RITMER NETWORK FOR THE RESEARCH AND INNOVATION IN OIL AND CHEMICAL ANTIPOLLUTION TECHNOLOGY: A FRENCH TOOL FOR INNOVATIVE PROJECTS

Jean Croquette[1], Ifremer, BP 70 29280 Plouzane - France,
Jean.croquette@ifremer.fr

Georges Peigné[2], Cedre -715 rue Alain Colas - CS 41836 - 29218 Brest Cedex 2 - France,
Georges.peigne@cedre.fr

Monique Guillou[3], IUEM, Technopole Brest Iroise- 29280 Plouzane- France,
Monique.guillou@univ-brest.fr

François Laurent[4], Ministère Délégué à la Recherche,5 reu Descartes 75005 Paris, France.
Francois.laurent@education.gouv.fr

Michel Huther[5], Bureau Veritas, 17 Place des Reflets 92077 Paris la Défense, France
Michel.huther@bureauveritas.com

ABSTRACT

The Technological Research and Innovation Network RITMER was created by the French Ministry of research in 2001 after the ERIKA oil spill, in order to structure the French research, and to develop links between public and private research and development in the fight against accidental pollution domain. The network is a tool created to stimulate the innovative research and is complementary to activities carried out by Ifremer and Cedre. It brings together representatives of academic research, industry and authorities responsible for spill control preparedness and operations. Ifremer and the Brest University are the moderators of the network, and Cedre is one of its most active members.

The main activity of the Ritmer is to define priority areas and to publish calls for proposals, and organize the selection of innovative projects to be supported by the French Ministries. These projects must associate research institutes or universities, with industry or other users of the R&D results, and they should have direct potential application in the fight operations.

Since 2001, 25 projects have been selected, representing more than 13 million Euros of budget and 7.7 million Euros of support by the ministries. These projects concern the main problems encountered in case of accident: detection tools, evaluation, models, recovery at sea and on the coast, waste treatment, organization, communication . Two of them deal with chemical spills.

The paper describes the main projects and gives more detailed description of seven of them which have already produced significant results after two years of work: remote sensing of sunken oil, thermal treatment of oily waste, oil biodegrading parameters, behavior of chemical products at sea.

The future priorities for the French research are also presented in relation to two Ritmer seminars organized in 2003 and 2004, respectively on detection devices and probes, and on innovative tools and methods for the response in coastal areas. Several international actions which have been conducted for the coordination of research in Europe, and in cooperation with Japan and Spain are also described.

INTRODUCTION

After the Erika oil spill in December 1999, the French government undertook several important actions to improve the response to such situations : regulations of traffic along the French coasts and international control of old tankers, increase of the capacity of Cedre in it's role of technical adviser to the authorities, and start of new scientific programs : Suivi-Erika, a monitoring program on the ecological impact of the accident, and Liteau Erika, a research program on the ecological impact of pollution by heavy fuels.

The French government also decided to apply to the fight against pollution his system to develop innovative research through networks, called RRIT Réseau de Recherches et d'Innovation Technologiques. This system is reserved to important technological domains for industrial, economic or socioeconomic reasons : transport, energy, computing, telecommunication, genomics,... 16 RRIT networks are presently in activity. Their objective is to stimulate innovation and create new links between governmental research and industry, which should give rise to reinforced activity. The RRIT give advice to the French authorities for research orientations and funding, and they organize the selection of projects supported by the Ministries.

The spill control network is called RITMER: Réseau de Recherches et d'Innovations Technologiques sur les Pollutions Marines Accidentelles et leurs Conséquences Ecologiques.

The RITMER network deals with oil and chemical spills. Nevertheless, other pollutants may be considered if a special concern appears: floating debris, containers, massive release of low toxicity products. Nuclear spills are not considered due to their very particular nature and sector of activity, but, accidents

of transport by sea or recovery of containers are domains covered by RITMER which could have applications for nuclear transport accidents.

The network complements research activities already carried out by Ifremer and Cedre on the fight against accidental pollution.

The web site *http://www.ritmer.org* gives the main information on it's activities.

RITMER ORGANIZATION AND ACTIVITIES

Coordination and Organization Group: The functioning and organization of the network are under the responsibility of a small group including the governmental French institute of research for the exploitation of the sea : IFREMER and of the Brest University IUEM.

Steering Committee: The network is built on a group of technical and scientific experts, which includes nearly 30 persons, appointed by the ministry of research to represent academic research, governmental research centers, industry and authorities responsible for spill control preparedness and operations. The supporting ministries are also represented: Research, Ecology, Equipment-Transport-Sea, Defense, Industry.

