

**European Commission
DG Environment – Civil Protection Unit**

**Community co-operation
Mobilisation of expertise**

MISSION REPORT

**of the governmental delegation of Italian experts mobilised
after the accident of the chemical tanker**

“IEVOLI SUN”

France, 19 - 25/11/00

In the framework of the mobilisation of expertise requested by the French Authorities to the EC following the accident of the chemical tanker “IEVOLI SUN”¹, the Italian Ministry of the Environment appointed a group of seven experts. The group was composed by personnel belonging to public scientific institutions and a private petrochemical industry as follows (addresses are in Annex I):

Ezio AMATO, Icram (Istituto centrale per la ricerca scientifica e tecnologica applicata al mare), accidental marine pollution assessment and response, scientific co-ordinator and head of delegation;

Aurelio CALIGIORE, Capitanerie di Porto, marine environment protection, operational co-ordinator;

Antonella AUSILI, Icram, organic pollutants fate assessment in marine ecosystems;

Giuseppe BELLINA, Enichem, logistic technologies;

Giuseppe GIORDANO, ENI, emergency planning;

Enrico MARSANO, Università di Genova, characterisation and properties of polymeric material;

Salvatore MINARDI, Enichem, human health and environmental risk assessment of styrene.

The Civil Protection Unit of the General Directorate Environment of the European Commission took charge of the group’s public component through their secondment. A member of the Civil Protection Unit, Guido Ferraro, joined the group on Nov. the 22nd.

On the basis of the pertinent documents acquired or examined in France as well as of the discussions held during the meetings in which the group took part, summarising the remarks expressed by its members during and after the mission, the group reports the following.

¹ Particularly, the French Authorities asked the European Commission to disseminate to Member States the request of expertise with respect to video inspections of the shipwreck and to styrene behaviour and related protection measures concerning human health and marine environment.

The group attended to the work meetings held by French authorities as follows:

- *Secrétariat Général de la Mer* (Paris, November the 20th and 24th)².
- *Ministère de l'aménagement du territoire et de l'environnement, Direction de l'eau and Direction de la prévention des pollutions et des risques* (Paris, November the 20th and 24th)³.
- *Centre de Documentation de Recherche et d'expérimentations sur les pollutions accidentelles des eaux* (CEDRE) (Brest, November the 21st)⁴.
- *Secrétariat Général de la zone de défense et de la sécurité civile, Préfecture de la Zone de Défense Ouest*, (Rennes, November the 22nd)⁵.
- *Préfecture de la Manche* (Saint Lô, November the 22nd)⁶.
- *Préfecture Maritime de la Manche et de la Mer du Nord* (Cherbourg, November the 23rd)⁷.

In Brest and Cherbourg, the group had also the opportunity to exchange views with the responsible of CEPPOL (*Commission d'Études pratiques de Lutte Antipollution*), *Président Pierre Pinlou and Adjoint au Président Bernard Lefort*.

At CEDRE, the group had access to the available documents and to the results of the ongoing experiences carried out in CEDRE laboratories to assess the behaviour of styrene in seawater. The group was asked to report on the knowledge gained in controlling and monitoring measures and in the recovery of the loading in the cases of the gas carrier "BRIGITTA MONTANARI" and the chemical tanker "ALESSANDRO PRIMO" sunk in Southern Adriatic Sea.

² The group met the *Secrétaire Général Adjoint* Guy de Chauliac and members of his staff.

³ Particularly, the group met Geneviève Jourdier, *Sous-Directrice de la Réglementation de l'eau*, Daniel Robbe, *Chef du bureau de prévention et protection marine* and Laurent Moché, *Chef du bureau des risques technologiques et des industries chimiques et pétrolières*.

⁴ Along with the *Directeur* Michel Girin, the group has had the opportunity to exchange views with the researchers involved in the accident follow-up (particularly, Fanch Cabioc'h, Georges Peigne, Camille Lecat, Karen Quintin).

⁵ The group took part in the afternoon meeting of the *Groupe expert auprès du Préfet de ZDO* with representatives of institutions such as AFSSA (*Agence française de sécurité sanitaire des aliments*), CEDRE (*Centre de Documentation de Recherche et d'expérimentations sur les pollutions accidentelles des eaux*), *Centre Antipoison* de Rennes, CIRE Ouest (*Centre interrégional épidémiologique*), IFREMER (*Institut français pour la recherche et l'exploitation de la mer*), INERIS (*Institut national de l'environnement et des risques*), INRS (*Institut National de recherche sur la sécurité*), InVs (*Institut de veille sanitaire*), MAFF/CEFAS (*Centre for environment, fisheries and aquaculture science, UK*), MCA (*Maritime Coastguard Agency, UK*), Météo-France. *Colonnel Courtois, Chef d'Etat Major Sécurité Civile*, chaired the meeting and illustrated to the group the competencies and functioning of the ZDO.

