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Information Bulletin

Centre of Documentation, Research and Experimentation on Accidental Water Pollution

FEATURE
Chemicals risks at sea

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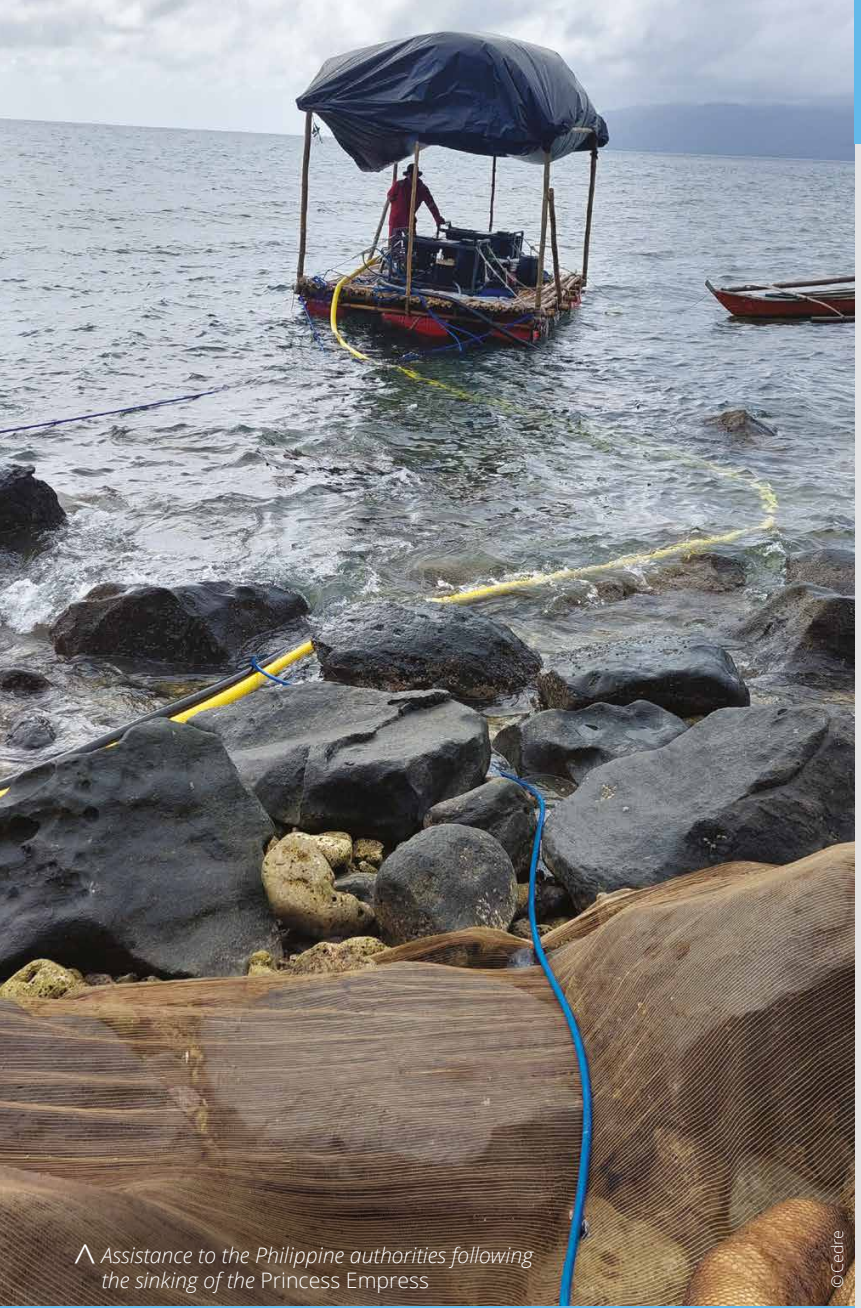

⋀ *Assistance to the Philippine authorities following the sinking of the* Princess Empress

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EDITORIAL

The International Maritime Organization – the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships – defines HNS as substances that are likely to create hazards to human health, harm living resources and marine life, result in economic or proprietary damages or interfere with other legitimate uses of the sea.

These substances represent a particular challenge due to the large number and wide variety of different products. This diversity gives rise to considerable uncertainty over how to respond to an HNS spill at sea. Information on the behaviour and fate of products is required in order to protect seafarers, responders and populations as well as to assess the environmental impact in the event of a spill.

While maritime incidents involving HNS attract less media attention than oil spills, they are nevertheless a frequent occurrence. Recent incidents, such as the loss of a tank truck transporting sulphuric acid in the Gulf of Genoa in December 2023 or the sinking of the *Rubymar* with several thousand tonnes of chemical fertilisers on board in the Bab-El-Mandeb following a Houthi attack, illustrate this reality. The many requests made by the maritime authorities in relation to assistance to vessels in distress highlight the need for information prior to on-board intervention and in order to safely manage the marine vessel.

In France, spill prevention and response is an interministerial action coordinated by the General Secretariat for the Sea, under the authority of the Prime Minister. Within this framework, the French Navy is in charge of response operations at sea. As these missions expose crews and assessment and response teams to chemical risks at sea, it is essential that they are fully aware of the hazards.

Cedre also conducts research as part of numerous projects on chemicals risks at sea, many of which are funded by the European Commission's Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO).

At a time when France has recently ratified the 2010 International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea (HNS Convention), and when the International Maritime Organization's GHG emission targets are set to boost the use of new propulsion fuels (methanol, ammonia, etc.), the enhancement of knowledge on chemical risks at sea is more crucial than ever.

I wish you an interesting read.

Didier Lallement,
Secretary-General for the Sea

Assistance to the Philippine authorities following the sinking of the *Princess Empress*

∧ *Containment and recovery at sea*

By Mikaël Laurent, Analysis and Resources Department engineer, Cedre.

On 28 February 2023, the *Princess Empress*, an oil tanker owned by RDC Reield Marine Services, was en route from Bataan to Iloilo (Philippines), carrying 800 tonnes of Intermediate Fuel Oil in rough seas, when it suffered engine failure followed by water ingress.

∧ *Deploying a skimmer*

The *Princess Empress* finally sank 7.5 nautical miles off Baligawan Point (Mindoro Oriental) to a depth of 400 metres. The 20 crew members were rescued by the cargo vessel *Efes* which was nearby at the time.

The same day, oil slicks were spotted on the sea surface by the Philippine Coast Guard, which mobilised aircraft and vessels to carry out surveys and take samples.

The owner of the *Princess Empress*, RDC Reield Marine Services, mandated the Malayan Towage and Salvage Corp (SALVTUG, or MTSC) to carry out response operations at sea (containment and recovery) and spray dispersant under the supervision of the Philippine Coast Guard.

Over the following days, the wreck of the *Princess Express* gradually released its cargo, first contaminating part of the coastline of Oriental Mindoro before reaching the island of Semirara further south and even Palawan, more than 300 km to the south-west.

As the oil continued to leak out slowly, it washed up on the shores for several weeks, sometimes drifting south, sometimes north-north-west, depending on the prevailing winds and currents.

At the request of the French Embassy in Manila and with funding from Expertise France, Cedre sent an expert on site from 16 to 29 March 2023, to assist the authorities in charge of the spill response.

Through our expert present in the field within a Philippine Coast Guard team, we were able to follow the response operations in progress, both on- and offshore. We also gained insight into the strong involvement of all the players, at both national and local level, in managing this incident.

At sea, Cedre's expert provided assistance with the positioning of the two tugs involved in the oil recovery operations, advising that they be positioned offset from each other to operate in a

IN SHORT

28 FEBRUARY 2023: SINKING OFF THE PHILIPPINES

Oil tanker *Princess Empress* • RDC Reield Marine Services

J- rather than a U-configuration. This adjustment helped to optimise the collection operation by recovering the oil continuously rather than sequentially.

On the oiled shoreline, our expert also took part in several surveys alongside the Philippine Coast Guards and recommended certain clean-up techniques that had already been tried and tested in France, such as the use of concrete mixers to clean oiled pebbles.

Cedre's laboratory, which specialises in pollutant analysis, also provided support to the Marine Environmental Protection Command (MEPCOM), by analysing several samples collected on the polluted shoreline to compare them with the oil from the tanks of the *Princess Empress*. A study on the pollutant's biodegradability potential was also carried out.

Finally, all the observations made in the field during this international mission will help Cedre to continue to expand its knowledge and enhance its ability to provide advice in the event of similar incidents. ■

Shoreline clean-up operations

Experimental trials to support spill response

By Stéphane Le Floch, Research Department Manager, Cedre.

In summer 2023, France ratified the International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea, known as the HNS Convention, highlighting the need to understand the fate and potential impact of these substances in the marine environment in the event of an HNS spill.

Furthermore, today there is a strong focus on new propulsion fuels. Indeed, the International Maritime Organization, within the context of its policy to reduce the carbon intensity of international shipping, has set a target of cutting greenhouse gas emissions from ships by 40% by 2030. The immediate upshot of this decision is the consideration of new types of fuel such as cryogenic ammonia (-30°C) and methanol, whose fate in the marine environment in the event of a spill is currently unknown.

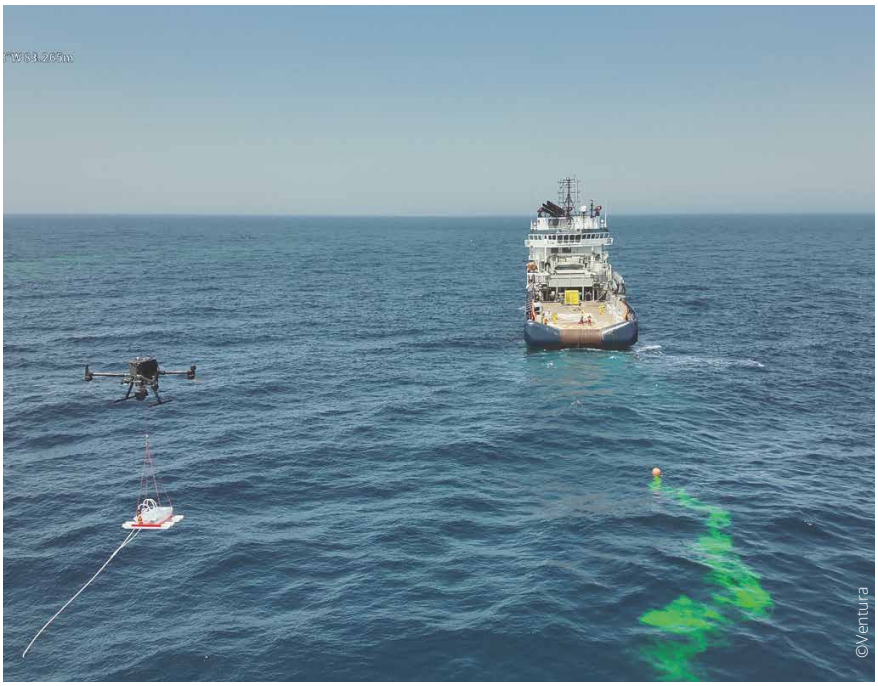
This context supports Cedre's policy relating to HNS spill response preparedness, initiated in the early 2000s with the support of the French Navy. Cedre's research strategy is based on a methodology developed to characterise the fate of chemical and oil products in the marine environment through tests at three scales: laboratory-scale, pilot-scale and at-sea trials.

In the laboratory, the dissolution of chemicals in the marine environment is characterised according to the salinity and temperature of the seawater. This information is very difficult, or sometimes impossible, to find in the technical (safety data sheets) or scientific literature, as it is often only assessed in freshwater and at standard laboratory temperature (20°C). Yet it is vital information, as it determines the capacity of products to enter and spread through the water column.

Cedre's chemical test bench

At pilot scale, Cedre has developed one-of-a-kind tools designed, for example, to study the quantity of product dissolved in the water column, per metre, as it rises from a sunken wreck. To date, this system, known as the Cedre Experimentation Column (CEC), has been used to measure the volumes released and upwelling rates of 65 chemicals. In terms of operational conclusions, the results have shown that products with a significant solubility can unexpectedly form a slick at the surface of the water. Among Cedre's other pilot-scale equipment is a counter-current column to study the fate of products upwelling from the deep sea and a chemistry test bench used to study the distribution of a floating product between the water column and the atmosphere. Using this equipment, it was possible to demonstrate that methanol, a completely soluble product, entered the aqueous phase and formed a subsurface slick that could

Cedre's counter-current column



UAV at-sea trials as part of the C.NEST project

potentially evaporate to form a toxic or even flammable cloud. The main purpose of these tools is to study the fate of a product spilt at sea via an integrated approach, i.e. by simulating the various weathering processes (dissolution, evaporation, settling, etc.) simultaneously, under controlled environmental conditions. The risk analysis for a specific incident can thereby be fine-tuned, and the responders can be alerted as to the incident's specificities.