It is managed actually by a representative of the Bureau Veritas.

Activities: The Committee meets every 4 months and its main activities consist in information of its members and discussion of the research progress in the area, identification of the lacks of knowledge, equipment and organization. It fixes priorities, organizes calls for proposals for research projects, receives the proposals, organizes the evaluation and the contracting for support by the Ministries, the exploitation of the results, and their dissemination to the spill control organization.

MAIN THEMES

The actions of RITMER must be specific and targeted to the following themes:

1. The characterization of transported products:

- physico-chemical behavior after a spill
- impacts on the ecosystems (ecotoxicology) and temporal development.

2. Technologies for tracking and monitoring pollutants (on the sea surface, underwater, in sand...):

- prediction of drift (modeling, quantification, evolution, transport)
- observation and monitoring of drift (airborne tools, instruments, methods of tracking, survey and monitoring at the surface and underwater).

3. The recovery and treatment of pollutants at sea and on land

- treatment techniques and products
- containment and recovery techniques.

4. Management of the wrecks:

- immediate containment
- in situ monitoring
- technologies for response and survey

5. Management of risks with respect to the ecosystems

- vulnerability indicators and sensitivity maps
- prediction and evaluation of impacts (particularly on the food chain)
- decision-making tools.

6. Technologies for the protection and rehabilitation of sensitive sites and ecosystems

- littoral zone developments
- mobile response techniques
- techniques for avoiding contacts and transfers to threatened surfaces and species
- techniques for biological rehabilitation.

7. Technologies of treatment for the collected waste

- storage
- treatment
- disposal.

8. Methods of risks management

- risks identification
- crisis management.

PROJECTS

Projects Selection:

The evaluation of the projects is made by independent experts, and they present a report which comments 5 criteria concerning the scope of the project, the scientific content, the partnership, the management and the financial aspects.

The projects must include a significant part of research, and associate research institutes or universities, with industry or other users of the R&D results. The partnership with SME's is encouraged. The expected results should have direct potential applications in response operations.

Selected projects

Between April 2001 and December 2004, The RITMER has received 39 different projects. The steering Committee gave advices and often helped coordinators to improve the partnership and content for new proposal. Finally, the committee had to organize 60 evaluations by experts, and 26 projects have been selected. (Table 1)

These 26 projects represent more than 13 million Euros of budget not including academic research personnel, and 7.7 million Euros of support by the ministries. (Table 2)

An abstract of the objective of each project is given on our web site. Some of them are already finished and have produced interesting data. They are presented more in detail in the next paragraphs and the coordinators e-mails are given at the end of the paper.. One of these projects, which deals with the design of a high seas recovery ship,. gave rise to an European project coordinated by the French Shipyard *Les Chantiers de l'Atlantique*.

*** ECOPEL : Behavior of chemical spilled at sea**

ECOPEL aimed at studying the behavior of chemicals spilled in the marine environment. The program had three phases:

1. Analysis of the chemical maritime traffic along the French coasts, in order to determine the most dangerous products
2. Research on the most important parameters to characterize the behavior of floating products released at sea, through tests at various scale: labo, pilot (vertical column) and mesocosm (floating cells)
3. Development of a test permitting to have an indication of the effects of such a spill on marine species

Table 1 - List of the projects selected by Ritmer

Theme		Selected Projects		Not selected	
		Number	Name	Number	Total
1	Behaviour of transported products	1	ECOPEL	0	1
2	Technologies for spills detection and monitoring of spills	8	ESCAPI SCOPMAR2 DETECSUIV2 CLARA2 JETSTAR2 ROSE2 STORM SURLITOP2	2	10
3	Recovery and treatment of spills offshore and on shore	8	BIOREHAB ECREPOL BLACMOR3 OSH2 NAVPOLEM2 RENAPIM2 BARGE TAPI	3	11
4	Management of wrecks	2	JETSTAR2 ROSE2	1	3
5	Management of risks for ecosystems	1	CONCHPOL3	2	3
6	Technologies for the protection and rehabilitation of sensitive areas	3	BIOREHAB SIMBAR (BOOM) CONCHPOL3	3	6
7	Technologies for the treatment of wastes	4	BIOREHAB THERMER EVABIODEG2 DESEMULSIFICATION	3	7
8	Methods for risk management	5	POLLUCOM2 CONCHPOL3 CLARA2 OERS2 ARGEPOL	0	5
		32		14	46

- The traffic data were based on questions asked to the French ports, which were completed with data from regional agreement working groups and centers and from Navy documents. They identified the main products : vinyl acetate, acetic acid, phosphoric acid, sulfuric acid, oleic acid, ammonia, benzene, ethylene glycol, vegetable and animal oils, sodium hydroxyde, molasses, methanol, MTBE, phenol, styrene , toluene, xylenes, dioctylphtalate and urea.
- Tests have been conducted on a series of products given in table 3.
- A methodology was set-up for assessing the solubility of chemicals in sea water. It is based on three tests derived from French and EPA standards which evaluate the solubility in calm seas and also the total amount of product dissolved or dispersed into the water in rough conditions, which includes soluble components and also micro droplets incorporated into the water by agitation.

