollutant • Assessment of risks and possible evolution of the situation • Alerting of the authorities and responders • Estimation of the volume/surface area	• Search for polluter and giving of formal notice if identified • Collection of samples, evidence, photos etc. • Establishment of a formal report (by a qualified police officer)
Determination/search for the origin/cause/source	• Marking out and ensuring safety of the area on land and on the water	• Giving of formal notice to the polluter to stop the pollution or to intervene
Reduction or prevention of spreading towards the water	• Response actions on land: protection, dyking, pumping, absorption, collection, storage, clean-up, waste treatment...	• Intervention in principle by fire service, or alternatively by polluter or company called upon by polluter or authorities in charge of operations
Reduction or prevention of spreading on the water surface	• Response actions on the water: protection, containment, trawling, absorption, or natural dispersion	• Intervention in principle by fire service or specialised company
Recovery of the pollutant from the water	• Response actions on the water: absorption, concentration/ thickening and pumping of the slick	• Probable intervention of a specialised company or the port's technical support services
Storage/transfer of the pollutant for subsequent treatment	• Waste storage and treatment	
Restoration of the site	• Clean-up of polluted infrastructures • Treatment of affected ground	
End of intervention		
Documentation and feedback		• Preparation of the legal case, assessment of cost of intervention and damages for transmission to the polluter or his insurer

Table showing the different possible response actions

The specificities of small-scale pollution in ports and harbours

B

Sources and transit of liquid pollution

The potential sources of pollution in ports and harbours are numerous. Furthermore, such water bodies are sometimes located downstream of water catchment areas and are a natural collection point for many types of pollution from outside of the port itself, and sometimes even from relatively far away.

These sources include leaks from storage facilities or pipes, spills during hydrocarbon handling operations (such as bunkering fishing or pleasure boats or similar operations on land) or transfer of chemicals. Pollution can also be caused by incidents on industrial sites, collisions between vessels as well as road or rail accidents, shipwrecking, fire onboard ships in dock and so-called "chronic" or "illicit" discharge often due to negligence (release of bilge water for instance). All types and sizes of solid waste from port areas (vessels or industrial or commercial establishments) and nearby urban areas, or their hinterland via rivers or channels, can also be possible sources of pollution.

This diversity may seem difficult to accommodate, however preventative examination can simplify and facilitate first response actions, thanks to improved prior knowledge of the risks involved:

- mapping (for the "catchment area" of the port in question) of the sites where hydrocarbons and/or chemicals are handled or transferred (bunkering facilities, industrial sites...)
- mapping of existing storage sites (for example all storage sites with a surface area greater than 10 or even 5m^3), including buried storage facilities for domestic/heating fuel
- up-to-date map showing the course of any pipelines (aerial, buried or underwater) in the port area
- detailed map of the sewer system and rainwater drainage systems (drainage ditches, streams...) in the port area
- all other information (maps or documentation) which may be used to list potential sources of pollution or the routes taken by liquid pollution:
  - in the waterways flowing into the port basin
  - underground, and amongst other things the contact details of local hydrogeologists.

This information and all other similar elements relating to possible sources of pollution can be added to the port's contingency planning database. In this way, in the event of a pollution incident, even if the origin of the spill cannot be immediately identified, the search for the source is greatly facilitated.

Finally, it is important to note that liquid pollution on the surface of a waterway or water body will be likely to strand in natural areas of accumulation where solid waste regularly washes up. When pollution is detected, it is often advisable to visit these generally well-known sites to check for the presence of liquid pollution, and begin clean-up where necessary.

Port infrastructures and pollution

B2

Cleaning riprap and the harbour basin as a result of pollution by heavy fuel oil. Port de la Turballe, France.

Cleaning riprap under a wharf on piles in a port with a large tidal range.

Quays and wharfs

A general distinction can be made between quays with solid foundations and wharfs constructed on piles. Wharfs, like piers and jetties, are liable to be polluted underneath, sometimes depending on the tidal range and movements. Such structures should therefore be protected with booms or sorbents deployed in front of them to prevent propagation of a pollutant in this area, as cleaning underneath wharfs and piers is a complex and delicate operation (requiring divers, pontoons and specialised equipment).

Riprap

Riprap (embankments, jetties, underneath quays) is often designed to act as a breakwater, as only a small volume of water can pass through the boulders. However, a pollutant can therefore also penetrate these boulders and may only be released gradually, with the following tides or due to wave action, causing the pollution to remain in the water. Riprap (as well as stone embankments) should be protected from the impact of surface pollution, as cleaning such structures is particularly complex and costly.

Slipways, pontoons and locks

Slipways and locks are other sensitive sites where protection should be a priority in ports and harbours as they are essential elements for the use of the port, including during pollution response operations. It is also advisable to protect pontoons as cleaning them, like for riprap and wharfs, is a delicate operation.

Most frequently spilled pollutants, their behaviour and the risks involved

C

The pollutants most commonly spilled in ports and harbours belong to the following families of products:

- diesel and similar products: light marine diesel, marine diesel oil (MDO), domestic fuel oil, fuel residue...
- heavy products: heavy fuel oil (for boilers or bunker fuel – IFO 180 or 380 – Intermediate Fuel Oil with a maximum dynamic viscosity of 180 or 380 centistokes at 50°C); heavy, medium or light crude oil; lubricating oil, often used; vegetable oil...
- petrol and similar products: motor vehicle petrol, premium petrol, super unleaded, super unleaded 95, super unleaded 98, kerosene, JET A1, jet fuel...
- potentially hazardous chemicals or petrochemical substances, in particular acids (sulphuric, hydrochloric, phosphoric, nitric or acetic acid), bases (ammonia, soda), fertilisers and phytosanitary products (pesticides, insecticides, weed killer), petrochemical products...

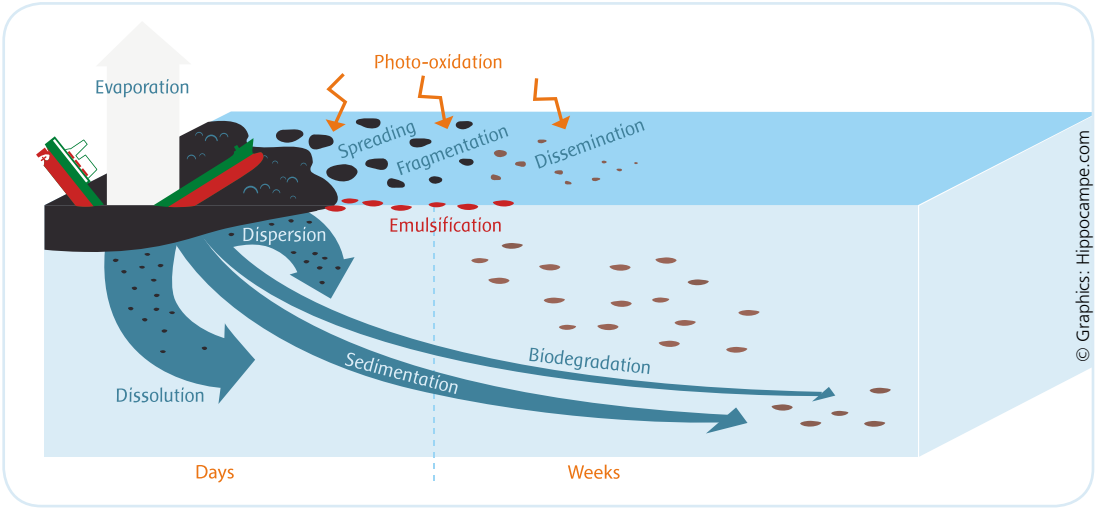
When spilt in water, hydrocarbons and chemicals are subjected to the prevailing conditions (air and water temperature, wind, current, agitation of the water surface...) and transform at varying rates. This phenomenon is known as weathering.

During the first few hours, the volatile parts of the product spilled may evaporate and the substance may float and spread out to form a film of varying thickness, dissolve or sink. However, nearly all refined hydrocarbons float, spread out and evaporate to a varying extent. Dissolution of such products remains limited. They can quite frequently sink and be deposited on the bottom after adsorption by matters in suspension present in the water in ports and harbours. A few rare hydrocarbons, heavier than water, also sink as soon as they are spilt. In the case of chemicals however, their behaviour varies greatly and can only be studied on a case by case basis, as many chemicals dissolve, float, sink or evaporate, or combine several of these properties.