The final, and no doubt the most important, scale is that of the at-sea trials. Cedre, in cooperation with the French Navy and with logistical support from CEPPOL, has been organising at-sea trials for over forty years. These trials are designed to test response equipment (booms, skimmers, dispersant spray arms, etc.) or detection equipment (cameras, detectors, etc.), to assess the performance of response products such as dispersants, or to confirm the results of laboratory and pilot-scale tests on the fate of products in natural conditions. The ultimate purpose of these trials is to optimise response strategies, taking into account the chemistry of the product (oil, HNS or plastic) and of available or newly developed response equipment, such as UAVs (Unmanned Aerial Vehicles). These operations fall within the regulatory framework of the MARPOL Convention (see box).

The C.NEST project (2023) provided the opportunity to determine whether a major methanol spill at sea could lead to the formation of a toxic cloud. These trials are also the chance to involve our colleagues from the contracting parties to regional agreements (in particular the Bonn Agreement). During these trials, the United Kingdom, Spain and Belgium have been able to validate their on-board systems (on vessels and aircraft) for detecting pollutants at sea. The European Maritime Safety Agency (EMSA) has also provided satellite images (radar) showing slick drift in real conditions. To conclude, these trials are crucial to enhancing the decision support systems required to define response strategies and equipment requirements. ■

MARPOL Convention and at-sea trials

The International Convention for the Prevention of Pollution from Ships, or MARPOL Convention, was adopted at IMO (International Maritime Organization) in 1973. Amended by the 1978 and 1997 Protocols and updated by various amendments through the years, the MARPOL Convention covers pollution by oil, noxious liquid substances carried in bulk, harmful substances carried by sea in packaged form, sewage from ships, garbage from ships and the prevention of air pollution from ships.

Article 2, paragraph 3, of the MARPOL Convention states that the term "discharge" does not include the discharge of harmful substances for purposes of legitimate scientific research into pollution abatement or control. At-sea trials are therefore carried out in compliance with current international regulations.

An introduction to CEPPOL

Interview with Captain Gauthier Dupire, Director of CEPPOL and Lieutenant Commander François, Deputy Director of CEPPOL

By Anne Ily, Information and Communication Department Manager at Cedre.

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François, Deputy Director of CEPPOL and Gauthier Dupire, Director of CEPPOL

Can you briefly present CEPPOL?

Gauthier Dupire (G.D): For that we need to backtrack to 1972, when a decree issued by the French Prime Minister assigned responsibility for responding to oil pollution in the open seas to the armed forces. Seven years later, in the aftermath of the *Amoco Cadiz* spill, CEPPOL came into being. Historically situated at the naval base in Brest, we work for the Maritime Prefects and are the centre of spill response expertise for all the coasts of mainland France and the French overseas territories.

François (F.): CEPPOL is the reference centre for all of the French Navy's pollution response units. Our team of around ten people focuses on three areas of expertise on a daily basis: assistance to vessels in difficulty, pollution response and rescue at sea.

What are your ties with Cedre?

G.D: We are both offspring of the *Amoco Cadiz*. That naturally creates a bond! In concrete terms, Cedre provides scientific expertise and knowledge, while CEPPOL contributes technical and operational skills and has access to the French Navy's substantial resources. We are highly complementary.

Can you explain the collaboration between CEPPOL and Cedre in more detail?

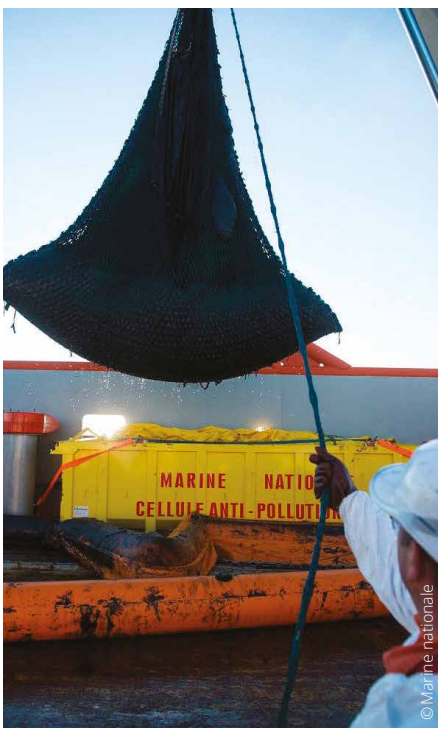
G.D: In terms of training, for example, we have close links with Cedre. Our role at CEPPOL is to define the spill response training needs of the French Navy and other relevant administrations. We then send these specifications to Cedre, so that we can draw on their scientific and technical expertise. The real added value of Cedre's training courses lies in the fact that they are jointly designed in order to match the Navy's needs (this is the case, for example, of the aerial observation course for naval aviation and customs crews).

F.: CEPPOL also provides lecturers for some of Cedre's training courses to ensure the exercises are as realistic as possible. One example of this is our team's contribution to an exercise simulating an oil spill in the open sea.

G.D: We also sometimes have specific requests, for example the creation of a board game for use during a training course or the production of a video tutorial on "how to take oil samples" for all the French Navy units. Again, in these instances, our proximity and complementarity with Cedre facilitate these tasks.

F.: As far as equipment is concerned, our role is to define the quantitative requirements for all of France's coastlines. We define the list of equipment required in case of a spill. We draw up the technical clauses for the different contracts and call on Cedre to assess new equipment. It is important for us to have neutral, unbiased advice on recent, lesser-known equipment.

G.D: Recently, we commissioned a study by Cedre on the resistance of clearance divers' equipment in the event of a chemical spill. Cedre has the necessary skills and facilities to



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Recovering oil at sea

investigate these technical issues. For our part, we provide significant in-kind services to help projects move forward more quickly. Cedre also benefits from innovation by the French Navy to make advances in these areas. It's a win-win relationship.

And what about emergency response?

F.: CEPPOL is responsible for validating the operational readiness for spill response of the different military units. To do so, our team takes part in emergency response exercises, known as ORSEC exercises, for the coastlines of mainland and overseas France, in which Cedre plays a key role, from scenario design to implementation. It also contributes to the Drift Committee.

Can you tell us about the at-sea trials?

G.D: To respond to a spill, it is essential to know the fate of the pollutant at sea, i.e. how it will behave, how it reacts and where it will end up. The answers to these questions will help to define the response strategies to be implemented. We therefore organise at-sea trials to validate the results of laboratory tests on the fate of pollutants. During these trials, we are also able to test our on-board sensors and assess the potential of new detection techniques, as well as validating the modelling tools currently used to manage incidents. This work provides input for the marine chemical emergency response sheets drawn up for response teams.

What are the upcoming challenges?

G.D: Our main focus is now on the future and the new risks at sea. What will we be facing in the coming years? We are keen to stay one step ahead and find answers to this question at an early stage. This is one of the reasons why we work synergistically with Cedre. Chemical pollution is a threat that has been clearly identified by the Navy. Cedre is also well aware of these new challenges and conducts studies in this field. To support its experimentation, Cedre has access to the resources of the French Navy and CEPPOL. This creates a virtuous cycle thanks to which we are able to progress intelligently and efficiently.

F.: In the future, our attention will also be turning to spill response at offshore wind farms and the risks related to new propulsion fuels, such as methanol, for which studies are already underway, but also other new fuels. ■

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Coordination by CEPPOL of the resources deployed to respond to the sinking of the Grande America

At-sea trials: an important component for developing and validating marine pollutant drift and behaviour models

By Sébastien Legrand and Ludovic Lepers, Royal Belgian Institute of Natural Sciences.

Marine pollution drift models such as OSERIT, MOTHY, MOHID, OpenDrift, GNOME, OILMAP/CHEMMAP and MEDSLICK have been used for many years by maritime authorities to simulate the fate of crude and refined petroleum products, fuel oils and, in some cases, liquid or gaseous chemicals spilt at sea. These models help to assess the risks posed by marine pollution and guide decision-makers in their choice of the most effective spill response strategy.

But did you know that each model is the result of a long, multidisciplinary collaboration involving laboratory measurements, small-scale testing and at-sea trials? To illustrate this point, we explain below various key stages in the development, calibration and validation of the OSERIT "HNS" module developed as part of the European MANIFESTS and MANIFESTS-Genius projects (see Cedre Bulletin #42, 44).

Step 1: Define the purpose of the model and identify the dominant physico-chemical processes

The overall purpose of the OSERIT "HNS" module is to provide information on the drift and fate of one or more chemical substances spilt at sea during the first few hours or even days following their release. Although the module is designed to be generic, the developments made as part of the MANIFESTS projects focus mainly on gases such as methane and liquids known as "evaporator-dissolvers" (e.g. methanol or aqueous ammonia) which can be transported and/or handled at ambient temperature. In addition to drift, the model must be able to predict information on the persistence of the pollutant at the surface, the changes in concentrations both in the water column and in the atmosphere over time, and the exposure times to concentrations above certain predefined toxicity thresholds.

Step 2: Identify the dominant physico-chemical processes and their parameters

Applying the simplifying assumption that hazardous and noxious substances do not chemically react with each other, the model must be able to simulate evaporation, dissolution, volatilisation, degradation (biodegradation and photo-oxidation) and, where relevant, emulsification. The model must also be able to simulate the advection and spread of the pollutant at the sea surface (in the form of slicks), as well as the advection-diffusion-dilution of the pollutant in the water column (in the form of bubbles, droplets or dissolved substance), or the advection-diffusion-dilution of the pollutant in the lower layers of the atmosphere (in the form of a toxic cloud).

The effect of each physico-chemical process can be described using an empirical law, also known as a "parameterization" in modelling jargon. These laws are expressed as far as possible in terms of the physico-chemical properties of the substance in question (density, viscosity, solubility, saturation vapour pressure, Henry's law constant, etc.), the phase of the pollutant (surface area and thickness of the slick, size of liquid droplets or gas bubbles, concentration of the dissolved phase, etc.) or environmental conditions (air or water temperature, wind, waves, currents, salinity, etc.).

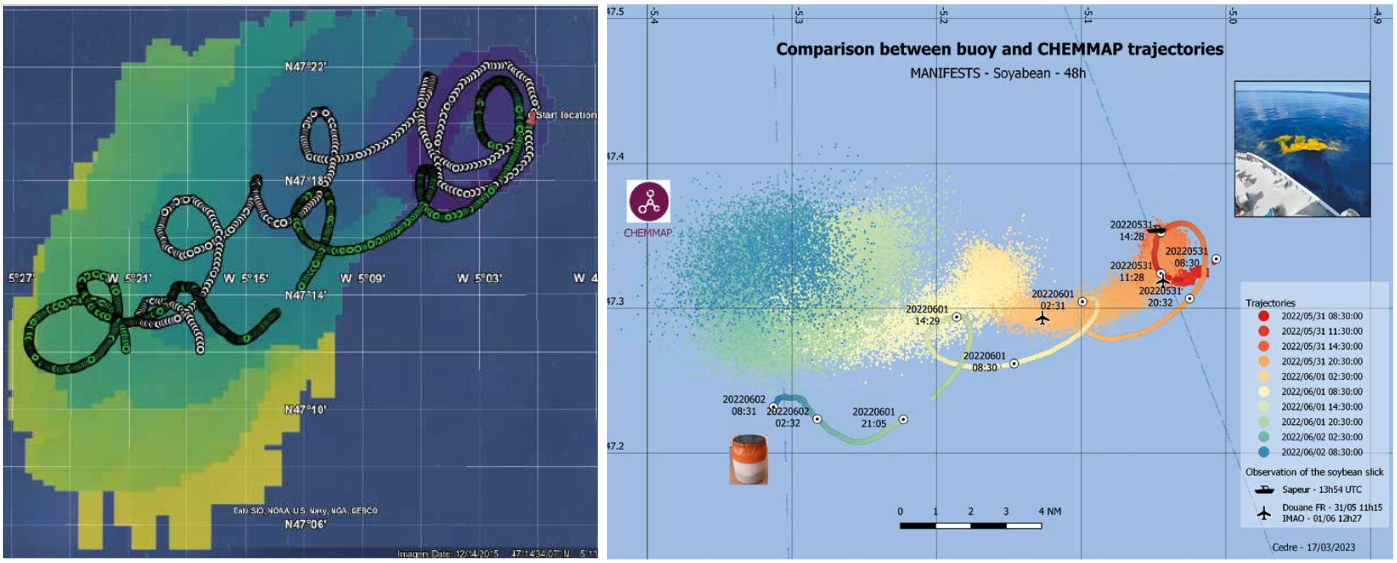
These parameters are often calibrated on the basis of small-scale laboratory measurements, for a limited number of substances and/or a limited number of environmental conditions. In order to improve our models, we need to continue and consolidate this experimental work.