Data on the behavior of substances released in the water column or on the bottom has also been obtained from tests with an experimental column device.

Finally, tests in floating cells have been performed to approach the behavior in the open sea, and two toxicity tests have been put in place in Cedre to expose marine species , which could be used by biologists in case of chemical spills. (Figure 3)

Table 2 - Subjects of the selected projects

RITMER projects	Subjects
ECOPEL	Behavior of chemical spilled at sea
EXCAPI	Underwater detection of pollutant by sonar
SCOPMAR	Treatment of remote sensing data
DETECSUIV	Spill detection through aerial and satellites radar imaging
CLARA	Modeling the behavior of chemicals spilled at sea
JETSTAR	Teleoperated device for spill detection at sea
ROSE	Survey of wrecks by acoustic network
STORM	Technologies for detection and monitoring of pollutants
SURLITOP	Survey of the coastline with HF radar
BIOREHAB	Effect of environmental conditions on the oil biodegradation
ECREPOL	Offshore recovery of viscous oil with nets
BLACMOR	Coastal booming by nets
OSH	Oil Spill Harvester
NAVPOLEM	V shape oil spill recovery vessel
RENAPIM	Recovery of immersed slicks
BARGE	Barge for the recovery of oil and debris
TAPI	Conveyor for the transport of waste
SIMBAR	Models for the dimensioning of booms
CONCHPOL	Protection of oyster farms
THERMER	Thermal treatment of wastes
EVABIODEG	Method for the evaluation of waste clean-up treatments
DESEMULSIFICATION	Treatment of water-in-oil emulsions
POLLUCOM	Improvement of communications in case of a spill
OERS	Assessment of health risk for operators
ARGEPOL	Computer device for archiving and treating the spill data
CONTINMAR	Integration of knowledge for the improvement of contingency plans

FIGURE 3 : ECOPEL : LIST OF TESTED PRODUCTS

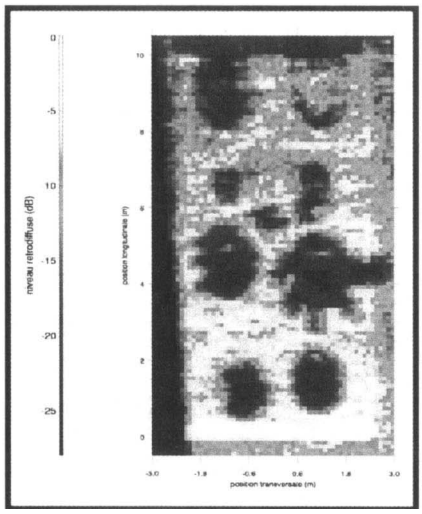
soya oil	MIBK (methyl isobutyl cetone)
castor oil	adiponitril
palm oil	ethyl2 hexanol
oleic acid	nonylphenol
benzene	octanoïc acid
styrene	n-butyle acetate
dioctylphtalate	octanol
ethylbenzene	

*** EXCAPI : Detection of pollutant underwater by sonar**

The objective of EXCAPI was to proceed to the experimentation of several sonars and determine their capacities to detect oil slicks laying on sand bottom of the sea. The experimentation carried out in test tank consisted in putting in place oil slicks of varying dimensions, compositions and thicknesses on a 3 cm thick sand bed in a big dimensions tank.

The results obtained can be summarized as follows : some high frequency sonars frequency (200-500 kHz) used frequently at sea (side looking sonar, multibeam sonar, front sectorial sonar) can detect the presence of oil slicks on, sand on the bottom of the sea, in relation to the low reflectivity of these slicks due to very strong attenuation of the signals The contrast obtained with three different heavy oils is nearly similar. Nevertheless, the contrast depends on the system considered and also on the configuration of use (Figure 1).

In conclusion, a lateral sonar could be used for a quick evaluation of the contamination of a wide area. When there is a strong presumption that slicks are present, more detailed investigations can be made with other systems like multibeam sonars, vertical sonars, front sectorial sonars, deployed from ships, submarines, ROV or AUV.