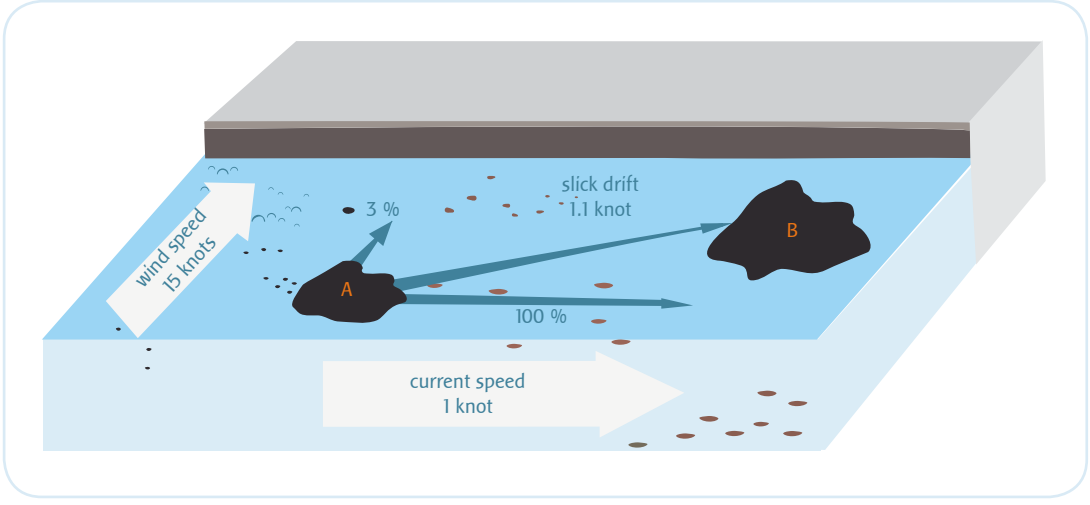
Over and above the very nature of the product, external elements may also promote evaporation, including the wind speed and the air and water temperature. Agitation of the water surface depends on exposure to the wind and on the wind force, and can cause the pollutant to naturally disperse in the water column or on the other hand lead to the formation of an emulsion (known as a "reverse emulsion") between the product and the water, according to the type of pollutant.

Secondary transformations include oxidation and biodegradation. These processes are slow and need only to be taken into consideration after several weeks.

As the floating pollutant weathers, it drifts on the water surface and is subject to the action of winds and currents. The prevailing sea and weather conditions can cause it to accumulate against quays, vessels, riprap or embankments. When it has dissolved in the water column it is no longer subject to action of the current.



Evolution/weathering of a pollutant spilled in water.



Speed and direction of drift of a pollutant on a water surface, influenced by wind and current. The slick drifts at 3% of the wind speed and 100% of that of the current.

Diesel and similar products

C1

Behaviour

The behaviour of diesel or a similar product spilt in water depends on the exact nature of the product which can vary in composition, density and volatility. Diesel always floats, as it is far lighter than water: its density is most often between 0.82 and 0.87. Its behaviour depends above all, and to a great extent, on the wind force, the agitation of the water surface and the air and water temperature. In ports and harbours which are mainly calm and relatively sheltered from the wind, natural dispersion is limited, even in quite strong winds. Diesel therefore mainly evolves by spreading and evaporating. This evaporation usually, other than in exceptional meteorological conditions, affects 20 to 30% of the spill in the first 6 to 12 hours, 30 to 40% after 24 hours, 40 to 50% between 2 and 4 days after the spill and less than 60% after 7 days (according to weathering tests carried out in seawater by *Cedre*, average water temperature: 14°C, average air temperature: 17°C).

If diesel spilt in a waterway or water body is subjected to considerable agitation (due for example to wind or waves), it can emulsify by mixing with water which it retains, giving it an appearance resembling a mousse. This phenomenon is highly problematic when it comes to response operations, as it makes absorption of the diesel by sorbents very difficult. Whether the sorbents are oleophilic or hydrophobic they will absorb a diesel/water mixture less easily than pure diesel.

Risks

At ambient temperatures, the risks of fire and explosion for response personnel are relatively limited, due to the product's low volatility (flash point higher than 50°C). However, this risk should not be completely ignored in high temperatures or if the spill is in a unconfined area.

It is advisable to wear Personal Protective Equipment (PPE) suited to hydrocarbons to prevent contact with the skin and possibly inhalation of vapours.

The risks for the environment are mainly related to the certain toxic compounds dissolving in the water column and droplets of hydrocarbon being dispersed by wave action.

Diesel spreads very rapidly on the water surface to form a very thin film of a few microns to a few tens of microns in thickness, except if natural retention stops it from spreading. The presence of grey-silvery sheen, rainbow colours and slicks with a metallic appearance indicates that there are no more than 5 centilitres per square metre covered, i.e. from a few litres to a maximum of 500 litres per hectare.

Heavy products

Recovery of heavy fuel oil on the water surface using bulk sorbents and landing nets during an exercise at Cedre*'s technical facilities.*

Behaviour

Heavy products (crude oils, lubricating oils, vegetable oils, heavy fuel oils, bitumen) are characterised by a high viscosity and density in relation to petrol or diesel. These properties affect their behaviour when spilt in water. All these floating substances spread and can form slicks which can sometimes reach several tens of centimetres in thickness in the case of a large spill. This compact state slows down and reduces natural elimination processes such as dispersion or evaporation.

Experience shows that chemical treatments (such as dispersion) very often prove useless in the case of heavy fuel oils or bitumen. Their viscosity is generally high and thus sorbents and pumping operations are of limited efficiency. If the water surface is agitated, these products will tend to form an emulsion with water and even air, thus creating a mousse which cannot easily be absorbed by sorbents and complicates pumping operations. Furthermore, these heavy products stick to rocks and concrete structures and can prove resistant to even the most energetic attempts at clean-up.

Their density is close to that of seawater, therefore reducing their buoyancy. In ports and harbours, where the presence of matters in suspension is high, it is not uncommon to observe slicks of heavy substances being submersed, facilitated by the adsorption by particles in suspension.

Risks

The toxicity of a product is directly linked to its chemical composition and more specifically to its proportion of light aromatic compounds. Thus, amongst heavy products, the most toxic pollutants for the environment are light crude oils.

Furthermore, in the event of a spill of these products which can give off hazardous vapours, it is of vital importance to wear masks and personal protective equipment.

Certain crude oils which have a low flash point can present serious risks of fire or even explosion. In this case, see the paragraph entitled "Risks" in section C3, on the following page.

Fuel oils and heavy bitumens are slightly toxic for the environment, as light compounds are present in small proportions. However, due to their high viscosity, they have a significant impact on flora and fauna by smothering.

The risks of these products for humans are mainly linked to toxicity by contact. During clean-up operations, the main means of exposure is contact with the skin and mucous membranes. It is therefore essential to avoid all contact by wearing PPEs suitable for hydrocarbons. It is advisable to wear breathing apparatus when cleaning using high pressure or hot water because of the production of spray and vapours.

Petrol and similar products

Behaviour

Petrol spilt on the water surface floats, spreads and evaporates quickly. Petrols are light products (density of around 0.75) with a low viscosity, which evaporate almost entirely in the first six hours after they are spilled. Around 75 to 85% of a petrol slick will evaporate from the first hour after the spill.

In ports and harbours which are mainly calm and relatively sheltered from the wind, natural dispersion is limited, even in quite strong winds. However, as petrols are naturally rich in aromatic compounds, molecules which are recognised for their solubility and toxicity, the hydrocarbon content in the water column will be significant. The less the water in which the product is spilt is renewed, the more significant this phenomenon will be.

Risks

The risks generated by a significant petrol spill are particularly important for response personnel. They are linked to the production, by the petrol slick, of toxic and above all extremely flammable vapours. The flash point of this type of product is lower than ambient temperature and the risks of fire and explosion are therefore high.

If the vapours form a persistent cloud, it may come into contact with a source of ignition or of heat (vehicle with engine running, electric appliance or machine switched on, cigarette...) and take fire, or even explode.

Due to these risks, the possibility of containment and recovery should be put aside and evaporation and natural dispersion of the slick should be promoted, for example by mixing the pollutant on the surface using a fire hose with a solid jet. Nevertheless, if the slick is liable to drift towards sources of heat or an urban area, its deflection and containment remain response options which should be taken into consideration. In this case, use flameproof materials, contain where possible with a fireproof boom and cover the slick with a carpet of foaming agent (low to medium expansion) to reduce the formation of inflammable vapours. The product can then be recovered using a floating suction head, suitable for recovering the pollutant from under the carpet of foam (lightweight flat suction head, see section D3). The storage tank for the recovered pollutant will also present risks of release of flammable or explosive vapours. It is therefore important to restrict this release of vapours and ensure the absence of sources of heat in the area.