Step 3: Implement the model

This stage consists in developing calculation software that uses the physico-chemical processes in order to predict changes in the drift and the behaviour of the pollutant at sea over time, in various different environmental conditions. In addition to the general architecture of the code, many modelling choices are made at this point, such as the selection of parameterizations, the order in which they are calculated, the time step with which they are calculated, and so on. All these choices are guided, among other things, by the overall purpose of the model and the modeller's – often intuitive – understanding of the dynamics of the spill at sea.

Step 4: Calibrate and validate the model

Before it can be used for real spills, the calculation software developed in the previous step needs to be calibrated and/or validated with as many test cases as possible. There are



Comparison of the trajectory of a drifting buoy released at sea during the trials with the OSERIT (left image, 72 hrs) and CHEMMAP (right image, 48 hrs) simulations of a soybean oil slick. The trajectory of the drifting buoy is represented by the green line in the left-hand image and by the coloured line in the right-hand image. The forecast contamination is represented by the mass of coloured dots.

three main categories of test cases that can be used: past spills, small-scale experiments and at-sea trials. Each category has its advantages and limitations.

Past spills have the undeniable advantage of being real cases. However, the information obtained from situation reports and aerial and satellite imagery is generally sporadic. At best, they provide a qualitative validation of the model for the given incident.

Small-scale experiments have the advantage of being carried out in an controlled environment by scientists. According to their design, specific aspects can be validated. For instance, the small-scale experiments carried out by Cedre as part of the MANIFESTS project validated the simulation by the OSERIT model of the competition between evaporation, dissolution and volatilisation – at least on the scale of a Petri dish.

Finally, the at-sea trials led by CEPPOL and Cedre offer a better understanding of the behaviour at sea of an increasingly broad range of chemicals.

Based on the knowledge gleaned during each campaign of trials, we are generally able to reconsider the modelling choices we made when developing the model. Over recent years, the main objective of the at-sea trials has been to test equipment designed to detect chemicals on the sea surface and in the air. These observations have validated the simulation by our model of the drift, spread and persistence of chemical slicks. In the near future, changes in the concentrations of a chemical in the air and the water column will also be measured during at-sea trials, in order to validate all the processes. These trials thus undeniably play a decisive role in the development and validation of models simulating the fate of chemicals at sea. ■

Preparing buoys on the deck of a vessel

Evaluation of remote sensing equipment to support the management of chemical spills and incidents at sea

By Pierre-Yves Foucher, ONERA.

The French Aerospace Lab (ONERA) has been involved in research and development activities in the field of direct and indirect remote sensing of human activity, particularly for crisis management, for many years.

Both the optical and radar remote sensing equipment developed and/or available at ONERA has thus been tested and evaluated for maritime pollution surveillance as part of various research projects and industrial partnerships since 2013, in particular in collaboration with Cedre. During these various projects, at-sea trials under operational conditions have provided crucial additional information on the potential for detecting and characterising chemical spills at sea, compared with theoretical models and small-scale tests in tanks. As concerns radar, various multi-frequency and multi-polarisation SAR (Synthetic Aperture Radar) imaging concepts have been tested during airborne observation (SETHI equipment). In terms of optical observation, passive spectral imaging from the visible to the thermal infrared range has been deployed in different operational configurations: airborne observation and shipboard observation from response vessels.

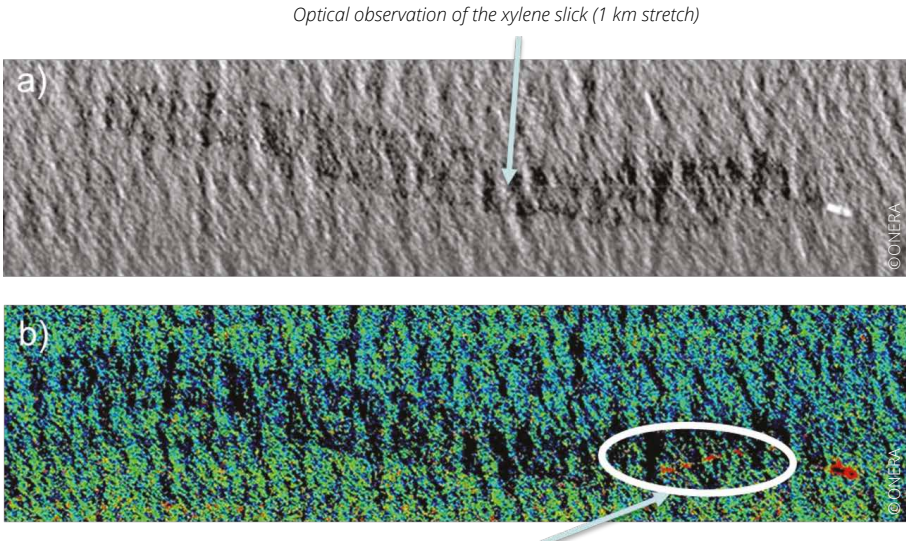


Figure 2: optical observation of a xylene spill during at-sea trials as part of the POLLUPROOF project. a) Wide-band near-infrared observation of the slick: detection over a 1 km-stretch. b) Spectral correlation map for xylene: identification of the product (shown in red) over a very limited area.

As part of the ANR POLLUPROOF project, three different airborne technologies were tested during at-sea trials: hyperspectral optical imaging in the reflective range, thermal infrared and radar imaging. The potential of airborne SAR (Synthetic Aperture Radar) imaging was also demonstrated for the first time for the detection and characterisation of HNS slicks, given that small-scale testing in tanks is not well suited to this technology (overlap, spatial resolution). Furthermore, the project highlighted a radical change in the behaviour of liquid chemicals at the surface due to the presence of swell and capillary waves, which have a major impact on their detectability and identification using optical spectral imaging: the observations made during the tank tests proved to be poorly representative of the open-space trials conducted at sea. Figure 2 shows that the slick appears darker than the sea surface in the near infrared, while xylene spilt on an unagitated surface in a test tank is characterised by an intensity 50% greater than the clean water surface in the same spectral range of observation. In this figure, the thickest part of the slick where it is possible to identify the specific spectral signature of xylene is shown in red; the spatial variability of the slick thickness is difficult to reproduce in tank tests.

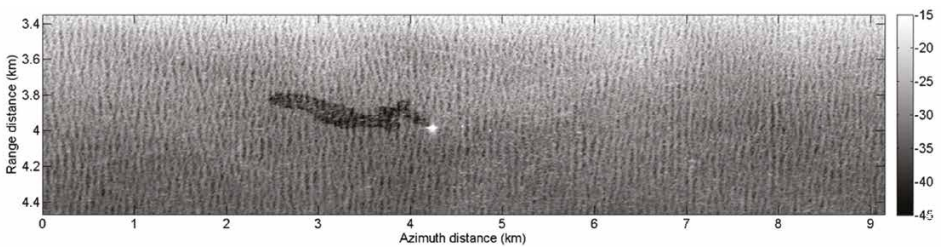
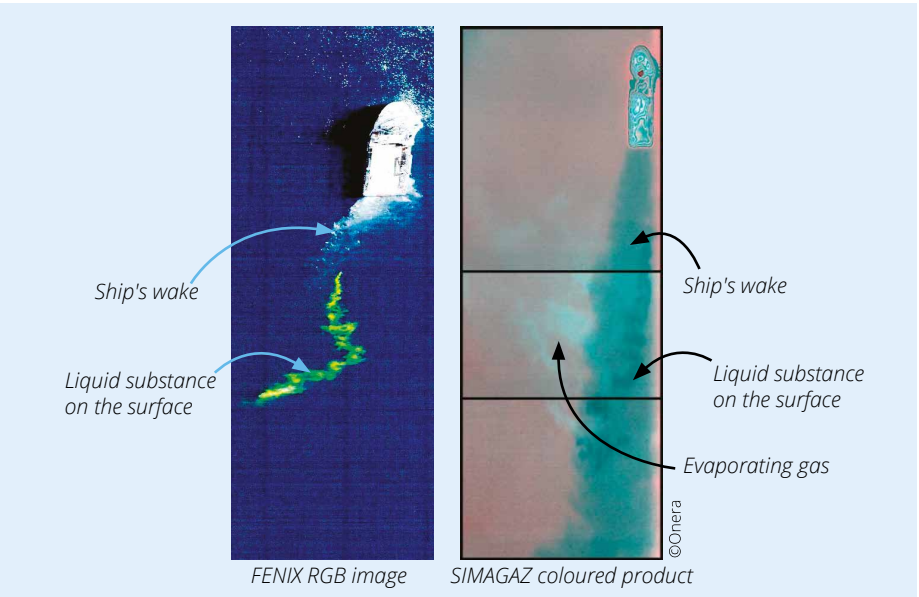
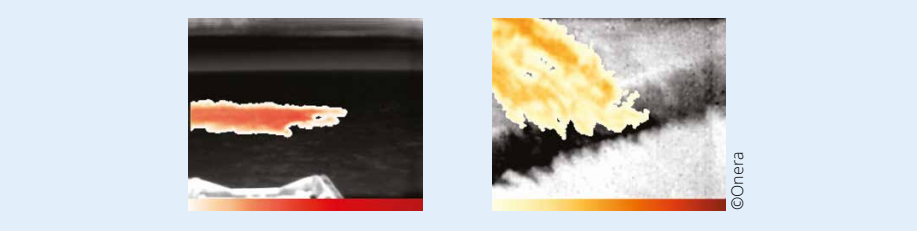


Figure 1: X-band radar (SAR) observation of a xylene spill over a distance of several kilometres during at-sea trials as part of the POLLUPROOF project.



Illustrations of optical observations during MANIFESTS at-sea trials. Typical airborne visible imagery for a release of dye (left) and spectral infrared imagery (SIMAGAZ instrument) for a colourless but volatile product (right): separation of the wake, the surface slick and the gas



Segmentation and quantification of evaporating gas (from 0 to 10,000 ppm from white to red) based on infrared spectral observations (SIMAGAZ instrument) from the vessel (left-hand photo) and the aircraft (right-hand photo).

Optical instruments that operate at wavelengths in the reflective range (0.4-2.5 µm: related to solar radiation) show a strong potential for identifying the spectral signatures of products for thicknesses of around 1 mm in tanks over relatively long periods (around one hour for a volume of 1 litre). However, during the various trials carried out in the open sea, the environmental conditions generate dispersion conditions that cause the chemical slicks to quickly spread, thereby affecting the optimal strategy for detecting and identifying them.

Similarly, when we study the contribution of optical imagery in the thermal range (8-12 µm: related to natural radiation emitted by surfaces), we observe significant differences in behaviour between the test tank scale and that of the open sea, making detection more complex, particularly in the case of agitation of the sea surface.

Since 2020, in collaboration with Cedre and CEPPOL, ONERA has taken part in various open sea experiments as part of the IPOMAC and MANIFESTS campaigns. During these experiments, a new thermal spectral imaging system, dubbed SIMAGAZ, was deployed on an airborne platform together with hyperspectral imaging in the reflective range from a vessel (surface view). While these at-sea trials confirmed that the identification of HNS slicks that appear identifiable during tank tests is particularly complex and limited in the case of spills at sea, they also showed that it was possible to observe evaporating clouds of volatile products. Although the detection of evaporating gases had previously been demonstrated during the POLLUPROOF project during tank trials, its operational application in the open sea initially appeared to be a delicate task. The images obtained during at-sea trials conducted since 2020 on various volatile products with the SIMAGAZ instrument thus open up new prospects for the operational management of chemical spills at sea. For various products, the characteristic sizes of the gas clouds observed are much larger than the characteristic sizes of the observable slicks and can be monitored over relatively long periods of time.