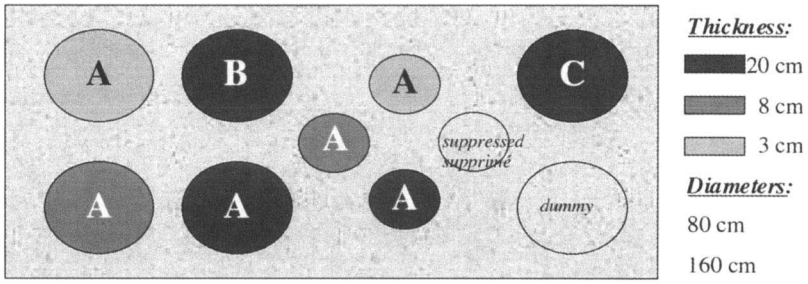


FIGURE 1

*** THERMER : Thermal wastes treatment**

The Thermer project has studied the possibility of burning the oil waste on fluidized bed . First the project evaluated the fluidization of polluted sand in relation to the oil content. Then, tests have been conducted in oven to determine the thermal level necessary, and the kinetics of combustion. An equipment has then been defined for a good remediation of the polluted sand, avoiding atmospheric pollution, and minimizing the energy consumption.

The results of fluidization tests have shown that the Prestige fuel containing up to 62% of water can be treated. The autocombustion temperature is about 700°C, and then the polluted sand is completely cleaned in about 30 seconds. The residual pollution is about 50 ppm of total hydrocarbons. The emissions of NO, N2O, CO, S02 depend on the pollutant (water content, volatility, nitrogen and sulfur content), and the cost of the treatment is considered as acceptable (80-100 per Ton of oily waste).

*** POLLUCOM : Improvement of communications during spills**

POLLUCOM is a system dedicated to communication and to data management for spill control operations, operable in metropolitan France and in overseas territories.

The POLLUCOM system, capable of transporting an important volume of data in an acceptable lapse of time, uses a support common to all the actors, the Internet, whether operating on ground, at sea or in the airs. Conceived around standard products, POLLUCOM is a flexible and evolutionary system as for the attendance figures and for the natures of the exchanged data. Thanks to its architecture, POLLUCOM can be used in various environmental and geographic contexts.

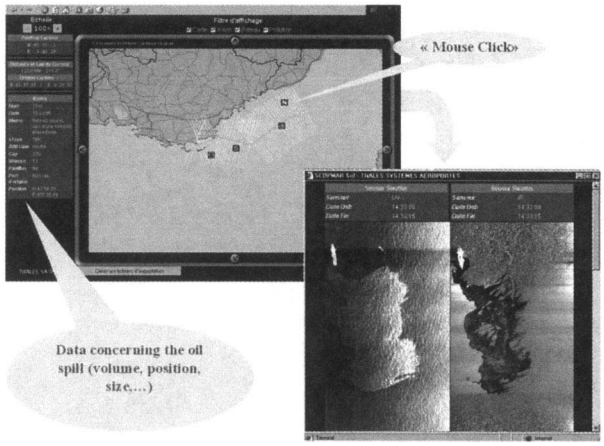
The operation of the system respects perfectly the organization in place, the role and the methods of work of the various actors. It accepts all operational situations, before, during and after an accident, and can be exploited by the actors to :

- maintain their field of knowledge thanks to the real-time sharing of the data,
- estimate the situation and the risks by means of the geomantic based on the ECDIS,
- elaborate operational answers arranged by the implemented of cooperative tools.

POLLUCOM participates in the management of crisis widened by proposing a quantitative and qualitative enrichment of the piece of information and the cartographic helps adapted to the mode of reflection of the users.

*** SCOPMAR : Treatment of remote sensing data**

The main objective of Scopmar is to produce a view of the situation analyzed by the Polmar remote sensing aircrafts (images of the slicks, and of the coast, position of ships,..) for the authorities responsible of the spill control operations.



The chosen solution is to transmit a numerical object elaborated in the plane by fusion of data of different types, then converted in a commercial standard (SHAPE, GEOTIFF) for integration in the GIS (Geographic Information System) of the technical and scientific institutes and centers involved in the operations(CEDRE, IFREMER, SHOM, METEO FRANCE).

*** EVABIODEG : Method for the evaluation of biological waste treatments**

The objective of EVABIODEG is to define a methodology and to build a platform for the evaluation of physical, chemical, and biological treatments for the disposal of oily waste.

The system will bring information and technical evaluation of the clean up methods efficiency and of the toxicity of the degradation products and effluent on marine resources .

The method has been defined through tests with sand and algae polluted with heavy fuel oil.