⁶ The group was invited to attend the evening meeting of the emergency committee and to outline the experience gained in controlling and monitoring measures and in the recovery of the chemical loading after the "BRIGITTA MONTANARI" and "ALESSANDRO PRIMO" accidents (Southern Adriatic Sea, 1984 and 1991 respectively).

⁷ The group took part in the morning briefing chaired by *Contre Amiral* L. Merrer. Around the table, along with the military personnel were representatives of the *Ministère de l'équipement, des transports et du logement*, of the British Ministry of transports, of CEDRE, of the Maritime Coastguard Agency (U.K.), of EXXON, of SHELL, of the shipowner and of P&I Club. Among the documents and information the group was provided with during the day, the group had the opportunity to watch copies of the videotapes recorded on the wreck.

The main topic discussed was the behaviour of styrene in the peculiar conditions in which it is in the wreck (among the three products carried by the chemical tanker, the styrene gives rise to the strongest worries due to the amount, two third of the total cargo, and its toxicological properties)⁸. Taking into account the exiguity of previous experiences⁹, this topic brings up many questions, among which:

- polymerisation reaction:
 - ⇒ time left with respect to the efficiency of the inhibitor utilised by SHELL¹⁰ (producer of the styrene) in presence of seawater;
 - ⇒ polymerisation kinetic (possibility of violent reaction(s) and subsequent rupture of the tank(s) implying massive leakage of the pollutant(s));
- effects on halieutic resources (cf. tainting).

Regarding the wreckage, in the copies of videotapes recorded during the sinking of the “IEVOLI SUN” the group observed on the stern keel (starboard side) what seemed to us to be dents and leaks¹¹. Images of a better quality could be useful for clarification. Watching the same videotapes, the group considered that some undetermined (but significant) quota of the cargo was spilled at sea during the sinking of the ship. About the wreck, it lies on the sea-bottom on port side in an unstable position and a minor leakage of product has been observed in correspondence with the No 8-9 tanks through surveys conducted by Remotely Operated Vehicle¹². During the day spent at CEDRE as well as during the meetings held in Rennes, Saint Lô, Cherbourg and Paris, the main points raised about the wreck were:

- amounts of pollutants that still remain into the tanks;
- stability of the wreck on the sea-bottom;
- the relevance of the location of the wreck in international law;
- intervention feasibility and methodologies.

During the mission, the group expressed its views summarised in the herewith enclosed document, sent on Nov. the 23rd to *Ministère de l'aménagement du territoire et de l'environnement*, to *Secrétariat Général de la Mer* and to European Commission, D.G. Environment – Civil Protection Unit.

Particularly:

- taking into account:
 - ⇒ the video recorded during the sinking of the “IEVOLI SUN”;

⁸ The cargo of the chemical carrier “IEVOLI SUN”, sunk on Oct. the 31st 2000, was composed by styrene (3998 tons), methyl ethyl ketone (1027 tons) and isopropyl alcohol (996 tons). At Fawley (UK) the “IEVOLI SUN” embarked around 160 tons of IFO 180 (Intermediate Fuel Oil, density 0.97 @ 15.5°C) and 40 tons of diesel oil.

⁹ As reported in the CEDRE web site: http://www.ifremer.fr/cedre/rubriques/ievoli/autre_accident1.htm

¹⁰ P-TCB (para-tertiary-butylcatechol) or 4-TBC (4-tert-butylpyrocatechol). The latter density is 1.049 @ 60°C and solubility is 2 g/l @ 25°C.

¹¹ On November the 29th, the R.O.V. embarked on board the “NORTHERN PRINCE” detected small cracks in correspondence with a bunker tank.

¹² The R.O.V. was operated from the ship “NORTHERN PRINCE”, chartered in the interests of Marnavi SpA, shipowner of “IEVOLI SUN”.

⇒ the leaks from the hull of the wreck observed by R.O.V.;

⇒ the density of pollutants lower than seawater;

⇒ the PV valves set-point¹³,

the group considers that salt water has most likely substituted an undefined amount of the content inside the tanks.