Through at-sea trials, it is possible to compare observations of the liquid slick and the evaporating gas cloud, in a realistic environment, with modelling results for product dispersion at the surface and in the air. It currently appears necessary to combine the use of measurements and models in order to provide reliable forecasts of the short- and medium-term fate of these pollutants in water and air, thus facilitating the definition and deployment of the appropriate emergency response resources in the event of chemical spills at sea. ■

ARISE – A unique private-public collaboration for consistent risk assessment of ammonia at sea

By Laurent Ruhlmann, Yara Clean Ammonia.

Yara Clean Ammonia is uniquely positioned to drive the hydrogen economy forward and mitigate carbon emissions in industries notoriously challenging to decarbonize. To make meaningful contributions to decarbonization efforts, it is imperative that ammonia production shifts towards using more sustainable energy sources and processes.

However, clean energy sources may not always be situated near the areas of ammonia consumption, necessitating an increase in ammonia transportation over long distances, particularly by sea. Ammonia, which does not emit CO_2 when burned, is expected to become a next-generation fuel as it contains zero carbon. Such developments are significantly altering the risk landscape of the shipping industry, as they introduce complex accidental release scenarios that must be addressed to ensure safety and sustainability in this new paradigm.

Accurately evaluating this impact requires acquiring specialized knowledge to evaluate the environmental and safety impacts of expanding ammonia usage. Cedre and INERIS are crucial partners in this endeavour to navigate the challenges posed by ammonia's lifecycle from production to end-use. Yara Clean Ammonia brings extensive operational experience and global leadership in developing a clean ammonia market for diverse applications.

Ammonia at scale release experiment – a long-standing tradition...

Ammonia has been produced, stored, and transported across the world at an industrial scale for more than 100 years. Around 80 percent of the ammonia produced today is found in agricultural products such as nitrogen-based fertilizers.
Starting in the 60s up to 2010, five major field-scale experiments have been conducted to understand the behaviour of ammonia releases.

Historically, ammonia safety research and modelling have been centred on its use in the fertilizer industry, focusing on warm ammonia releases over land. This research was crucial for developing safety guidelines and mitigation strategies, such as setting appropriate safety distances around land installations. However, as ammonia begins to play a significant role in shipping, particularly as a fuel, we encounter new risks associated with cold ammonia release over seawater. Unlike warm releases over land, cold releases over seawater are less understood, presenting a gap in the industry's ability to adapt existing consequence modelling software for maritime applications.

Trials conducted on ammonia by INERIS in 1997

Ship-to-ship bunkering in a port

ARISE
Ammonia Response In Sea Emergencies

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ARISE has been specially designed to acquire this missing knowledge through a unique collaboration between Cedre, INERIS, and the French Navy through its CEPPOL unit.

The journey started one year ago, when Yara Clean Ammonia approached Cedre to evaluate the possibility of updating previous work done in 2006 about ammonia dispersion onto sea water. Since then, considerable effort has been made, ARISE leaders, Cedre & INERIS, have progressively teamed up with globally recognized public organizations.

ARISE is conducted by steps over a 2-year span, starting with the validation of the various sensors' capabilities in the lab, followed by sea trial to test the measurement protocol and the buoys' deployment. Once these preliminary steps have been validated, a full-scale experiment will be conducted during Q2 2025. Yara Clean Ammonia logistics capabilities will then be combined with CEPPOL support, and multiple stakeholders will join to test various detection systems and later contribute to mitigation response establishment.

ARISE will aim at establishing clear guidance for impact prediction related to cold ammonia releases onto sea water. In continuity with this, multiple workshops will be organized to further propose/establish relevant mitigation strategies. Once the data have been collected, studies will be launched into the impacts on the marine environment.

Safety is a mindset that will continuously influence decision-making processes across all organization levels, starting with thorough and transparent risk evaluations. Ammonia's role in the energy transition is critical and ARISE marks a key milestone to ensure its safe deployment into society. Leveraging our deep ammonia expertise, we are committed to supporting ARISE, and we encourage the broader industry to join us in this effort. We would like to thank the sponsors who have already expressed their intention to contribute to the funding of the project. ■

ARISE
Ammonia Response In Sea Emergencies

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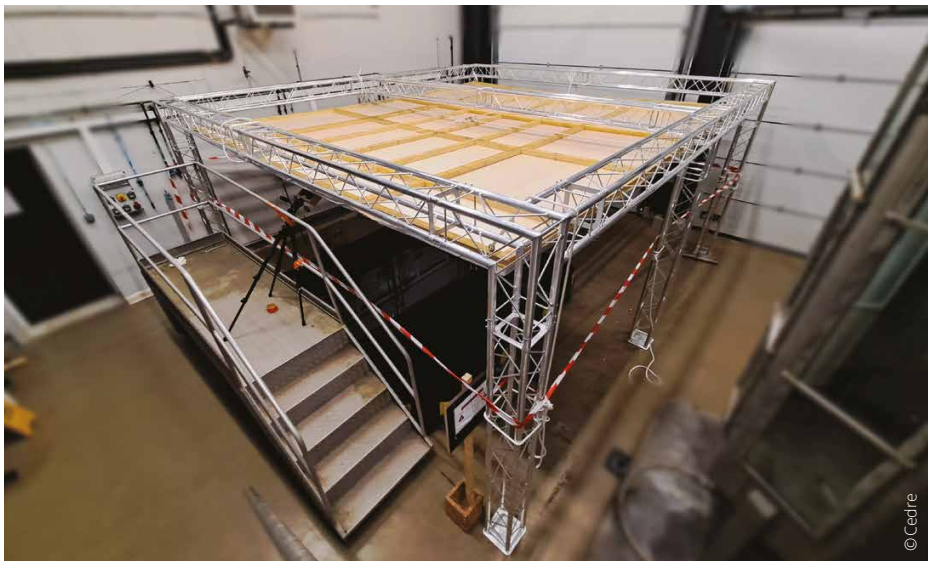
SINTEF

Expanding knowledge of sheen

By Ronan Jézéquel, Research Department engineer, Cedre.

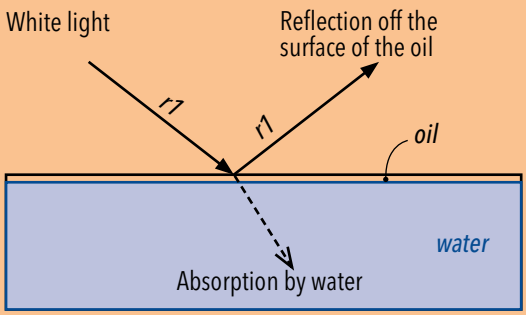
The term sheen is used to refer to a thin organic film at the water surface. There are two colour categories of sheen according to its thickness. These differences are not explained by a difference in chemical composition but rather by an optical phenomenon resulting from a change in how white light is reflected:

- for a thickness of less than 0.30 µm, white light is completely reflected, resulting in a "silvery/grey" colour;
- for a thickness between 0.30 µm and 5 µm, an optical phenomenon occurs involving the diffraction of white light and reflection and interference between different wavelengths, causing this sheen to take on a "rainbow" colour.

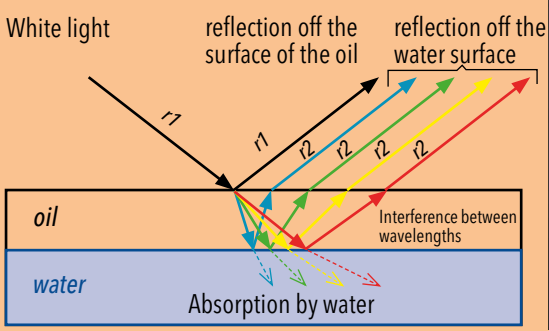


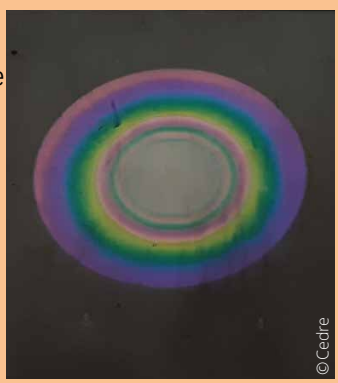
View of Cedre's experimental sheen observation system.

Sheen - thickness < 0.30 µm



Sheen - 0.30 µm < thickness < 5 µm





How is the volume of oil determined according to the surface area of sheen?

In order to obtain data to determine the volume of oil based on the surface area of sheen, Cedre has developed an original system together with an experimental protocol in order to repeat sheen observations over a total surface area of 20 m² under controlled conditions. Following tests carried out on a panel of crude oils and refined products, a correlation was established between the surface area of sheen and the volume of product spilt. The table below shows the results of this correlation, which confirms the data in the literature, in particular the Bonn Agreement Oil Appearance Code.

What happens to sheen?

Like oil slicks, sheen is sensitive to natural degradation processes (evaporation, photo-oxidation, dissolution and biodegradation). The kinetics involved in the disappearance of sheen are linked not only to environmental conditions

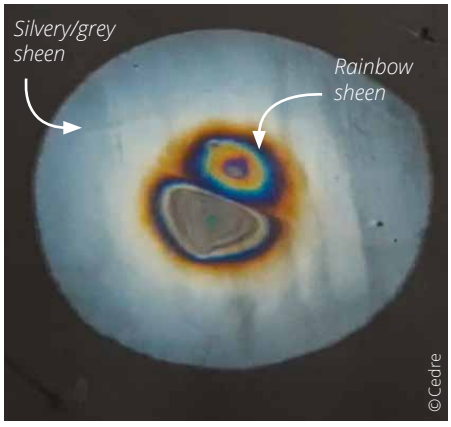
Surface area of sheen	Maximum volume	
	Silvery grey	Rainbow
1 m²	0.3 mL	5 mL
10 m²	3 mL	50 mL
100 m²	30 mL	0.5 L
1,000 m²	0.3 L	5 L
1 ha	3 L	50 L
10 ha	30 L	500 L
1 km²	300 L	5,000 L
10 km²	3,000 L	50,000 L

Correlation between the surface area and colour of sheen and the volume of product spilt.

(temperature, sunshine, wind, agitation) but also to the initial chemical composition of the product spilt. In the case of a light product (petrol, light crude oil, white spirit), sheen may disappear within a few hours due to evaporation and dissolution. In the case of heavier products (diesel, hydraulic oil, heavy fuel oil), sheen may persist for longer, especially if trapped in a soft substrate (sand, mud, earth).

Differentiating between natural sheen and oil sheen

Sheens occur naturally in the environment. It can sometimes be tricky to differetiate between natural sheen and oil sheen. The figure below shows some straightforward indicators that can be used to easily differentiate between sheens. Chemical analysis may be carried out to remove any doubt about the nature of the sheen. Sampling should be carried out by adhesion of the sheen to an inert material (e.g. Teflon film rinsed with solvent). Samples should ideally be analysed by gas chromatography with detection by mass spectrometry (GC-MS). The analysis should seek in particular to identify the presence of compounds in the alkane and aromatic families (specific to petroleum hydrocarbons) or carboxylic acids, fatty acids and squalene (compounds found in natural sheens).



Observation of the two colour categories of sheen following an oil spill.

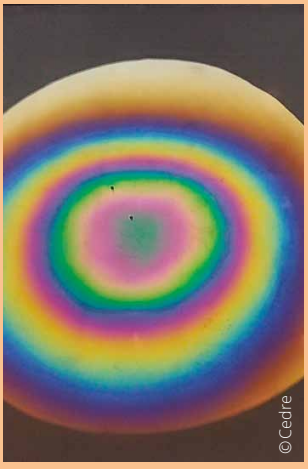
Managing sheen

In terms of recovery, the tests carried out confirmed the difficulty of recovering sheen. Sorbent pads are the most suitable method for recovering this oily film by adhesion to the surface of the sorbent. This recovery technique can only be used in inland waters. ■

Natural sheen (biogenic)

Iridescent appearance (rarely rainbow) whose colour depends on cloud cover. "Inelastic"/fragile film that fragments upon contact with a twig (like an ice-breaker navigating through an ice floe).