It is advisable to wear Personal Protective Equipment (PPE) suitable for hydrocarbons to prevent contact with the skin and possibly inhalation of vapours.

From an environmental point of view, a spillage of such a product generates the presence of toxic molecules in large quantities in the water column. In turbid waters, these molecules will become combined with matter in suspension and will then settle. Furthermore, most additives present in petrols, and in particular in unleaded petrol, are also toxic.

Potentially hazardous chemicals

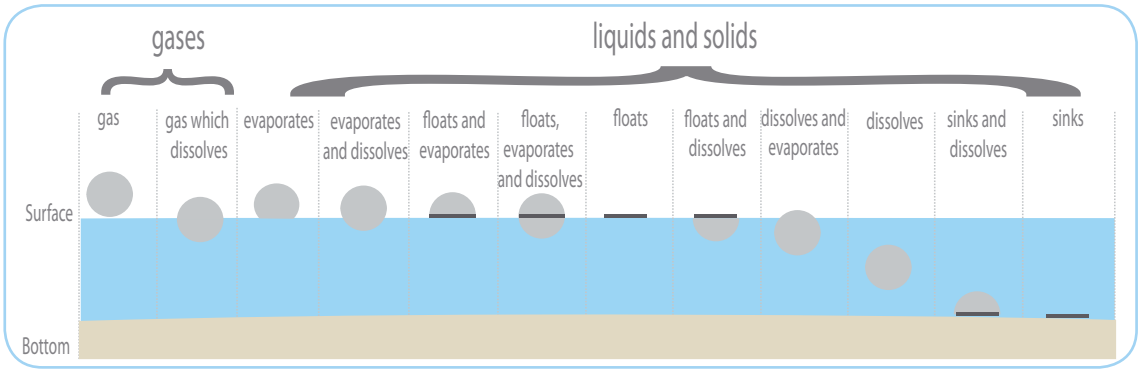
Behaviour

Hazardous chemical substances are defined as such due to their harmful properties for human life, equipment or the environment. They are differentiated from hydrocarbons by the 1973 International Convention for the Prevention of Pollution from Ships (MARPOL 73/78).

Chemical spills present far more varied risks than oil or petroleum product spills due to the variety of products transported (tens of thousands of different substances transported worldwide). Thus the consequences of chemical pollution depend on the type of spill (quantity, rate of leakage...), local circumstances (weather conditions in the area, geography of the site infrastructures...) and the physico-chemical properties of the pollutant (solubility, vapour pressure...).

In terms of behaviour in the aquatic environment, reference should be made to the Standard European Behaviour Classification (SEBC), based on the behaviour of chemicals spilt in water. This classification divides substances into four main groups, as follows: evaporator (E), floater (F), dissolver (D) and sinker (S). It is established based on the main physical and chemical properties which characterise a given substance, which are: the state of the substance (solid, liquid, gas), the density compared to that of water, the vapour pressure as well as solubility in water. A thorough knowledge of this classification can help to define then to implement the most appropriate response methods and those which are best suited to the product spilt.

C4



Different possible behaviours of chemicals (SEBC).

Risks

In order to protect human life, to choose the most suitable response options and to assess the impact of chemical pollution on the environment, it is important to estimate the immediate reactivity of the substance spilt as well as its behaviour in the aquatic environment. It is therefore necessary to acquire information on its chemical, physical and toxicological properties.

Concerning the reactivity of chemicals, it is of utmost importance to identify their ability to chemically alter themselves, by processes which may be endothermic or exothermic, so as to define the possible response approach in the event of a spill. The first element which must be evaluated is the substance's capacity to react with:

- oxygen in the air (problem of release of heat which could cause an explosion)
- itself (risk of polymerisation reactions which could easily progress rapidly)
- the water (some products can go on fire, explode, become toxic or even become highly corrosive to materials, all the more problematic as water is very often used to fight fires onboard vessels)
- other substances amongst the cargo (a chemical when in contact with another may lead to violent chemical reactions causing fire or explosion, or produce toxic gases which may be harmful for the ship, the crew or responders).

Cedre publishes a series of chemical response guides. These guides can be used during emergency response in the event of an incident involving hazardous substances liable to cause water pollution.

Chemical response guides published by Cedre.

Containers and packages

Although pollution in ports and harbours usually involves liquids, or sometimes solids (bulk products such as cereals or minerals), the possibility of objects falling into the sea is not out of the question, especially during handling and transfer operations. This problem may occur in a port of commerce, in which case it may concern merchandise in barrels of all sizes and types (metal, plastic, cardboard...), in bags, or more often on pallets, in crates or in containers.

Recovering packages which have fallen into the sea can be a difficult operation and the risks presented by its contents may also be major concern, as the contents could be released into the environment if the container were to give way. Such a pollution incident could cause an instant or gradual release, depending on the damage to the packaging.

Pallet of combustive substances.

Labels and symbols. Extract from Cedre*'s operational guide "Containers and packages lost at sea".*

A substance escaping from a package either at the surface or on the bottom may float, evaporate, dissolve or sink, depending on the product's properties. This substance could present risks for humans or the environment (see previous pages). Before intervening, these risks must be assessed, in particular by inspecting the labels on the container in question or on similar containers which may be more easily accessed.

Using the knowledge gained on these risks, intervention can begin in order to recover the package, repair the container if necessary and store it in a predetermined area for hazardous merchandise. If a high risk level is suspected, responsibility for intervention should be handed over to the fire service, which will have the necessary detection means at its disposal.

▼ For more information on these matters, see the operational guide entitled "Containers and packages lost at sea", published by *Cedre*, which can be downloaded from www.cedre.fr.

C5

Response techniques and means on the water

D

Containment and protection techniques

Containing pollution means stopping a slick from spreading further and concentrating the pollutant in a specific area to facilitate recovery by pumping or using sorbents. It may also be necessary to protect the most sensitive or strategic parts of ports and harbours from the arrival of a pollutant (inner basin, water intakes, slipways). In this case, protection and deflection aim to stop the pollution upstream of the site needing protected, by channelling the pollutant towards an area where it will be easier to recover. For safety reasons, highly flammable volatile pollutants, such as petrol or certain chemicals, should not be contained. On a water surface, the evaporation and dispersion of such products should be promoted. Accumulations in naturally formed containment areas can even be dispersed using a fire hose. Containment techniques should thus be set aside for less volatile products such as diesel, heavy fuel oil and other similar products.

Containment of a small volume of liquid pollutant on the surface of a harbour basin can be carried out using floating or sorbent booms. These two types of booms are often used simultaneously, sorbent booms being deployed to ensure that the areas sealed off by floating booms are more watertight.

If a slick has already spread over the water surface, booms can be deployed to trawl the slick before drawing it against a solid quay or in the corner of a basin. It is important to choose a solid quay and not a wharf or pier to prevent the pollutant from moving under the structure with tidal movements. The origin of this slick (vessel, run-off from a quay...) should be included in this confined area wherever possible.

Fence boom (grey), curtain boom with foam-filled floats (orange), self-inflating curtain boom (yellow), sorbent boom (white).

Containing a slick on the water surface using a fence boom with absorption by bulk sorbents.

In ports and harbours, fence booms should be favoured over curtain booms as they are lighter and quicker to deploy. Although fence booms have poorer roll response (resistance to wind, waves and current), this is not a handicap on calm water bodies. Fence booms are also easier to store, on reels for instance, to clean and to transport.

Where floating booms are not available, the use of sorbents alone (preferably sorbent booms with a skirt or rolls of sorbent used as booms) is a possibility, although their retention capacity and resistance are low and when the sorbent is saturated with pollutant it will be considerably less effective.

Sorbent boom sections connected with overlap.

Sorbent boom with ballasted skirt and connectors positioned for overlapping connection.

As an alternative to protecting quays and slipways using booms, a simple system can be set up to effectively protect these types of structures and reduce the extent of otherwise substantial clean-up operations in the case of a large tidal range. This system involves a water supply pipe (e.g. a PVC pipe or fire hose) perforated with regularly spaced holes and positioned at the top of the quay to create a film or curtain of water running vertically down the side of the quay or slipway. As hydrocarbons are hydrophobic, the water curtain will create a liquid barrier between the slick and the quay, so as to protect it from being polluted and facilitating recovery on the water surface.