***BIOREHAB : Effect of environnemental conditions on the oil biodegradation**

The project studied the medium impact on hydrocarbon bio-assimilation by Pseudomonas putida PpG7 and P. aeruginosa PAO1pNAH7. A marine NaCl concentration (0.5 M) inhibited hydrocarbon assimilation. This osmotic stress acts by preventing the synthesis of metabolic enzymes and probably the uptake of some hydrocarbons. This inhibition was reversed by adding osmo-protectors . Petroleum (Arabian Light) metabolism was followed, revealing that petroleum-contained microorganisms degraded n-alcans, which was stimulated by P. aeruginosa PAO1pNAH7. The assimilation can be improved by emulsifying hydrocarbons with rhamnolipids, and their production by P. aeruginosa PAO1 was observed using various hydrocarbons as carbon source. However, it was only obtained in phosphate-limited media.

WORKSHOPS

The RITMER network has organized two workshops on innovation.

The first seminar dealt with the needs in probes and analyses devices to detect, identify and monitor spills. The experience in different sectors was presented : Oil industry, chemistry, drinking water, and potentialities for development have been identified.

The Seminar pointed out that numerous probes are available, but the properties of pollutants, mainly chemicals, have not been enough studied, and these probes need adaptation to the particular use in marine environment. Also the market is limited, so the developments can only complement the detection and monitoring markets.

The main potential areas for innovation which were identified are the use of drones for the remote detection of potentially dangerous areas, the development of wide spectra analyze methods (Spectrometry, chromatography, biocaptors, biomarkers), and finally the development of low-cost probes.

The second seminar (Nov. 2004) dealt with innovative means and techniques for in shore and on shore operations. Four themes were discussed : (1)Monitoring of slicks close to the coast, to guide the response vessels (2) Innovative use of nets and geotextiles , (3) recovery of pollutant on the sea floor, and (4) clean-up of areas poorly accessible and ecological sensitive.

INTERNATIONAL ACTIONS

The Ritmer wants to cooperate with other countries . Some of his members like Cedre are already involved worldwide. The network Ritmer is already linked at the governmental level with Spanish and other European partners (for the preparation of a European Network (ERANET) for the coordination of governmental programs of research on spill control (Spain, France, Belgium, Estonia, European Science Foundation, Ireland, Norway, Portugal, United Kingdom) . Trans national projects are also possible through projects selected by Ritmer. Two existing projects include foreign partners. The possibilities of cooperation with the Japanese NMRI (National Maritime Research Institute) have also been investigated .

CONCLUSION. FUTURE ACTIONS

In conclusion, the Ritmer network has permitted to identify the needs for innovation and to orientate the flux of projects after the Erika and Prestige spills. The network answers to a permanent need in research and development of innovative technologies and methods in complement to the French research programs existing before Erika spill. The Network reinforced the response capacity of the French spill control organization, and attracted a number of academic research laboratories (15), research centers (25), and private companies (39), which cooperate now in common innovative projects.

After 3 years functioning, the Ritmer has selected 26 Projects covering unequally the needs of antipollution which have been identified by the network.

The future actions will be oriented mainly towards a few primary directions :

Theme 1. The characterization of transported products :

First priority of the network: Focus on the chemical spills, their evolution at sea, their dangerousness.

Theme 3. The recovery and treatment of spills at sea and on land:

Remote sensing, monitoring of slicks in coastal areas, improvement of netting techniques.

Theme 4. Management of wrecks:

Feasibility studies of innovation tools for the monitoring of wrecks

Theme 7. Treatment technologies for collected waste:

Techniques for storage, transfer and final disposal of oily products collected by ships; waste from chemical spills.

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The authors acknowledge the projects coordinators who have contributed in this paper . Their e-mails are :

ECOPEL : *Stephane.le.floch@cedre.fr*

EXCAPI : *francois.parthiot@cedre.fr*

SCOPMAR : *Sylvain.Pierrard@lne.fr*

THERMER : *arnaud.delebarre@emn.fr*

EVABIODEG : *yves.andres@emn.fr*

BIOREHAB : *dominique.haras@univ-ubs.fr*

POLLUCOM : *gwendal.lecoq@ago.fr*

BIOGRAPHY

Jean Croquette, 58 years, Chemical Engineer (1973), Director of the Experimental Research and Development Department at Ifremer. He has been working in Cedre during 7 years, from 1978 to 1985, where he was responsible of the response products department.

He has been involved in the major oil spills in France (Amoco Cadiz, Tanio, Erika, Prestige), and is now in charge of the Ifremer R&D program on marine spill control preparedness. Since 2001, he has been moderator of the Ritmer network, and has organized the project selection and international contacts.