Oil sheen (petrogenic)



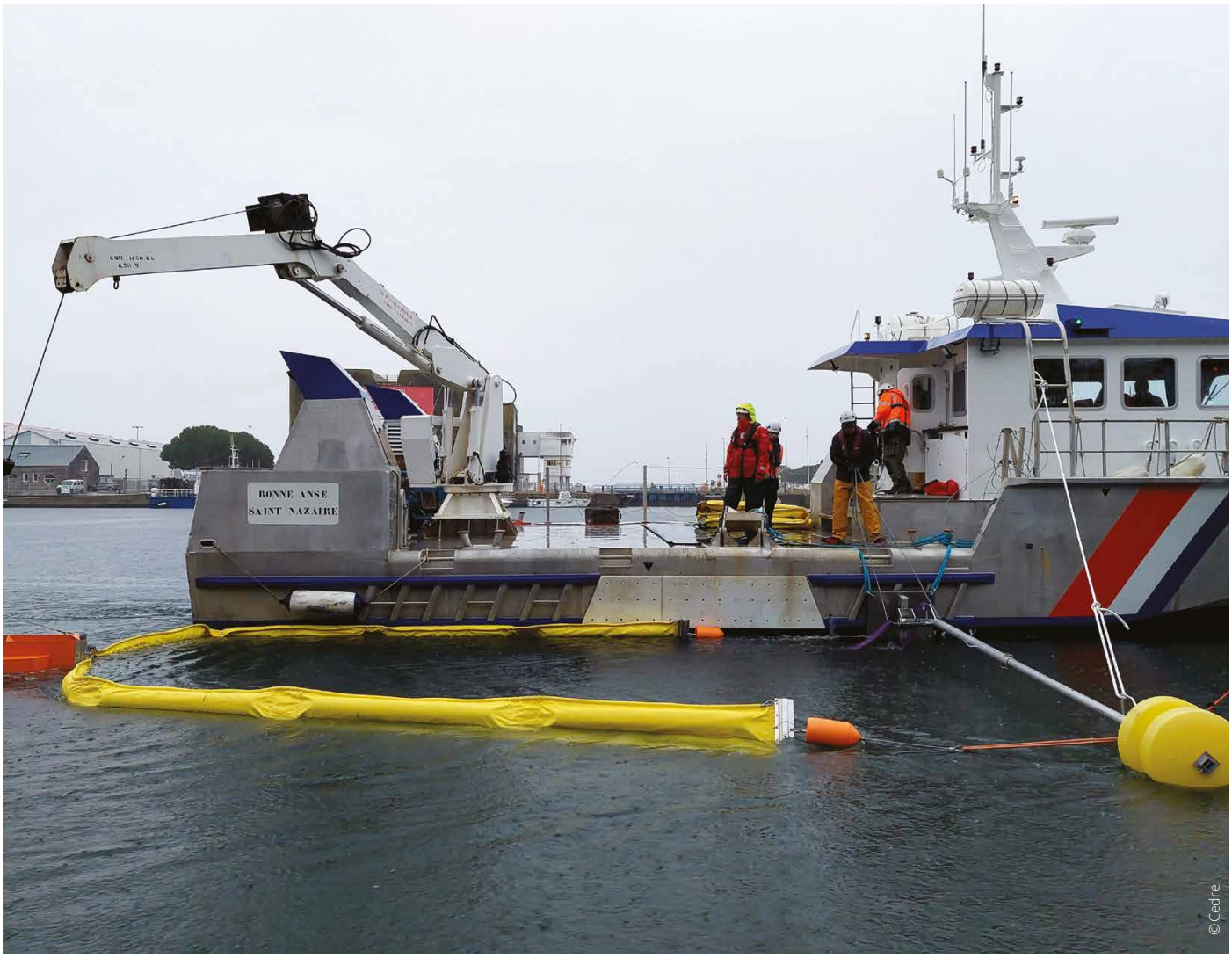
According to its spread, the colour may change from rainbow to silvery/grey. An "elastic" film that quickly reforms after being agitated.

Spill response equipment trials on the Loire

By the Analysis and Resources Department, Cedre.

Major and moderate spills regularly remind us of the need to be capable of implementing different response strategies both at sea and on the shoreline. They also sometimes highlight certain shortcomings or inadequacies of response systems, particularly for new types of pollutant.

Research and tests therefore need to be conducted on response equipment, whether newly developed or already on the market, which could fill the gaps observed or be complementary to existing equipment. Cedre has been contributing to this effort ever since its creation, through its ongoing assessment of response techniques at sea and on the shoreline. This initiative is part of Cedre's technical programme and aims to assess equipment for which there is a perceived need for investment by spill response equipment stockpiles (POLMAR Terre and Fast Oil Spill Team (FOST) in particular), or equipment that the French State or Cedre's other partners are likely to mobilise via French and foreign private stockpiles, or foreign public stockpiles, EMSA stockpiles, etc. Sometimes, well-established strategies may need to be partially revised in the light of lessons learnt and advances in techniques or products, as highlighted in the knowledge reviews and state-of-the-art reports that are an integral part of this initiative.



Recovery system on a vessel of opportunity

These equipment assessments are carried out either at Cedre, at partners' facilities, or in the natural environment. Since 2013, Cedre has been organising trials in the Loire estuary. These trials are carried out in partnership with the port of Nantes-Saint-Nazaire (GPMNSN) and the Nantes-Saint-Nazaire subdivision of Phares et Balises, with the support of the manufacturers and distributors of the equipment being tested. The Loire estuary has certain specific characteristics: currents often in excess of 1 knot, and up to 4 knots at flood tide and 6 knots at ebb tide, the risk of oil pollution due to the various activities in the area, the proximity of particularly sensitive sites, in particular classified natural areas, the significant size of the body of water, and the infrastructure available to facilitate equipment deployment.

Since 2013, six containment systems specially designed for strong currents have been tested, with or without paravanes, as well as skimmers and floating storage tanks. UAVs have also been tested over the nearby streams. As part of Cedre's 2023 technical programme, the French Directorate General for Maritime Affairs, Fisheries and Aquaculture (DGAMPA), via the *Pôle National d'Expertise POLMAR Terre* (PNE), TotalEnergies via FOST, and *UFIP Énergies et Mobilités* wished to assess two types of spill response systems: floating oil storage barges, designed to store oil recovered from the water, and collection systems with the specificity of being able to be adapted relatively easily to vessels of opportunity, i.e. vessels other than specialised spill response vessels. ■

Towing a floating storage tank

Determining the health status of estuarine ecosystems

By **Jennifer Laurent**, as part of a PhD thesis co-funded and co-supervised by Cedre and the *Université de Bretagne Occidentale*.

Estuaries, vulnerable ecosystems

Estuaries – where inland and marine waters meet – are considered to be one of the most productive natural habitats and provide a multitude of ecosystem services. Estuaries are areas of migration, reproduction, growth and survival for a large number of aquatic and marine species.

Many human activities of particular socio-economic importance are carried out in estuaries, for example fishing, port industries, agriculture, aquaculture, shellfish harvesting and tourism. Estuaries are thus exposed to a multitude of pressures, as well as to climate change.

All these stressors (multistress) greatly influence the health status of estuaries by triggering an overall decline in the quality of transitional waters together with biodiversity loss.

The degradation of estuarine habitats will affect estuaries' capacity to fulfil their ecosystem roles and have an impact on many estuarine species, including the flounder.

It is therefore crucial to develop high-performance diagnostic tools to determine the health status of estuarine ecosystems.

PIT tagging a juvenile flounder (RFID technology)

The European flounder: a sentinel species

The European flounder (*Platichthys flesus*), an estuarine flatfish, is mainly found in coastal and brackish waters, with a preference for soft bottoms and sandy-muddy substrates.

This species is found in all French and European estuaries, since its range extends from the White Sea (Russia) to the Mondego Estuary (Portugal). Like the eel, the flounder is a catadromous fish. It therefore spends a large part of its life in inland waters, migrating to coastal areas only to breed.

Consequently, the flounder, with its resolutely estuarine life cycle, its very high tolerance of variations in salinity and the low mobility in the estuarine system of juveniles, is a sentinel species of major interest for assessing the health status of estuarine ecosystems.

First case study: the Seine estuary - Chronic and accidental pollution

Assessing the impact of different types of chemical stressors in the Seine estuary

During the 19th century, the Seine estuary was greatly altered with the development of industrial and agricultural activities and urban areas. These human activities have led to multifaceted, chronic contamination, making the Seine estuary one of the most polluted in Europe.

The wide range of pollutants present in the Seine cannot be accurately quantified because not all of them are known. Biological analysis is therefore a very relevant approach, as it can directly measure the impact of man-made molecules on organisms.

Dissection equipment for taking tissue samples for analysis (stereo microscope, dissecting equipment, Eppendorf, liquid nitrogen)

This study aimed to review the current impact of multistress on flounders in the Seine, in order to analyse adults' response and to determine whether climate change constitutes an additional stress factor.

To do so, a multi-biomarker approach was developed on sexually mature adult flounders to characterise their health status in the Seine compared with the Canche (reference estuary to the south of the Seine).

Temporal variation in winter temperatures in the estuarine waters of the Seine and Canche shows a slight increase in the winter water temperature since 2017, as a consequence of climate change.

Initial analyses conducted on flounders revealed changes in their reproductive phenology compared with previous years. These changes would appear to be the result of higher water temperatures in winter, which delay oocyte

maturation and spawning in flounders in the Channel. The rise in temperatures in the English Channel in winter thus leads to a later spawning period.

Metal concentrations in flounders were relatively similar between the two systems, although the levels were lower in the summer. In the Canche estuary, the lower metal concentrations in flounders in the summer could be related to the low flow rate of the coastal river in a northwards direction, between the Seine and the eastern Channel, reducing the flow of metals. This flow, drifting towards the north-east of the Channel, carries pollutants as well as eggs and larvae from the Seine.

Measurements of organic pollutants in the livers of flounders revealed higher concentrations in the Seine than in the Canche. However, it is important to note that contamination in the Seine was much lower in 2018 than in the 2000s.

Thanks to the biomarkers measured, it was possible to detect the impacts of chemical stress and climate change on the flounder population in the Seine. Based on the findings of this study, we suggest that the flounder population in the Seine, as well as those in the eastern Channel, could be seriously affected in the future by multiple stresses, such as higher winter temperatures combined with high levels of chemical contamination.

Assessing the impact of a spill in the Seine estuary: the Lubrizol and Normandie-Logistique fire

On 26 September 2019, in Rouen, a fire broke out at the Lubrizol plant (classified Seveso as it produces and stores perfluorinated and organosulphur compounds) and in the chemical storage warehouses of Normandie-Logistique, which specialises in the transport of dangerous goods.

The fire brigade used firefighting foam to extinguish this major blaze. As a result, the fire-fighting water mixed with various chemicals was discharged into the Bassin aux Bois harbour basin (2,000 m^3), which is connected to the Seine. The fire also produced a thick plume of black smoke, reaching an altitude of over 20 kilometres.

This study aimed to assess the impact of the spill caused by this incident on water quality in the Seine estuary.

This work built on a previous study, carried out in 2017, which focused on assessing the quality of estuarine water in the Seine through proteome analysis of flounders. Following the fire, a similar experiment was carried out, in particular by capturing juvenile flounders in the Canche, then caging them in Rouen, 10 kilometres downstream of the factories where the blaze occurred.

SAY WHAT ?

***Proteome analysis:**
A technique providing an image at a given moment of all the proteins in a cell, whether human, animal or plant.

Sampling juvenile flounders by hand-seining in the Horn estuary (Plougoulm, October 2019)

The flounders that were caged for a month downstream of the incident site showed no apparent symptoms of deteriorated health.

However, the proteome analyses carried out on the livers of caged flounders showed an overexpression of proteins associated with xenobiotic detoxification pathways in the Seine, confirmed by biomarker measurements.

Proteomics also revealed a strong dysregulation of lipid metabolism in the Seine, and more specifically cholesterol synthesis, which was confirmed by the measurements taken in the muscle tissue of the caged fish.

In view of these results, we performed biomarker measurements (fire-fighting foams) in the sediments, in order to detect additional pollution generated by the incident, which could explain the responses induced in the flounders.

However, the pollutant concentrations in the sediments sampled at the start of the caging operation in 2019 were lower than those measured in 2017. The low level of sediment contamination could be related to the emergency protocol introduced at the time of the incident (POLMAR plan), which involved containing the contaminated water in a basin adjacent to the Seine (containment booms), and pumping out the contaminated water.

We therefore suggest that the fire may have led to diffuse contamination of the Seine as the smoke plume, containing dioxins and furans formed by combustion, spread over the city of Rouen. The toxic substances were then deposited on the ground and leached by rainwater into the Seine.

The caged flounders could have been contaminated through their food intake, as amphipods concentrate dioxins and furans without being affected by their toxic effects. Contamination by these organisms could explain the lipid metabolism dysregulation detected in flounders by proteomics.

Second case study: the estuaries of Brittany - Chronic pollution

Assessing the ecological quality of small estuaries in Brittany exposed to chronic multistress

Small estuaries are characterised by their limited size, low environmental heterogeneity and low inter-individual variability. They are less affected by human activities, as their small size restricts the installation of industrial and urban areas.