- Consequently, taking into consideration that:

⇒ the experiments carried out in France at CEDRE facilities indicate a solubility of styrene in seawater lower than expected and the formation of micro emulsions¹⁴;

⇒ the flow of seawater around the wreck is well sustained by the existing strong currents;

⇒ the products are subject to a hydrostatic pressure of about eight atmospheres, thus affecting their behaviour,

⇒ the seawater temperature along the water column is about 14°C,

the group considers as a priority the prosecution of the laboratory experiments intended to assess the behaviour of inhibited styrene monomer in the actual conditions and retains that many factors lead to a significant abatement of the risk of a violent styrene polymerisation reaction (thus excluding any explosion of the tanks)¹⁵.

- Furthermore, knowing that:

⇒ the wreck lies on a fishery ground where *Cancer pagurus* (edible crab, tourteau) and *Maja squinado* (spinous spider crab, araignée de mer) are among the most valuable catches;

¹³ The setting of the breathing valves for the tanks are - 350 mm H₂O for vacuum and + 2000 mm H₂O for overpressure. Maintaining the wreck the actual position (valves downward) no further product spill will take place from the valves (excluding diffusion process through the openings); should the wreck recover the upside position, the density difference between the seawater and the styrene will produce a hydrostatic head greater than the setting of the PV valves, thus causing the spill of the products until a new pressure balance is reached. This evaluation could be reported to the appropriate *fora* (i.e. IMO, International Maritime Organisation) to allow further considerations.

¹⁴ While in literature values of solubility for styrene in fresh (distilled) water are reported to be near 300 mg/l, for seawater the ones observed at CEDRE in two different experimental conditions were 6 and 20 mg/l.

¹⁵ Polymerisation should take place after few months (when the action of the inhibitor will be reduced by the dilution and by the time) as suggested by Shell, at a very low rate, due to the low temperature (about 12 g of polymer per ton of monomer @ 15°C) and due to the presence of the seawater mixed with the styrene mass, which inhibits itself the polymerisation. The heat of reaction (144 kcal per kg of polymer) should be removed by the convective flows (inside the monomer and of the water in the double hull; the vents are open) and finally by the infinite amount of the seawater surrounding the wreck. The global volume of the styrene/polystyrene mass will be gradually reduced due to the higher density of the polymer. Should, due to unpredictable causes, the temperature increase of the mass become significant and accelerate the reaction, a tank collapse could take place causing the entrance of water, thus quenching and stopping the reaction. Even in such case, the partly polymerised mass should remain confined in the double hull space. The hypothesis of an explosion of the tanks containing styrene is not supported by the industrial experience of accidental polymerisations which in some case took place in industrial vessels exposed to air, where styrene had been accidentally left, or in lines exposed to the sun and then in less favourable conditions of heat removal. Only some flange leak has been reported in such cases without any collapse of the equipment.

⇒ the available data on styrene bioaccumulation are not immediately transferable to the species threatened by the leakage of the product from the tanks of the “IEVOLI SUN”;¹⁶

⇒ the data acquired by IFREMER on specimen of the above mentioned crustaceans caught in proximity of the wreck show values that require further investigations¹⁷ in order to assess the background/contamination threshold as well as the contamination/decontamination processes,

the group fully agrees with the proposition of AFSSA, CEDRE and IFREMER to carry out bioassays in laboratory and in the field to gather data about persistency of styrene contamination in biological resources of commercial interest.

- In order to obtain data about the leakage of pollutants from the tanks and to monitor the surrounding environment, the group advised their correspondents about the need for daily control of the pollutants in the waters surrounding the wreck by means of Niskin type sampling bottles operated from ship (or helicopter) and R.O.V.. The small size particles of sediment are likely to be contaminated too; thus there is a need for sampling and analysis of sediments near the wreck. Furthermore, the group remarked the importance to operate keeping the samples as little as possible in contact with the air also preserving the samples in sealed glass containers and the need for measurements of seawater chemical-physical parameters (dissolved oxygen, pH, temperature, etc.) near the wreck by multiparametric probe.
- The group fully agreed with the French Authorities on the need for the preparedness of equipment suitable to face the possible surfacing of bunker products.
- Taking into account the uneven position of the wreck on the sea-bottom (about 120° port side), the sedimentary characteristics of the site (sand and gravel) and the strong currents (3÷4 knots on average) affecting the area, the group considered as probable the occurrence of erosive processes that, consequently, could cause adjustment movements of the wreck resulting in possible further leakage of pollutants.