Water curtain to protect a quay or slipway.

Recovery techniques by absorption

Explosive or highly flammable petrol and chemicals

Recovery on the water surface by absorption is advised against for certain substances, such as petrol, for the same safety reasons which mean that containment of certain volatile substances should be also avoided. Recovery of such substances would involve transferring the risk of fire or explosion from the water to land, increasing the risk on the site where the used sorbents are stored, from where the volatile products recovered would evaporate.

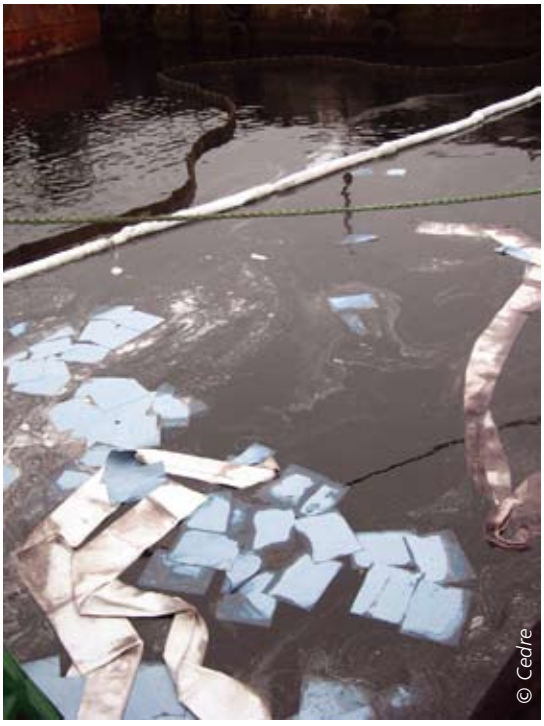
Diesel and similar products

Recovery of small volumes of diesel or similar products on the water surface should mainly be carried out using sorbents in the form of mats, sheets, rolls or booms with or without a short ballasted skirt. The rapid implementation of this technique is advantageous for a few litres to a few hundred litres of pollutant. A minimum of 2 volumes of sorbent for 1 volume of pollutant spilled will be required.

Heavy fuel oil and similar products

Recovery of heavy products can also be carried out using sorbents, but in this case a bulk sorbent will be most appropriate (flakes, fibres, strands...). Sorbents are spread manually and recovered using landing nets. Heavy products do not permeate into the sorbent to a great extent, but easily stick to its surface by adsorption. The multiplication of this surface by using bulk sorbents makes this recovery technique more effective for these products.

Roll of sorbent.



Sorbents in sheets (blue squares), rolls (white strips) and booms (white boom).

D2

Recovery techniques by pumping

Pumping by sanitation trucks

When the volume of pollutant needing recovered exceeds 1 to 2 m^3, the use of a vacuum truck (sanitation truck or sewer cleaning truck) equipped with a suction nozzle or surface skimming head is advantageous. Sorbents can be used to finish off the work.

Sanitation trucks are widely available and can simultaneously ensure pumping and storage, and where necessary settling and transportation, following regulations for road transportation of hazardous materials.

Vacuum truck: combined ADR unit certified for use in potentially explosive atmospheres (ATEX directive) for vacuum pumping flammable products, with a flash point of less than 61°C, as well as road transportation according to ADR regulations. The recovered pollutant is stored in a tank which can be compartmentalised to separate different products. This equipment can also be used for high, or very high, pressure washing, up to 1,000 bars.

Pumping using a pump and skimmer

This technique requires a skimmer, pump and storage unit and is only used in ports and harbours in the exceptional situation whereby no sanitation truck is available.

Lightweight flat suction head for floating pollutant.

Suction head with a wide opening, equipped with an arm designed to correctly position it on the slick.

Storage techniques

In the case of pumping a liquid pollutant by a sanitation truck, the pollutant is stored in the truck which can then transport its contents to the appropriate treatment facility. In other cases, it is necessary to store the pollutant in a storage tank or at an intermediate storage site.

Intermediate storage tank in a port.

Storage areas should provide a sufficient surface area, be outside of floodable areas and be sufficiently far away from residential areas, yet accessible by road. The ground must have a good load-bearing capacity. The ground and subsoil should be protected by geotextiles or watertight membranes. Access routes and traffic should be controlled to stop the pollution from being spread to clean areas.

In order to facilitate treatment operations, the polluted waste should be sorted from the onset. The waste can be divided into seven categories, each category corresponding to a distinct treatment process: liquids, pastes and solids, polluted pebbles and stones, polluted sorbents, polluted seaweed, macro-waste, fauna and polluted PPE.

The container must be watertight and suited to the pollutant's characteristics:

- pastes: skips or cells with bunds
- liquids: tanks, containers or trenches
- solids in bulk or in bags: skips or if unavailable a watertight platform.

There are many different types of storage means which are presented in section E4 "Equipment for storage and transportation of recovered pollutant". Storage facilities must be protected from rain with covers or tarpaulins to prevent the pollution from spreading downstream and to stop the volume of products needing treated from increasing.

Liquid waste with a density lower than water can be settled. For this, the storage tank must be fitted with a purge valve in the lower section. To prevent any accidental release of pollutant during settling, it is advisable to discharge settling waters within the containment area on the water body and to permanently supervise this operation.

Warning: in the case of recovery of a flammable or explosive product, the storage facility will present similar risks of fire or explosion. It is therefore important to take appropriate measures to prevent all risks of ignition (e.g. smoking ban, elimination of all sources of heat, closed tank to reduce the release of vapours...).

▼ For more information on waste management, see *Cedre*'s operational guide entitled "Oil Spill Waste Management" which is available from *Cedre*'s website: www.cedre.fr.

Cleaning vessels' hulls

In the event of a pollution incident in a port or harbour, it is rare that no fishing, pleasure or commercial boats are affected by the spreading or drift of the pollutant on the water surface. Once response on the water is completed, embankments and quays must be cleaned up and the hulls of any vessels affected must be washed. This operation can be conducted when the vessels are afloat, but often small boats can be hauled onto the shore and placed on a cradle. In the case of tidal ports, clean-up on graving dock or slipway may also be considered.

The solution of cleaning the vessel when afloat can only be considered for large vessels which would require excessive means (such as a dry dock). In the case of clean-up when the vessel is in the water, the water surrounding the vessel must be completely contained as close as possible to the ship and the pollutant and washing effluents recovered by pumping or absorption.

Clean-up on a cradle should be conducted in a careening area with an effluent collection, and if possible treatment, system (run-off and careening waters) to collect at least the heavy particles and hydrocarbons, and possibly other pollutants, dissolved or otherwise, such as fine particles of paint and heavy metals.

Such careening areas generally have a watertight surface, a sufficient slope and a water collection network, as well as vessel access and handling facilities. The equipment used includes in particular high pressure washers.

When no careening area exists, a provisional area can be developed by demarcating an area of ground while respecting the following constraints:

- ensure that the ground is watertight (for example using a geomembrane or a tarpaulin) as well as the area itself (the geotextile should be raised up around the perimeter of the area by an earthen bund or bundles of straw)
- collect the water, hydrocarbons and washing effluents by pumping them from the lower end of the provisional area, where a sump can be set up (a pit dug in the ground and made watertight using geotextile)
- plan to treat these effluents after pumping operations, and take care to limit the flow speed of water used for clean-up so as to produce as small a volume of effluents as possible.

Solid waste

Solid waste is a chronic problem in ports and harbours. As such basins are open to their environment, they tend to accumulate waste which is transported by waterways, rainwater drainage or sewer systems, swept along by the wind or directly dropped from quays or vessels. On certain sites, heavy rain or violent winds often lead to large-scale arrivals of solid waste and debris of all types.

This floating waste drifts on the surface of harbour basins under the influence of currents and waves. It often gathers at the same sites which can be easily identified, then cleaned on a regular basis.

A waste collection policy should be implemented whenever the problem becomes a disturbance for users and local residents (an eyesore, particularly for the tourist industry but also for everyday users of the basins).

However, preventative measures can also be very effective:

- managing and ensuring safety or elimination at the source, if it is known, or on the journey (e.g. waterway)
- protection of water bodies by cleaning up quays and open areas, or even the application of rules aiming to reduce or eliminate the generation of solid waste.

The management of waste which has not been oiled can pose problems. The management of oiled waste is therefore even more complex and costly, as landfill sites where such waste is usually disposed of become inaccessible.