The primary objective of this study was to establish a typology of small coastal rivers in order to identify the main stress factors for each estuary and to define a reference system little affected by stressors. The second objective was to integrate proteomic responses in flounders in order to assess the overall ecological status of these small estuaries.

Sampling juvenile flounders by electrofishing in the Aven estuary (Pont-Aven, September 2019)

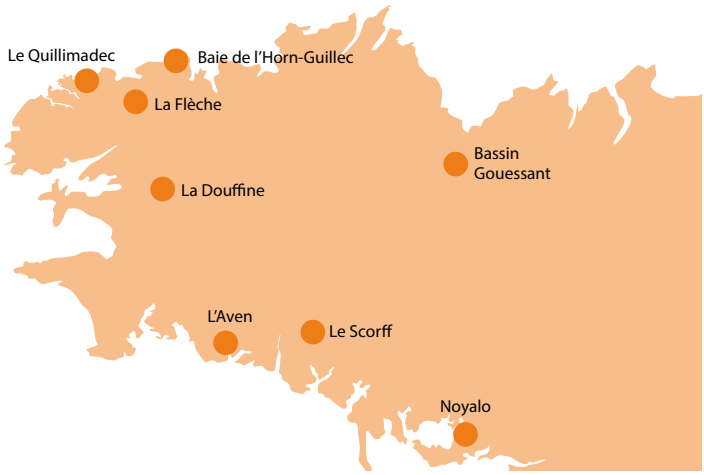
Electrofishing gear for sampling juvenile flounders in the natural environment

To do so, we developed a multidisciplinary approach combining catchment geography (land use), hydrobiology of the watercourses (physico-chemical parameters), pollutant chemistry and flounder biology (multi-biomarkers and proteomics). The results of the study revealed a diverse range of stressors in the estuaries studied.

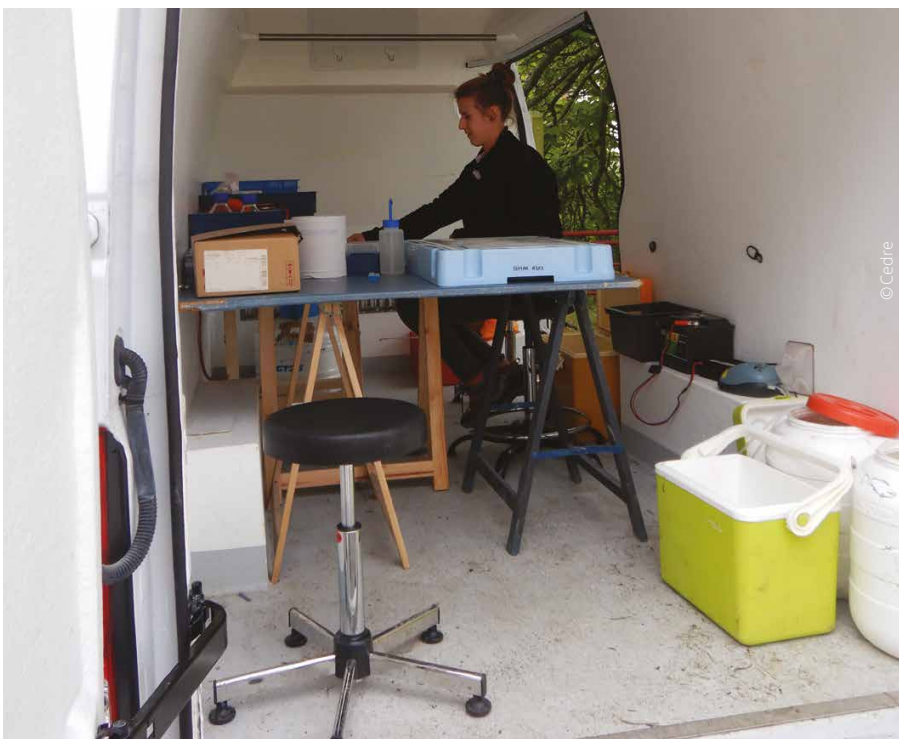
The most stressed systems were found to be Horn, Guillec, Flèche and Quillimadec, with high agricultural pressure and high concentrations of nitrites, nitrates and ammonium due to intensive vegetable production. The Gouessant basin is also under pressure from livestock farming and maize cultivation. Conversely, the Noyalo estuary shows high levels of organic pollutants, while the Scorff estuary shows chronic metal pollution. Finally, the Douffine estuary was marked by multi-metal contamination due to past mining activities and intense fish farming. In contrast, the Aven estuary was identified as the least affected.

Proteomics also revealed specific physiological responses by fish in each estuary. Fish in the Horn showed signs of detoxification and dysregulation of their urea cycle, those in the Penzé showed hypoxia-induced responses, and those in the Noyalo showed signs of xenobiotic exposure. Flounders in the Flèche estuary showed differences in their response to the cocktail of pollutants. Individuals in the Quillimadec showed responses to hypoxia and thermal stress, as did flounders in the Gouessant.

The results highlight the importance of an integrated, multidisciplinary approach to assess the impact of human activities on estuarine ecosystems.



Geographical representation of the Breton estuaries studied



Dissection equipment set-up in the field (fitted van)

In addition to *in natura* monitoring of flounder health, exploratory trials were carried out at Cedre's facilities. From an operational point of view, the main outcome was the definition of a measurement protocol to monitor the quality of aquatic environments subject to chronic or accidental anthropogenic pressures. This protocol could be used to assess the impact of fire water spilt into a river, or the impact of methanol, a future shipping fuel, in the event of a spill.

LAURENT J. *Ecologie du stress et qualité écologique de l'estuaire de Seine et des fleuves côtiers bretons : signatures environnementales et moléculaires chez une espèce sentinelle, le Flet (Platichthys flesus). PhD thesis presented and defended in Plouzané on 12 December 2023. PhD thesis of the Université de Bretagne Occidentale. Ecole doctorale n°598. Sciences de la Mer et du Littoral. Spécialité Biologie Marine.* Brest: Université de Bretagne Occidentale (UBO), 2023. 254 p.

Cedre and Cerema strengthen their cooperation

Signing of a partnership between Cedre and Cerema by Christophe Logette, Director of Cedre and Pascal Berteaud, Director General of Cerema

On 9 January, Pascal Berteaud and Christophe Logette formalised a scientific and technical cooperation agreement, consolidating the collaboration between Cerema and Cedre.

Cerema is a public body under the aegis of the French Ministry for Ecological Transition and Territorial Cohesion. It supports the State and local authorities in adapting to climate change and in their ecological transition. Cedre is delighted to be strengthening its ties with Cerema in litter prevention and management in natural environments, pollution risks posed by offshore wind farms and water pollution in coastal areas, ports, urban water systems and watercourses.

A new network to reduce plastic litter created and run by Cedre and OiEau

By **Marine Paul**, Aquatic Litter Monitoring and Studies Department engineer, Cedre

The International Office for Water (OiEau) and Cedre have joined forces to set up and facilitate a network, funded by the Loire-Brittany Water Agency, to support local authorities in the fight against plastic macro-litter.

3.3 tonnes of litter enters rainwater systems every year, according to a study carried out by Cedre in the Brest metropolitan area. Urban networks have been identified as routes for the transfer of litter into aquatic environments, whether watercourses or the marine environment.

Litter in urban areas

At national level in France, litter in wastewater and stormwater systems is the focus of several action plans led by France's Environment Ministry, in particular the Biodiversity Plan (2018) and the associated "Zero Plastic Waste at Sea" action plan (2020-2025).

At a more local level, while local authorities and urban water systems operators show interest in this issue, they are often confronted with operating constraints, debate over the best strategy and methodologies to be applied, roles and responsibilities, and return on investment.

Against this backdrop, OiEau and Cedre have joined forces to launch a support network for local authorities in order to promote innovation and the sharing of feedback and best practices.

To implement this project, funded by the Loire-Brittany Water Agency, 3 objectives have been defined, to be achieved by 2026:

- set up and facilitate a network of local authorities across the Loire-Brittany area, which are involved or wish to become involved in such an approach,
- support the implementation of measures to reduce plastic macro-litter,
- produce reference resources and make them available to the urban water systems.

Local authorities and urban water systems operators will thus benefit from independent advice in order to build a global, effective, sustainable strategy to reduce plastic macro-litter. ■

Taiwan OCA and Cedre collaborate to produce a Chinese version of the HNS Manual

By 游佳雯 (Sophie), Ocean Conservation Administration.

The Taiwan Ocean Conservation Administration and Cedre have collaborated to publish a Chinese version of the HNS Manual.

Given Cedre's extensive experience in marine pollution training, in 2019, Cedre solidified its collaboration with Taiwan OCA by signing a Memorandum of Understanding (MOU). The MOU aimed to bolster the exchange and cooperation between the two entities in various aspects related to pollution prevention and response capabilities.

Taiwan, situated in the Asia-Pacific shipping hub, sees numerous container ships, oil tankers, bulk carriers, and various vessels pass through its waters annually. Beyond establishing a structured response framework for oil pollution, Taiwan urgently requires the latest information on Hazardous and Noxious Substances (HNS) preparedness and response. The Marine HNS Response Manual (HNS Manual) serves as a crucial guide and standard for responding to HNS incidents. Consequently, Taiwan's Ocean Conservation Administration (OCA) and Cedre have collaborated to publish a Chinese version of the HNS Manual. This collaborative and friendly partnership between Cedre and Taiwan OCA not only strengthens Taiwan's capabilities in marine pollution response but also sets a model for international cooperation in marine protection, collectively contributing to the preservation of the Earth's marine ecology.

The HNS Manual provides practical and comprehensive information on marine HNS pollution. Produced under the direction of the French General Secretariat for the Sea and through collaboration with experts from Cedre, ISPRA, and ITOPF, its contents encompass conventions, regulations, classification of hazards and behaviours, preparedness, response, and post-leak management related to HNS transportation. It equips governments, interest groups and response organizations with responsibilities and cooperation methods to ensure efficient coordination and cooperation during a crisis. Additionally, it offers technical guidance and best practices for responding to specific HNS incidents, enabling response personnel to assess and manage the risks of marine HNS incidents immediately, make correct decisions, and take appropriate actions, thereby minimizing losses and negative impacts. Recognizing the manual's significant value for Taiwan in establishing a framework and division of labour for HNS pollution response, Taiwan OCA sought permission translate it into Chinese.

Through proactive communication and support from Cedre, the Chinese version of the HNS Manual has been successfully approved by all authors and sponsoring institutions and can be published and disseminated on its official website. Translating the handbook into Chinese enables Taiwanese personnel involved in marine pollution response, whose native language is Chinese, to overcome language barriers. This facilitates a better understanding of its guiding principles, procedures, and best practices, enabling them to take concrete actions to effectively manage HNS incidents. This initiative aims to enhance Taiwan's ability to address HNS incidents in the marine environment, effectively managing and mitigating potential impacts on the ocean ecosystem and public health.

Cedre will continue its collaboration with the Taiwan OCA, focusing on personnel training and equipment operation drills. Taiwan OCA also plans to undertake practical IMO level 2 oil spill management and IMO operational level HNS spill management training at Cedre in 2024, further elevating the professional proficiency of Taiwan's marine pollution response personnel.■

Marine HNS Spill Response Manual in Mandarin
Available at **www.cedre.fr**

Cooperation between Cedre and the Finistère fire and rescue service

by **Marguerite Lamour**, Chair of the Finistère fire and rescue service.

Finistère fire and rescue service's new training centre under construction in Saint-Ségal, Brittany

Response to water pollution incidents is of particular importance to the Finistère fire and rescue service. In an area with 1,430 kilometres of coastline that is highly exposed to the risks generated by maritime shipping, the fire and rescue service must be ready to take action on the shoreline in the event of an oil or chemical spill. Finistère is also characterised by a drinking water supply mainly provided by surface water catchments, which are at risk of being impacted by spills into watercourses, a risk which the fire and rescue service must be prepared to handle. The Finistère fire and rescue service (SDIS 29) has therefore invested in spill response units (DEPOL*) and mobile chemical response units (CMIC*).

SDIS 29 regularly contacts Cedre's duty team for operational advice or to request field expertise in the case of a complex situation. Cedre's expertise, based on its scientific research, databases and experience, is much appreciated by our DEPOL and CMIC teams.

In terms of training, ongoing collaboration is also in place with Cedre. SDIS 29 can train its personnel at Cedre's technical facilities and can rely on its experts to run certain training modules. In return, Cedre can also call on SDIS 29 to give presentations to its team or those of its partners.

Finally, SDIS 29 and Cedre cooperate as part of various research projects. The latest such project is IRA-MAR, a project funded by the European Civil Protection Mechanism. SDIS 29 and Cedre worked together on the use of unmanned aerial vehicles (UAVs) for spill response support and conducted various experiments at Cedre, at sea and on an Italian island, resulting in the design of a prototype sampling platform.

Presenting spill response equipment at Cedre

Testing UAVs and sensors above Cedre's test tanks as part of the IRA-MAR project

Boom laying training for the Finistère fire and rescue service at Cedre

A departmental training centre for the Finistère fire and rescue service is currently under construction and due to open in September. Cedre has been involved in this project since 2020 and helped SDIS 29 to define the specifications for its technical facilities. This training centre will feature several platforms, where Cedre will be able to conduct different types of exercises, equipment tests and research work that cannot be organised at its own technical facilities. At a first platform consisting of a leakage system and shipping containers, work will be able to be carried out on chemical spills at industrial or port sites. A road area composed of a tarmac road lined with different types of ditches, stormdrains, manholes, and overground and underground pipes, will be used to train teams in the containment of spills of hazardous substances on roads via a unique range of scenarios. The burn chambers were also designed to enable Cedre to conduct research on the burning of oil slicks. The future centre is set to open up numerous other opportunities for collaboration.

I am delighted to see such strong synergies between the Finistère fire and rescue service, which I chair, and Cedre, whose history is connected to the town of which I am mayor. Indeed, as an upshot of the grounding of the *Amoco Cadiz* oil tanker on our coastline in 1978, triggering the largest oil spill ever known, greater attention has been devoted to the preservation of the oceans through the creation of organisations such as Cedre, a trailblazer in marine pollution response.

Through this collaboration, major advances have been made in terms of spill preparedness and response, thus benefitting the environment and all users of aquatic environments. ■

SAY WHAT ?

*DEPOL

The "DEPOL" spill response unit comes under the Technological Risks Unit. One of its mains uses is to deploy booms in watercourses and canals.

*CMIC

The mobile chemical response unit (CMIC) is a specialist support unit set up to implement operational, preventive response actions in the presence of hazardous, polluting or unidentified products.

IRA-MAR
AMÉLIORER LA LUTTE INTÉGRÉE CONTRE LES ACCIDENTS DE POLLUTION EN MER ET LES RISQUES CHIMIQUES DANS LES PORTS

IRA-MAR

The IRA-MAR project on "Improving the Integrated Response to pollution Accident at sea & chemical risk in port", co-funded by DG-ECHO and coordinated by France's General Secretariat for the Sea, aimed to support countries in the Western Mediterranean and Atlantic regions (France, Italy, Malta, Morocco, Portugal, Spain and Tunisia) in improving preparedness for marine pollution events (including the risks related to traffic in ports of hazardous and noxious substances) through an integrated approach to response, both at sea, on the shoreline and in ports. This two-year European project, in which Cedre was heavily involved, came to a close on 29 February 2024.

Cedre, a key player in the development of Indonesia's maritime safety capabilities

MINISTÈRE DE L'EUROPE ET DES AFFAIRES ÉTRANGÈRES
Liberté Égalité Fraternité

DCSD
Direction de la coopération de sécurité et de défense

By **Héloïse Humbert**, French Security and Defence Cooperation Directorate.

With almost 16,000 islands, Indonesia is the world's largest archipelago, situated where the Indian and Pacific Oceans converge, at a strategic maritime location which 40% of the world's shipping traffic passes through. The Government of Indonesia, which embarked on an ambitious maritime development programme that is set to further increase shipping traffic along its coasts, has become aware of the need to develop an appropriate maritime safety policy.

Within this framework, France, through the Security and Defence Cooperation Directorate (DCSD), offered its assistance, which led, in 2021, to a French military volunteer being positioned within the Indonesian Ministry of Maritime Affairs. Placed under the Director for Maritime Security and Resilience, this naval officer is tasked with liaising between French and Indonesian specialists in this field.

As concerns marine pollution management, which is of vital importance in an archipelagic state, Indonesia is in a situation similar to that of France in the 1970s, before awareness was raised as to this issue following major spills. This was again demonstrated in February 2023 during the management of the grounding of the bulk carrier *MT Aashi* on the island of Nias. It was therefore natural for the DCSD and its French military volunteer to turn to Cedre to instigate bilateral cooperation in this field.

Pre-empting a year of rich discussions between Indonesia and Cedre, Ms Kusumawardani, the Indonesian Director for Maritime Security and Resilience, travelled to Brest on 28 December 2022 to visit Cedre and launch cooperation. This highly productive meeting led to new initiatives, in relation to both training and operations.

On 5 and 6 July 2023, a regional conference on maritime security was held in Batam, bringing together four Indo-Pacific coastal nations under the aegis of the European Union. During a crisis management exercise, an engineer from Cedre was able to advise participants on maritime pollution management.

A tour of Cedre's facilities for an Indonesian delegation

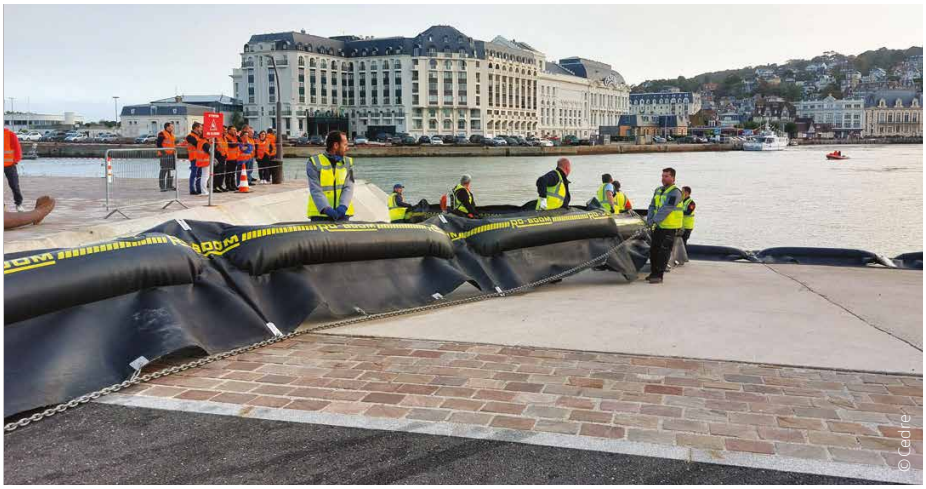
An Indonesian delegation taking part in the "Principles of chemical spill response at sea" course, organised by Cedre

Finally, from 7 to 10 November, a course entitled "Principles of chemical spill response at sea" run at Cedre, Brest, in compliance with International Maritime Organization standards for manager level training, included for the first time two Indonesian trainees, an oceanographic researcher from the Indonesian National Research and Innovation Agency (BRIN) and a policy analyst. ■

Two new training courses developed for local authorities and local councillors

By **Natalie Monvoisin**, Training and Studies Department Manager at Cedre.

Municipalities are on the front line for dealing with spills in aquatic environments, be it rivers, inshore waters or in port areas. The guidance for mayors and local authorities (www.mementodumaire.net) recently revised by IRMA (Institut des Risques Majeurs) now includes a section on "Maritime, river and coastal pollution" drafted by Cedre. The POLMAR Instruction, updated on 19 July 2022, also states that the responsibility for responding to pollution of the marine environment and the resulting coastline permanently lies with the maritime prefects, the departmental prefects and the mayors in charge of operations in their municipalities.



Deploying booms as part of a practical ORSEC/POLMAR exercise

Against this backdrop, Cedre offers standard training courses that are open to local councillors, as well as contributing to training courses for State services and local authorities run as part of the national ORSEC/POLMAR emergency response system, financed by France's Directorate-General for Maritime Affairs, Fisheries and Aquaculture and organised in each coastal department every three years. Cedre also decided to develop two specific training courses for local authorities and councillors, to be run throughout France, one devoted to "Managing accidental **marine pollution**" and the second to "Managing accidental pollution in **inland waters**". On 20 July 2023, Cedre was granted approval to deliver these training courses for local councillors by the French Ministry of the Interior and Overseas France.

These one-day courses will cover a range of topics, including pollution sources and aspects at risk, the legal and regulatory framework, the tools and expertise available, and the pollution section of local contingency plans, and will end with a case study. ■

Deploying a protective boom as part of a practical exercise in inland waters

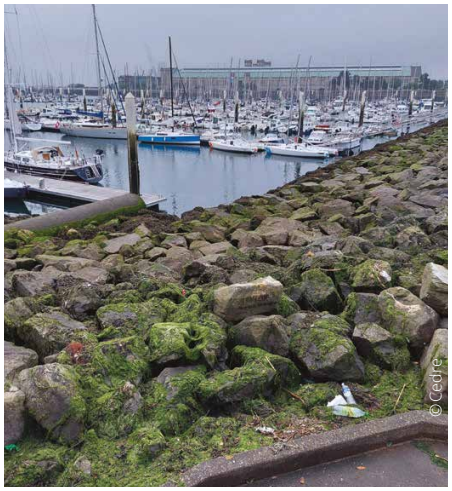
Worksite organisation and manual clean-up as part of a practical exercise

Find out more about these courses in the 2024 Cedre Training Catalogue available at **www.cedre.fr**

New European projects launched on aquatic litter

By the **Aquatic Litter Monitoring and Studies Department**, Cedre.

Cedre's aquatic litter activity continues to develop with the launch of two new European projects which have been awarded funding and will be tackling new subjects such as litter in ports and accumulation areas on the shoreline.



Litter washed up in a marina

TREASURE | Interreg North Sea | Co-funded by the European Union

Since June 2023, Cedre has been a partner in the European TREASURE project, co-funded by the Interreg North Sea programme and led by the University of Oldenburg (Germany). The TREASURE project, whose full name is "Targeting the reduction of plastic outflow into the North Sea", brings together 15 partners from 5 countries: Belgium, Denmark, France, Germany and the Netherlands.

This three-year project aims to reduce the outflow of plastic waste into the North Sea through five "Living Labs" in different countries. As part of these Living Labs, work will be carried out in order to improve:

- Governance & policy,
- Data collection & analysis,
- Prevention & behaviour change,
- Removal of plastic waste.

Within the TREASURE project, Cedre is in charge of coordinating the action focusing on the collection and remoal of plastic litter. Furthermore, under the French Living Lab covering Brittany, Normandy and Hauts de France, Cedre will be working on litter reduction in ports and watercourses by carrying out a pollution assessment, identifying best practices and existing response equipment, and developing resources to support the implementation of reduction actions (training, operational guides, awareness-raising tools, etc.).

For further information visit
www.interregnorthsea.eu/treasure
or **www.cedre.fr**

Interreg Atlantic Area | Co-funded by the European Union | free litterAT

Cedre is also participating in the Interreg project "Free-LitterAT", led by CETMAR (Spain), which aims to protect biodiversity by implementing innovative approaches to preventing and reducing marine litter. This project, whose full title is "Advancing towards litter-free Atlantic coastal communities by preventing and reducing macro and microlitter", is co-financed by the Interreg Atlantic programme. It was launched in November 2023 and brings together 24 partners and associate partners from 4 countries: France, Ireland, Portugal and Spain.

For this project, Cedre will be working on the development of new methods for analysing microplastics, the identification of marine litter sources, an overall assessment of plastic pollution in the Atlantic area and good practices for managing important standings of litter and areas of accumulation on the shoreline. Through this project, Cedre is set to strengthen its links with *IFP Énergies nouvelles*. This French research and training institute in the fields of energy, transport and the environment will be contributing to the project alongside Cedre, for the development of innovative methodologies for quantifying microplastics in the environment. ■

For further information visit
www.atlanticarea.eu
or **www.cedre.fr**

28 th Cedre Information Day on chemicals risks at sea

By **Christophe Logette**, Director of Cedre.

This year's Cedre Information Day was held in Paris on 21 March 2024. This 28th edition was hosted by TotalEnergies, to whom we are very grateful. The chosen theme for this event, organised with the support of the French Ministry of Ecological Transition and Territorial Cohesion, was chemical risks at sea.