Solid waste trapped in a heavy fuel oil slick.

When a spill occurs, solid waste greatly impedes recovery by obstructing skimming systems or damaging sorbent booms. This waste generally has to be collected before being able to begin pollutant pumping and recovery operations.

▼ For more information on this matter, see *Cedre*'s operation guide entitled "Oil Spill Waste Management" which is available from *Cedre*'s website www.cedre.fr.

Equipment available on the market

One of *Cedre*'s roles, as part of its missions for the authorities in charge of response, is to provide advice, in particular in terms of the means to use to respond to a pollution risk. Port and harbour authorities can therefore contact *Cedre* directly for more information on the most appropriate response means for the risks in a given situation.

Equipment for containment on land and on the water surface

Containment on the water surface

Containing a slick on the water surface can prevent it from spreading and drifting, and is often necessary for recovery operations.

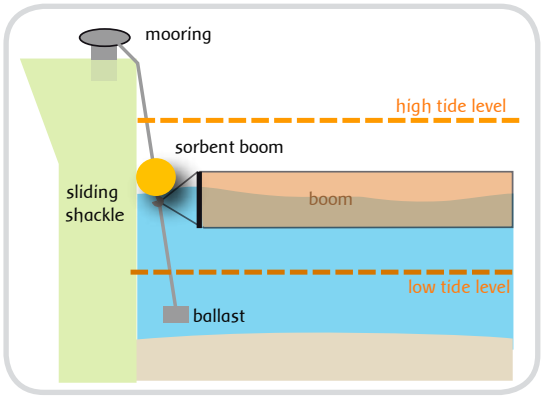
Slicks can also be contained in order to protect particularly sensitive areas such as water intakes or marinas.

The most effective means of containment are floating booms. Many different models exist, but those best suited to ports and harbours are small booms (total height of around 0.60 m) with foam-filled floats, therefore not needing to be inflated. However, for certain specific sites (slipways, embankments or slightly sloping access routes), shore-sealing booms (filled with air and water) may be preferable as they form a watertight seal between the water and the embankment, as well as being able to adapt to tidal movements.

Booms can be stored on reels (inflatable booms or fence booms i.e. flat booms) or in special containers (curtain booms) to allow rapid deployment. They can be stored in certain strategic places in order to reduce their deployment time.

Whatever the storage method chosen, it should protect the boom from ultraviolet rays, severe weather conditions, frost, rodents and bird droppings. Furthermore, booms must be cleaned, repaired and stored away with care after each use.

During intervention, booms may be attached using anchors, moorings or piles, or attached to vessels' steel hulls using magnetic moorings.



Boom mooring arrangements and tidal compensators: slide rail fixed to the quay (right) or sliding shackle on a ballasted rope (left).

E1

Mooring points on the quayside can be fitted with floating tidal compensator systems.

Watertight protection at these anchorage and mooring points can be reinforced by sorbents or a water jet creating a counter flow.

If no floating booms are available, the use of sorbent booms fitted with a small ballasted skirt can be considered.

After use, these soiled sorbent booms should be disposed of as waste requiring specific treatment. Furthermore, in the absence of booms, a slick can sometimes be contained or even moved on the water surface using a fire hose with a flat water jet.

Finally, when a slick is spread out over a large surface area, it is possible to attempt to trawl using a boom at a speed of less than 1 knot by two boats such as mooring tugs.

Containment on land

If the source of the pollutant is on land, stopping or containing at the source can be considered, as long as there are definitely no risks involved for the personnel (flammability, explosiveness, toxicity...).

The spill can be contained using sorbents (earth, sand, sorbent booms...) and the various routes which could be taken by the pollutant (e.g. sewer system, manholes) can be sealed off using specialised means such as inflatable stoppers or drain covers, or simply using weighed down tarpaulins.

Shore-sealing boom.

Deploying a boom from a container on the quay.

Introducing an inflatable stopper into a waste water evacuation pipe.

Boom deployed on the water surface.

Equipment for absorption

Floating sorbents (hydrophobic sorbents) are used to respond to small-scale spills on the water surface (1 or 2 m^2 at most). Upon contact with the pollutant, sorbents become impregnated like a sponge, allowing the pollutant to be recovered with the sorbent itself.

The standard application ranges from 2 to 4 volumes of sorbent for 1 volume of pollutant.

Floating sorbents are more effective and easier to use on substances with a low viscosity (for example diesel) than on heavy products which are not easily absorbed, but simply stick to the surface. Sorbents are specifically designed for certain chemicals.

Sorbents come in a number of different forms:
- bulk: in granules, strands, powder...
- sheets, mats, rolls
- pillows, booms
- mops, pom-poms...

Sorbents are most often applied by hand, to allow the best possible distribution over the polluted surface (i.e. to avoid clumps) to improve contact and accelerate absorption. Bulk sorbents can also be spread using a shovel or an air blower.

Recovery is also carried out manually, using landing nets for bulk sorbents and pitchforks or boat hooks for other types of sorbents.

All used sorbents should be stored and treated as special waste.

Using bulk sorbents to finish off mechanical recovery operations. Water curtain set up to protect a quay and recovery with a circular weir skimmer.

Sheet sorbent between a vessel and the quay.

E2

Bulk: large surface area for contact, easy to dose in relation to the volume of pollutant, more difficult to recover (landing nets) than other sorbents. Bulk sorbents are effective for recovering heavy or viscous products as they stick to or are adsorbed by the sorbents.

Sheets, mats, rolls: easy to use. They can measure up to 20 m x 0.5 m (rolls) and be reinforce by a rope for trawling or "sweeping" a large surface area. Less effective on heavy products.

Pillows, booms: easy to use. They are thick and therefore inefficient on heavy products. They are effective on light products and substances with a low viscosity.

Mops, pom-poms: effective on highly viscous products as the fibres become smothered with the pollutant.

Sorbent boom in use during the Happy Bride *spill.*

Oleophilic rope skimmer.

Used sorbent is soiled by the pollutant and should therefore be considered as special waste. Consequently, it is essential to remove it from the natural environment. Once collected and stored, soiled sorbents should be removed and treated through specialised processes.

Some suppliers now offer "ready-to-use solutions" by providing sorbents and taking them back and disposing of them after use.

Equipment for recovery, skimming and pumping

Natural containment or containment using floating booms reduces the drift and spreading of slicks of pollutant. This then means that slicks are thick enough to be recovered from the water surface by pumping or skimming.

In ports and harbours, two recovery techniques are used, the first being more suitable as it does not require complex equipment to be purchased and mainly involves calling upon a service provider.

• Sanitation trucks

These trucks are equipped with a vacuum pump and allow direct suction. This solution is simple to implement but not very selective, as it brings a lot of water with the pollutant. To improve selectivity and reduce transport and treatment costs, a skimmer can be used for suction.

This quick, simple and widely available equipment is suitable for small-scale pollution in ports and harbours. It is used by the fire service during intervention involving hydrocarbons or chemicals. The choice of service providers with the ability to respond in an emergency situation can be made by the port authorities and may result in the establishment of an assistance contract.

• Skimmer, pump and storage units

This is a more complex and lengthy solution. The skimmer, the pump and the storage capacity must be compatible (rate, sensitivity to pollutant viscosity and solid waste…).

Two methods of skimming exist: oleophilic skimming and mechanical skimming.

- **Oleophilic skimmers:** disc, drum, rope, brush skimmers etc. have a limited collection rate. They are selective (little water recovered with the pollutant), not overly sensitive to solid waste but not very efficient on very heavy pollutants. Rope and brush skimmers also work by trapping the pollutant and are the most appropriate solution for emulsified pollutants (i.e. containing water).
- **Mechanical skimmers:** weir, direction suction, conveyor belt skimmers etc. have a very low selectivity and are sensitive to solid waste. They have a high collection rate (30 to 50 m^3/h or more). They must systematically be used with large storage tanks to ensure effective settling.

The pump used with the skimmer must be able to cope with the viscosity of the product needing recovered and with any solid waste which may be collected with the pollutant.

The most commonly used pumps are:

- centrifugal pumps, suitable for fluid products
- peristaltic pumps and diaphragm pumps, suitable for the transfer of fluid to viscous products, are often self-priming but sensitive to the presence of debris
- screw pumps, suitable for viscous products, are less sensitive to debris.

Equipment for storage and transportation of recovered pollutant

Experience has shown that sanitation trucks, the most commonly used recovery means, are the most appropriate storage solution as they facilitate settling in the lower part of their tanks and can also transport their contents to the relevant treatment facilities.

The use of these trucks must comply with regulations on potentially explosive atmospheres (ATEX regulations) and the transportation of hazardous materials by road (ADR regulations).

More generally speaking, waste storage should take into account the nature and consistency of the waste (liquid, solid, paste) and it should be sorted before being stored (see section D4).

Plastic bags and other flexible storage capacities

Solid waste can be stored in plastic bags with a maximum capacity of 100 litres, laid on a tarpaulin to prevent them from being pierced. Bigbags can also be used: they have a large storage capacity and high resistance (1 m^3/1 t) and can be lined with plastic sheeting on the inside to ensure that they are watertight.

Non-specialised means

Bins (60 litres), wheelie bins with a lid (650 litres) and watertight containers and skips (250 m^3), or even metal or plastic barrels (20 to 200 litres) can also be used for storage. These solutions are suitable for solids, liquids and pastes. They must be watertight and storage areas must be protected by a tarpaulin.

Specialised means

In the case of liquid waste, storage capacities fitted with a valve in the lower section are preferable to allow the elimination of settled water. They can be rigid (e.g. a tank specially designed for this purpose), but in this case they will be bulky. Flexible tanks can be folded away when not in use. These types of tanks may have a rigid frame or be self-erecting. Their volume varies between 5 and 40 m^3.

Using buckets and bins to collect small quantities of waste.

A flexible self-erecting tank.

E4

The most common spill and response scenarios

Scenarios illustrated

- Diesel: 1,000 litre spill
- Diesel: 10,000 litre spill
- Heavy fuel oil: 1,000 litre spill
- Petrol: 500 litre spill
- Potentially hazardous chemicals: 100 litre spill

Reflex measures

Diesel and heavy fuel oil

Reflex measures

- Stop the spill and ensure that the installation or vessel at the origin of the pollution is safe.
- If the source of the pollution is not within the port or harbour, determine the origin and look for the route that the pollution is taking (trench, run-off, sewer system...) towards the basin. Plan on responding as close as possible to the source.
- Identify the spilled product, its volume and its movement on the water surface according to winds and currents.
- Alert: the port or harbour authorities, the fire service and the police, then boat owners and other users of the polluted water body (fishermen, shellfish breeders, users of water intakes...).
- Determine exclusion zones and safe areas on land and on the water.
- Report the pollution: official report (police officer, port officer...), photos, samples...
- Begin response operations on the water or along the route that the pollution is taking, and then clean polluted infrastructures.

Petrol

Reflex measures

- Prevent/remove any sources of heat or potential point of ignition: stop motors (vessels, vehicles on land...), ban smoking, do not start electric or electronic equipment.
- Stop the spill and ensure that the installation or vessel at the origin of the pollution is safe.
- Alert the fire service and determine exclusion zones and safe areas on land and on the water; identify all dangerous areas: confined spaces such as sewers or ship's holds, potential areas of accumulation of petrol.
- If the source of the pollution is not within the port or harbour, determine the origin and look for the route that the pollution is taking (trench, run-off, sewer system...) towards the basin. Plan on responding as close as possible to the source.
- Identify the spilled product, its volume and its movement on the water surface according to winds and currents.
- Alert: the port or harbour authorities, the fire service and the police, then boat owners and other users of the polluted water body (fishermen, shellfish breeders, users of water intakes...).
- Report the pollution: official report (police officer, port officer...), photos, samples...
- Begin response operations on the water or along the route that the pollution is taking, while prioritising safety measures against explosion and fire.

Hazardous chemicals

Reflex measures

- Stop the spill and ensure that the installation or vessel at the origin of the pollution is safe.
- Prevent/remove any sources of heat or potential point of ignition: stop motors (vessels, vehicles on land...), ban smoking, do not start electric or electronic equipment...
- Alert the fire service and the port and harbour authorities. Determine exclusion zones and safe areas on land and on the water, and identify high risk areas: confined spaces such as sewers or ship's holds, potential areas of accumulation of petrol.
- If the source of the pollution is not within the port or harbour, determine the origin and look for the route that the pollution is taking (trench, run-off, sewer system...) towards the basin. Plan on responding as close as possible to the source.
- Identify the product spilt (chemical properties, SEBC classification and volume) and the risks involved. Predict its possible movement on the water surface taking into account winds and currents.
- Begin response operations on the water or along the route that the pollution is taking, after ensuring that all responders are equipped with protective clothing suitable for the pollutant. In addition, set up an air quality control network (protect personnel against risks of fire, explosion and/or formation of a toxic cloud).
- Alert: the port or harbour authorities, the fire service and the police, then boat owners and other users of the polluted water body (fishermen, shellfish breeders, users of water intakes...).
- Set up a monitoring system, in particular through sampling the different sections affected.
- Report the pollution: official report (police officer, port officer...), photos, samples...

Response strategies and techniques

Scenario: pollution by 1,000 litres of diesel

Response strategies and techniques

- Contain the polluted area or the source of pollution by surrounding or isolating the slick on the water surface with a floating boom and ensure that the system is watertight by additionally using sorbent booms. The pollutant may be concentrated by using a water jet to create a current in front of the slick and not directly on it (as this may cause the diesel to emulsify).
- Protect sensitive areas and structures from the pollution: water intakes, riprap, difficult access areas under wharfs on piles, natural sensitive areas such as marshes or mudflats, other sites such as shellfish breeding areas, pleasure boating basins, floating pontoons...
- Place sorbent sheets on the surface and renew them when saturated. Store used sorbents in watertight containers or skips.
- If the polluted area is very large, trawl the slick on the surface using a rolls of sorbent boom.
- In the case of small, sparse slicks which cannot be recovered or trawled, promote their dilution and dispersion using fire hoses with a solid jet.
- Dispersion of slicks of diesel using chemical dispersants is strongly advised against in ports and harbours. Due to the natural containment of the water in harbour basins, it is difficult or even impossible for the dispersed pollutant to quickly dissipate in a large volume of water.
- If operations to clean up polluted port infrastructures are implemented, any washing agents used should be insoluble so that they can be recovered at the same time as the washing effluents.

  Note: if the quantity of diesel contained justifies it, it can alternatively be recovered on the water surface by pumping using a sanitation truck and a skimmer.

Riec-sur-Belon (France), 2003

In July 2003, a leak of domestic fuel oil from an underground tank led to the pollution of the river Belon by several thousand litres of domestic fuel oil. The red-coloured product quickly began to accumulate in the small oyster-farming basins, after infiltrating the soil.

The site layout meant that the pollutant was naturally contained and the responders therefore decided to recover the pollutant using a vacuum truck, first of all without a suction head or skimmer, thus also unnecessarily pumping a large volume of water. A skimmer was then used to improve the recovery rate and selectivity by mainly pumping domestic fuel oil.

Recommended use of a surface skimmer.

What not to do.

A number of different participants were involved in intervention including maritime affairs, the police force and the local authorities. The fire service and their pollution response unit as well as the departmental equipment directorate were also called upon.

Port Barcarès (France), 2006

On 23 May 2006, five pleasure boats twelve to fifteen metres in length burnt while in dock. Emergency response, conducted by the fire service, first consisted of fighting the fire and reducing its spread. However, as a result of this fire and the shipwrecking of some of the boats, partially burnt hydrocarbons, diesel and oil, spread over the surface of the harbour basins. These hydrocarbons were mixed with all sizes of debris and were thus difficult to recover selectively.

Response operations involved containing the liquid pollutants and recovering them using specialised industrial sanitation trucks (for pumpable products). Other waste and debris was recovered using pitchforks, boat hooks and lifting machinery.

A team of divers inspected the bottom of the port and recovered sunken debris.

One of the main difficulties met during emergency response and the subsequent operations was related to fire fighting. It proved very difficult to control this fire involving synthetic and organic materials fuelled by the hydrocarbons present onboard the vessels, in the presence of a risk of explosion which was impossible to accurately assess.

Response to the pollution itself was promoted by very quickly deploying a boom and surrounding the area of water concerned. This boom was then doubled to reinforce the protection of the port.

A number of different participants were involved in intervention including maritime affairs, the police force and local council. Amongst the operational responders were the fire service and their pollution response unit, the technical support services of the port and the commune, a company specialised in industrial sanitation and the national organisation for salvage at sea.

The waste recovered by the sanitation company was as much as 20 m^3 of liquids and 1 to 2 m^3 of floating solids.