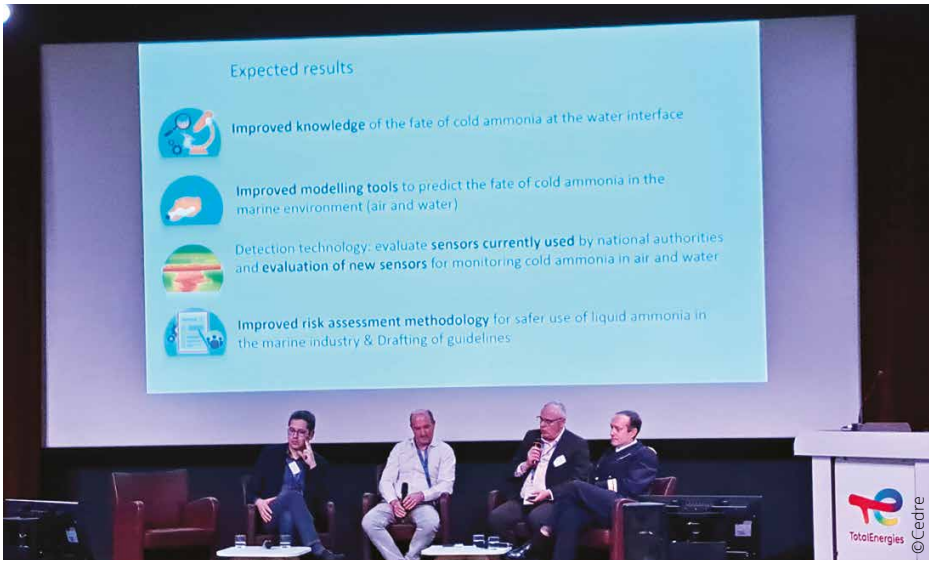
Panel session on chemical risks at sea with France's General Secretariat for the Sea, Transport Canada, the IOPC Funds, DGAMPA, and a P&I Club, chaired by Cedre's Director

The programme of conferences was dense and offered various different perspectives. Cedre would like to express its gratitude to the many speakers who contributed to the day's success. A number of international speakers took part, including Mr Gaute Sivertsen, Director of the IOPC Funds, Mr François Marier, Canada's representative to IMO, Ms Tonje Castberg for P&I Clubs, Mr Frédéric Hébert from EMSA and Mr Teemu Niemellä from the Finnish Border Guard. On the French side, the General Secretariat for the Sea, the Directorate-General for Maritime Affairs, Fisheries and Aquaculture, the French Navy's centre of practical expertise in pollution response (CEPPOL), CMA CGM, Yara Clean Energy, INERIS and, of course, several engineers from Cedre took the floor.

As an operational assistance centre with a public service mission, Cedre responds 24/7 to requests from the French State and local authorities in the event of a spill or pollution risk. Cedre also provides this service, in partnership with CEFIC, for European Union countries through the MAR-ICE network run by the European Maritime Safety Agency. This expertise is also on offer to foreign public or private players, as well as the United Nations through specific missions.

Within the context of an ongoing programme with the French Navy, Cedre has been studying the behaviour and fate of a wide range of chemicals in the marine environment for many years, and publishes operational guides, chemical response guides and spill response information sheets for the Navy's operational units. Cedre is also involved in, or in some cases leads, several projects on chemical risks funded by European programmes.

Spill response preparedness also requires regular training and exercises involving the release of chemicals at sea. Through its emergency response and training activities, Cedre makes a major contribution to the preparedness effort. ■



Discussion on the challenges and difficulties of ammonia as a shipping fuel with INERIS, YARA, CEPPOL and Cedre

IOSC 2024: Cedre was there!

By **Anne Ily**, Information and Communication Department Manager at Cedre.

This year, the International Oil Spill Conference, an unmissable event for all those involved in spill response, celebrated its 25th anniversary. From Monday 13 to Thursday 16 May 2024, the New Orleans Ernest N. Morial Convention Center (Louisiana) hosted more than 1,200 attendees and 360 exhibitors from the international community involved in responding to spills of oil, HNS and even plastics.

With international organisations, government agencies, private companies and associations, all sectors were represented to tackle today's major spill response challenges. This event showcased scientific advances, global research and operational innovations. The conference was also a networking opportunity for entrepreneurs, researchers, professionals and other stakeholders, promoting cooperation towards common goals by exchanging ideas and lessons learned from past incidents and research worldwide.

As in previous years, Cedre was in attendance! Seven of our team were present to run a stand, alongside members of Sycopol, France's union of spill response contractors, and to give six presentations on the following topics:

- Tackling the evaporation rates of volatile HNS: A lab-scale experiment to serve marine pollution response;
- Development of knowledge on plastic pellets pollution response;
- Study of the response preparedness in European and Mediterranean ports and identification of best practices and main gaps;
- Fate and behaviour of diesels (B0, B10, B30) and biodiesels (FAME, HVO) in case of an accidental spill;
- Evaluation of spill response equipment;
- Evaluation of multi-copter UAS performances in maritime pollution events through an integrated approach during fields trials with real HNS.

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The next event in this series of international conferences is INTERSPILL 2025, scheduled to take place from 8 to 10 April in London, where Cedre will be closely involved in the organisation and running of the conference. ■

EXCERPT FROM INLAND WATERS TECHNICAL NEWSLETTER #31

Pipeline leak: impact of a light product in a confined environment (Meraux Pipeline, Chalmette, United States)

On 27 December 2021, the 42-year-old Meraux Pipeline operated by Collins Pipeline Company (a subsidiary of PBF Energy, operator of the nearby Chalmette refinery) ruptured in St. Bernard Parish (New Orleans, Louisiana), releasing nearly 1,200 m^3 of ultra low sulphur diesel (ULSD) onto private land, from which it drained into two nearby artificial ponds.

Spill control operations were conducted under the coordination of the Louisiana Oil Spill Coordinator's Office, in conjunction with the State's various agencies (Department of Environmental Quality - LA-DEQ, and Department of Wildlife & Fisheries - LA-DWF) together with the relevant federal bodies (Pipeline & Hazardous Materials Safety Administration - PHMSA, US Fish & Wildlife - USFW, etc.), and representatives of the landowner and the industrial firm.

Recovery operations were conducted under the supervision of the State and federal authorities, with the company announcing that it had recovered more than 1,100 m^3 of a fuel/water mixture a fortnight after the spill.

These operations, which involved the deployment of booms, recovery barges and individual skimmer heads, focused on the "recoverable" fuel. Residual, emulsified diesel trapped in vegetation on the banks resulted in sheens that persisted after clean-up operations to remove the bulk of the fuel had ended.

Recovering the thickest accumulations of diesel along the banks using oleophilic drum skimmers (Source: Louisiana Department of Environmental Quality)

According to the Pipeline and Hazardous Materials Safety Administration (PHMSA), an inspection of the pipeline conducted over a year prior had revealed external corrosion, to varying extents (with the pipe having lost up to 75% of its thickness in places), along a 7-metre section including the rupture point. The work had however been postponed after a second inspection concluded that the damage did not require immediate repair under federal rules. PBF Energy stated that it had reduced the pressure inside the line shortly after the corrosion was first found and declared to the federal authorities, just two months before the incident, that it was awaiting approval for the repairs to the corroded section. The operator also stated that it had further reduced the pressure in the pipe a few weeks before the leak occurred.

This relatively large spill of a fuel with a high content of light compounds into a confined environment generated significant toxic impacts, resulting in the death of fish (more than 2,000 individuals) and other species (notably some 40 snakes and 30 birds), as well as shoreline vegetation and wildlife. Nearly 130 animals (70 alligators, a dozen turtles, 20 birds and as many snakes) were captured for rehabilitation at a centre set up and supervised by the specialised company Wildlife Response Services (in conjunction with LAWF). ■

EXCERPT FROM INLAND WATERS TECHNICAL NEWSLETTER #31

Pollution due to a pipeline leak in a rural area (Bashneft, Republic of Bashkortostan, Russian Federation)

On 1st April 2021 in the Russian Federation, near the village of Pavlovka (Bizhbulyaksky District, Republic of Bashkortostan), Bashneft (a subsidiary of Rosneft) reported a spill of around 300 m^3 of a mixture of crude oil and water from a pipeline running from the Skhapovskoye oil field. The operator's acknowledgement came after local residents and the Region's Ministry of Emergency Situations (EMERCOM) posted photographs of the spill.

According to EMERCOM, the incident (whose cause was unspecified) resulted in the contamination of rivers and 350 m^2 of snow-covered ground in the vicinity of the leak. Although no details are provided in our information sources, the spill response operations carried out by Bashneft's response teams are reported to have involved containment operations on the water and removal of the polluted soil.

Bahsneft announced that there was no threat of oil-containing liquid entering nearby water reservoirs, and that between 350 and 400 m^3 of excavated soil had been removed from the site and transported to a processing site in the Ishimbaysky District. ■

Discover the other topics covered in Inland Waters Technical Newsletter #31:

- Pipeline leak in the Niger Delta (Trans Niger Okordia-Rumekpe line, Nigeria)
- Major release of organic effluent from a pond (Walkerville, United States)
- Pipeline leak and pollution of tributaries of the Barents Sea (Lukoil, Komi Republic, Russian Federation)
- Moderate spill of condensates in a sensitive environment (Cox Oil LLC pipeline, Cameron Parish, USA)
- Pipeline leak: impact of a light product in a confined environment (Meraux Pipeline, Chalmette, United States)
- Review of significant spills having occurred worldwide in 2021
- Floating waste/debris
- Legal proceedings, fines
- Preparedness

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www.cedre.fr

Resources > Publications > Technical Newsletters

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COMING SOON !

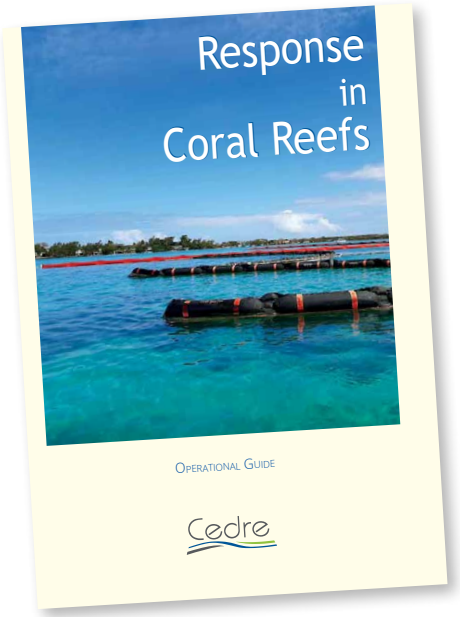
NEW ONLINE TRAINING COURSE

A new training course is available on our online training platform: the OPRC/IMO Level 2 equivalent "Oil spill response at sea and on the shoreline" refresher course.

Designed for trainees who have already taken Cedre's initial training course, this refresher course reviews all the topics addressed during the initial training course and offers trainees that chance to refresh their skills and know-how in order to update their theoretical knowledge of response strategies and techniques in case of oil spills at sea and on the shoreline.

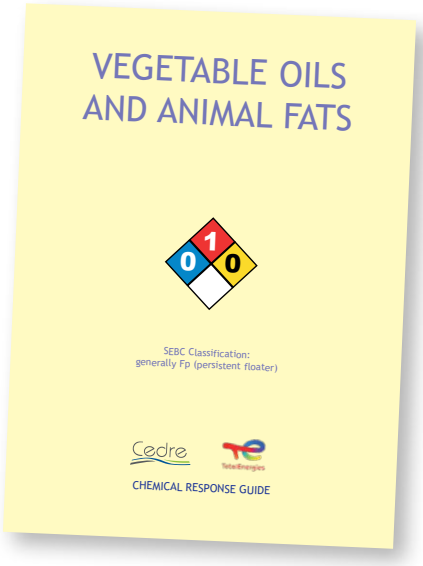
Register at **elearning.cedre.fr**

NEW GUIDES



Operational Guide: Response in Coral Reefs

This guide sets out the major aspects that need to be known and understood when dealing with an oil spill in tropical coral reef environments. It primarily draws upon a literature review as well as Cedre's experience in spill response in tropical environments (e.g. mangroves). ■



Chemical Response Guide: Vegetable Oils and Animal Fats

This guide is intended for responders who may be liable to face a spill of vegetable oil or animal fat in an aquatic environment. It is designed to provide them with useful information on spill response and on the establishment of response plans in case of such a spill. The aim of this guide is to enable rapid access to the necessary initial information, in addition to providing relevant bibliographical sources to obtain further information. ■

Find all the latest Cedre guides on our website **www.cedre.fr**

For a printed version please contact us directly: **documentation@cedre.fr**

Cedre AT A GLANCE

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