Pumping using vacuum trucks and manual recovery in a harbour basin.

Scenario: pollution by 10,000 litres of diesel

Response strategies and techniques

- Contain the polluted area or the source of pollution by surrounding or isolating the slick on the water surface with a floating boom and ensure that the system is watertight by also using sorbent booms.
- Pump the diesel from the water surface using a vacuum truck by positioning a skimmer in the area where the pollutant naturally accumulates pushed by the wind and currents. The pollutant may be concentrated by using a water jet to create a current in front of the slick and not directly on it.
- Complete recovery operations by pumping, or where no truck or pumping equipment is available use sheet sorbent on the surface and renew them when they are saturated, storing used sorbents in watertight tanks or skips.
- If the polluted area is very large, trawl the slick on the surface using rolls of sorbent or floating curtain booms.
- In the case of small, sparse slicks which cannot be recovered or trawled, promote their dilution and dispersion using fire hoses with a solid jet.
- Protect sensitive areas and structures from the pollution: water intakes, riprap, difficult access areas under wharfs on piles, natural sensitive areas such as marshes or mudflats, other sites such as shellfish breeding areas, pleasure boating basins, floating pontoons...

Douarnenez (France), 2003

In August 2003, the trawler *Landora* hit a jetty when entering the harbour in Douarnenez. Two fuel tanks lost around 18,000 litres of light marine diesel.

A large proportion of the product drifted out to sea while partially evaporating.

After being moored and stabilised, the vessel's list was corrected and its breaches plugged. To stop the pollution from spreading into the harbour basins, the bow of the trawler was surrounded by a curtain boom.

The vessel was then entirely encircled by a floating fence boom, reinforced by sorbent booms along the inner edge.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Sorbent mats, sheets and rolls were also deployed within the area contained by the boom.

The surface of the basin was trawled using a boom and two boats in order to concentrate the floating products by a quayside and recover them using a vacuum truck.

A number of different participants were involved in intervention including the port authorities, maritime affairs, the local police and the local authorities. The fire service was also called upon. The French navy and the Attorney General also intervened respectively to search for pollution at sea and to observe any offence.

Scenario: pollution by 1,000 litres of heavy fuel oil

Response strategies and techniques

- Contain the polluted area or the source of pollution by surrounding or isolating the slick on the water surface with a floating boom and ensure that the system is watertight by additionally using sorbent booms.
- Move and if necessary contain the heavy fuel oil slick using a fire hose with a flat spray, avoiding direct contact with the pollutant but rather creating a small surface current with the hose.
- Pump the fuel oil from the area where the pollutant naturally accumulates, pushed by the wind and currents, using a vacuum truck.
- For preference, use a single suction head with a wide opening, as this is the most suitable solution for products with a high viscosity.
- If the polluted area is very large, trawl the slick on the surface using a small curtain boom.
- Protect sensitive areas and structures from the pollution: water intakes, riprap, difficult access areas under wharfs on piles, natural sensitive areas such as marshes or mudflats, other sites such as shellfish breeding areas or pontoons for pleasure boats.

Rouen (France), 2006

On the morning of 19 January 2006, at around 5:30 am, operators on their way to discharge base stock from a barge in the Quevilly basin of the port of Rouen indicated the presence of whitish substances over a surface area of 200 m^2 under a wharf, between the docks and the barge, as well as on the water body. The port factory and authorities were alerted and the coasting pilots deployed the factory boom, stored on a reel on the wharf. Further investigation showed that the pollution had come from the factory through the rainwater drainage system and that the pollutant was a mixture of emulsified hydraulic oil and engine oil.

The boom was set up at around 8:30 am to limit the spread of the slick to 6,000 m^2 within the harbour basin. A private company contracted by the factory began to recover the pollutant using vacuum trucks and a weir skimmer.

Recovery from the water surface lasted all morning. By midday, at low tide, a light westerly wind pushed the slick towards the end of the dock. Operations were carried out, from the entrance to the innermost part of the port, to rinse the quaysides, the piles of the wharf and


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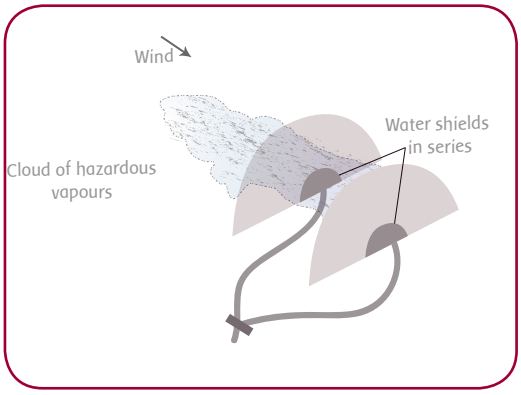
the hull of a grain carrier slightly affected by the pollution, while the boom was moved to reduce the containment area. The following day at midday, the use of the skimmer was abandonned due to the presence of a lot of solid waste and direct suction began, with settling and discharge of the clean water into the basin. This operation also continued the following day, resulting in the recovery of around 100 m^3, of which 8 m^3 were oil after settling. On the same day, the boom was repositioned at the rainwater outflow and was reinforced by sorbent booms in order to ensure that it would be watertight over the weekend. The outflow channel was rinced and cleaned on Monday 23. No impact on the environment was observed and the quaysides, washed by the tidal movements, did not require washing.

Scenario: pollution by 500 litres of petrol

Response strategies and techniques

- Determine an initial exclusion area, taking the wind into account. Evacuate all people present in this area and eliminate any sources of heat (vehicle engine, worksite, electric or thermal equipment...).
- Alert the fire service and the port authorities.
- Search for information on the origin of the spill and assess the risks of explosion.
- Monitor the air quality: risk of explosion and fire (explosimeter). Provide a response team equipped with personal protective equipment suitable for the risks involved.
- A petrol slick on the water surface spreads and evaporates very quickly, and only dissolves to a very small extent in the water column. Evaporation lasts from a matter of minutes to less than 2 hours depending on the air and wind temperature in the area. If intervention proves necessary, it should be carried out by a specialised body (fire service or navy fire department) or by a specialised company, and should act on:
  - floating slicks, either by moving them away from high risk areas (e.g. vessels) or potential areas of accumulation and promoting their dilution using fire hoses with a solid jet (preferable solution), or, with perfect knowledge of the risks involved in such an operation, by containing the pollution (far from any source of heat or any risk of heat generation) using booms and recovering the petrol using specific equipment (sorbents, pumps, vacuum trucks etc.). Note that it is possible to move and if necessary contain a slick using a fire hose with a solid jet, avoiding direct contact with the pollutant but rather creating a small surface current with the hose.
  - vapours given off by the slick, by defining an exclusion area where all sources of heat are prohibited and the gas cloud is regularly monitored, and by destroying vapours with a curtain of water or pulverised water spray.



Water curtain sprayed by water shields in series.

Scenario: pollution by 100 litres of hazardous chemicals

Response strategies and techniques

- Determine an initial exclusion area, taking the wind into account. Evacuate all people present in this area and eliminate any sources of heat (vehicle engine, worksite, electric or thermal equipment...).
- Alert the fire service and the port authorities.
- Search for information on the origin of the spill, the chemical properties of the product and its behaviour in the natural environment in order to assess the risks.
- Monitor the air quality: risk of explosion or fire (explosimeter), oxygen levels, if possible toxicity. Provide a response team equipped with personal protective equipment suitable for the risks involved.
- According to the element affected by the pollution (atmosphere, water surface, water column, bottom), if intervention proves necessary, it should be carried out by a specialised body (fire service or navy fire department) or by a specialised company, and should act on:

  - floating slicks, by containing them using booms resistant to the corrosive properties of the chemicals and recovering them using specific pumping equipment.
  - pollution in the water column, by monitoring the concentrations of the pollutant in the water. If the polluted water mass can be isolated, consider the possibility of treating it (in the case of small volumes, contact a specialised company; for larger volumes, set up a filtration unit).
  - sunken pollutant, by recovering it through dredging or suction.
  - an evaporating pollutant, by defining an exclusion area where all sources of heat are prohibited and the gas cloud is regularly monitored, and by destroying vapours with a curtain of water or pulverised water spray.

While spills of petroleum products can be detected and overcome using relatively widely available equipment by a port agent with a basic working knowledge of pollution response, operations to combat chemical spills require specific skills and equipment.

Experience feedback indicates that the majority of cases of response to a chemical spill in a port or harbour results in no intervention, other than ensuring the safety of personnel and equipment, (except in the case of fire) or in monitoring the polluted area and the pollution until it has entirely dissipated in the natural environment. This can easily be explained by the difficulty involved in analysing the various and sometimes high risks (toxicity, corrosiveness, flammability, reactivity...), and then protecting personnel from these risks. This is added to by the pollutant evaporating or dissolving, sometimes very rapidly, or else sinking, while being very difficult to detect visually.

Amongst the chemicals most frequently spilt in ports and harbours are acids (sulphuric, hydrochloric, phosphoric...) and bases (ammonia, soda...) which require the skills of professional response personnel as well as the use of sensing equipment such as a pH meter and protective equipment such as overalls, gloves and acid-proof masks. Furthermore, recovery of such chemicals in the water column is practically impossible due to their dissolution. All intervention on chemical spills should therefore be left to specialised services (e.g. chemical emergency unit of the fire service or navy fire department). The role of port and harbour agents is based on the first three points: identifying the polluted area, raising the alarm and finding out information.

Recommended equipment

To respond to accidental pollution in a port or harbour, responders must have a stockpile of equipment at their disposal. This recommendation can be simplified to the extreme by advocating a stock of 5 m^3 of sheet sorbents. Such a stockpile would be likely to be able to respond to far more than 50% of pollution incidents, which are mainly medium-scale spills (less than 5 m^3) of diesel. It is also possible to propose an equipment stockpile which would cover over 90% of small spills, while ensuring optimal size and complexity. The aim of this guide is to put forward operational, i.e. simple, solutions which can be rapidly implemented, are efficient and have a high success rate.

The table on the following page presents typical stockpiles according to the type and volume of pollutant spilled. These suggestions do not take into account the layout of the harbour basins which can vary greatly from one site to another, or the complexity of an incident which can in certain cases require further response means.

Thus, for example, in the case of an incident caused by a vessel hitting the riprap of a pier and mooring provisionally at a specific quay, it may be necessary to respond in one single polluted area or alternatively on the riprap, the vessel and the various polluted sites all at once, requiring considerable resources. To take a different example, in the case of pollution caused when bunkering a fishing boat, the area contained by a boom may only be around the bow or the stern, or around the entire vessel, thus necessitating great lengths of boom. It is therefore the responsibility of each port or harbour to estimate the risks and choose the equipment that it deems necessary to respond to these risks.

Dispersants

The use of dispersants in ports and harbours is not a technique recommended in this guide.

The dispersion of a pollutant in the water column using chemical dispersant requires a very large volume of water to ensure perfect dissipation/dilution of the dispersed pollutant. Ports and harbours, made up of naturally protected and more or less confined water bodies, hardly ever offer this possibility.

Furthermore, dispersants are designed for moderately viscous oils such as light crude oil or light fuel oils with a viscosity of less than 5,000 cSt. They do not apply to light products (petrol, diesel...), or heavy products with a viscosity of over 5,000 cSt (heavy fuel oil such as n°6 fuel oil, emulsified or not, or emulsified crude oil...) which cannot physically be dispersed using currently available techniques.

Finally, dispersion is not suitable for ports and harbours due to the low level of agitation (necessary for matters to be placed in suspension) as well as because of the limited renewal of the water, therefore not enabling the dilution of the oil plume to concentrations sufficiently low to be inoffensive. In many cases, an additional concern is the proximity of sensitive zones (shallows, shellfish farming areas, hatcheries...) which could be impacted by the dispersed oil.

▼ For more information on these matters, see the operational guide entitled "Using dispersant to treat oil slicks at sea" published by Cedre, which can be downloaded from www.cedre.fr.

Pollutant	Volume	Recommended equipment
Diesel	1,000 l	- floating fence boom: 100 m in sections of 10 to 15 m x 0.60 m - sorbent boom: 20 sections of 3 m - mooring and anchoring arrangements - sheet sorbent: 2 to 4 m^3 (2 to 4 times the volume spilled) - rolls of sorbent to trawl a slick over a large surface: 2 rolls of 25 to 30 m, fitted on one side with a polypropylene rope - 2 motor craft to work on the water surface, to deploy booms and possibly to trawl diesel slicks - watertight skips, tanks, barrels or bins and landing nets or boat hooks to recover and store used sorbents Note: possibility of using a vacuum truck + skimmer
	10,000 l	- floating fence boom: 100 m more (i.e. 200 m in all) - sorbent boom: 40 more 3 m sections (60 m in all) - vacuum truck equipped with a self-adjusting mechanical surface weir skimmer with suction hoses fitted with floaters
Heavy products	1,000 l	Warning: if the pollutant is crude oil with a low flash point, there may be a risk of fire or explosion - the fire service must be called upon - floating fence boom: 100 m in sections of 10 to 15 m x 0.60 m - sorbent boom: 10 sections of 3 m - mooring and anchoring arrangements - vacuum truck fitted with a skimmer head with a large opening - bulk sorbent: 1 to 2 m^3 - 1 motor boat to work on the water surface, to deploy booms and possibly to recover heavy fuel oil using bulk sorbents and landing nets - watertight skips, tanks, barrels or bins and landing nets or boat hooks to recover and store used sorbents
Petrol	500 l	Warning: risk of fire and explosion, the fire service must be called upon - floating fence boom: 50 m in sections of 10 to 15 m x 0.60 m - sorbent boom: 10 sections of 3 m - mooring and anchoring arrangements - sheet sorbent: 1 to 2 m^3 (2 to 4 times the volume spilled) - watertight skips, tanks or barrels and landing nets to recover sorbents - possibly vacuum truck - fire hose(s): movement of the pollutant slick on the surface or destruction of vapours in the atmosphere
Chemicals	100 l	Warning: risk of toxicity, fire, explosion, corrosion or reactivity, the fire service must be called upon - floating fence boom: 50 m in sections of 10 to 15 m x 0.60 m - sorbent boom for chemicals: 10 sections of 3 m - mooring and anchoring arrangements - specific sheet sorbent for chemicals: 1 m^3 - watertight skips, tanks or barrels and landing nets to recover sorbents - fire hose(s): movement of the pollutant slick on the surface or destruction of vapours in the atmosphere

Glossary and acronyms

ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road, which establishes, through annexes A and B, certain conditions in terms of packaging and labelling merchandise and the construction, equipment and circulation of the vehicles that transport such merchandise (see http://www.unece.org/trans/danger/publi/adr/adr_e.html).

Adsorption: retention, adherence or accumulation of a solid, liquid or gas at the surface of some other substance. Adherence of a floating pollutant, in suspension or in solution in the water, to the surface of a solid such as sediments or other matters in suspension in the water.

ATEX: regulation based on European directives which applies to equipment (materials, protective systems, components...) intended for use in potentially explosive atmospheres (see http://ec.europa.eu/enterprise/atex/index_en.htm).

Biodegradation: breakdown of certain substances, such as hydrocarbons, by living organisms.

Containment: act of stopping the migration or drift of floating liquid or solid pollutants away from a site by deploying a boom.

Dispersant: liquid chemical used to place oil in suspension in the water mass and promote its dispersal, in order to accelerate break down by the natural environment.

Effluent: waste waters or liquid waste discharged into the water during clean-up operations in pollution response.

Emulsification: dispersion of a liquid into very fine particles in another liquid, forming an extremely heterogeneous liquid.

Emulsion: mixture of two non miscible substances (i.e. which do not normally mix), such as water and oil (cf. emulsification).

Floating sorbent: natural or synthetic hydrophobic products designed to absorb liquids spilt in water in order to facilitate their recovery.

Hydrophobic: property of a substance whereby it has no affinity for or does not easily combine with water.

Oleophilic: property of presenting an affinity for oils, absorbing them selectively.

PPE: personal protective equipment.

Reverse emulsion: mixture of water, and sometimes air, with a hydrocarbon, possibly leading to an increase in the volume of this hydrocarbon up to as much as five times the original volume.

Settling: separation of water or matters in suspension contained in a liquid (pollutant) by leaving them to fall to the bottom of a recipient.

Skimming: selective recovery of hydrocarbons on the water surface using a skimmer.

Solid waste: all types of various forms of waste, either of human or natural origin, floating at sea or deposited onshore.

Trawling: increasing the concentration and thickness of a slick of pollutant spread out over a water surface using a boom towed in a U formation by two boats at a speed of less than 1 knot.

Water column: a volume of water in a real or imaginary vertical tube.

Also see the "Links" section of *Cedre*'s website: www.cedre.fr.