Regarding the accident circumstances, according to available data and information, the group considers credible that the severe weather conditions had been crucial in determining the wreckage through the flooding of the watertight compartments (such as the forepeak, unevenly big and not subdivided). Furthermore, the group notes that the “IEVOLI SUN” was equipped with only one hydraulic supply unit (no spare equipment for loading and ballast movements). The reported failure of the hydraulic supply unit did not allow the drainage of the seawater from the flooded compartments nor, as extreme measure the spillage at sea of part of the ship loading.

¹⁶ Even though the bioaccumulation in similar species is generally considered low and the current draft risk assessment report of styrene – UK Environment Agency, Final Draft, Nov. 1999 - concludes that “On the basis of the balance of the information available, it is concluded that styrene will not accumulate in aquatic organisms (...). The proposal is that styrene is not classified as dangerous for the environment.”

¹⁷ The values measured by IFREMER range from 4.9 to 340.0 µg/kg (w.w.) respectively in *Maja squinado* edible parts and in *Cancer pagurus* gills (both caught by fish traps). Gills and edible parts of a squid (Fr.: encornet, cf. *Illex illecebrosus*) caught by trawl north of the wreck on Nov. the 4th, showed a concentration of 8.5 µg/kg (w.w.) of styrene.

Regarding the operations that could be carried out on the wreck in order to avoid environmental and human health risks, the French authorities asked¹⁸ the shipowner to submit an executive plan to the panel of experts and to the *Comité de pilotage*¹⁹ before December the 10th. This Committee is chaired by the *Secrétaire Général de la mer* on behalf of the *Ministère de l'équipement, des transports et du logement* and includes representatives of the UK authorities. In any case, any activity should be completed before April the 7th 2001 in order not to jeopardise the tourist season in the Channel Islands.

The "IEVOLI SUN" wrecking site²⁰ represents a source of juridical questions because UK and France had declared the EEZ but no agreement on delimitation was signed. The wreck lies on a fishery ground reserved to British vessels and it is interesting to note the proximity at the site of the Channel Islands (Alderney, Guernsey, Jersey e Sark) territorial waters²¹.

Informally, French experts considered the most suitable hypothesis of intervention were the recovering through pumping of the residual loading and of the bunker or, secondary, the salvage of the entire wreck.

- About the foreseen interventions on the wreck²², taking into account:
 - ⇒ the known ecotoxicological properties of the pollutants;
 - ⇒ the health risks for coastal populations as assessed by French institutions;
 - ⇒ the simulations performed by IFREMER, INERIS and SHELL about the diffusion of styrene at sea and in atmosphere;
 - ⇒ the unfavourable rheological and meteorological conditions affecting the wreckage site;
 - ⇒ the care and the time required to investigate the best project(s) and to prepare and mobilise the equipment;²³

¹⁸ According to the art. 16 of the law promulgated on July the 7th 1976, the *Préfet maritime* holds the power to issue an injunction against a shipowner in order to bring him to undertake all the measures needed to eliminate the hazard within an established delay. After this deadline is reached, the State could act as substitute of the shipowner charging him with the expenses, risks and hazards.

¹⁹ The tasks of the *Comité de pilotage* are: a) to ensure control over the proposed solutions and operations; b) to validate the operations programme; c) to give full advice about the forthcoming operations. A panel of experts has been settled by the *Secrétariat Général de la mer* in order to provide a technical advice to the *Comité de pilotage*.

²⁰ The shipwreck lies at a depth of around seventy meters, 11.3 nautical miles from Alderney (also named Aurigny, Ch. Isl.) and 19.5 nautical miles from Cap de la Hague (F).

²¹ The islands are dependencies of the Royal Crown, owing allegiance to it, but without being incorporated neither into the United Kingdom nor in the European Union. They are self-governing in internal matters but the British Government is responsible for defence, overseas representation and international affairs in general.

²² The *Ministère de l'Équipement, de Transports et du Logement* indicated the following criteria as unavoidable with respect to the intervention on the wreck of the "IEVOLI SUN": 1) human and environment safety, particularly during the interventions, taking into account the nature of the products that are still in the wreck; 2) the carrying out of activities on the wreck aimed at eliminate all the risks for human health and the environment; 3) the quickness of the engagement and of the interventions.

²³ As in the case of the wreck of the tanker "ERIKA", a thorough preparation of the whole project is the starting point for a successful intervention.

- ⇒ the care and the time required for the implementation of adequate safety measures for the divers;
- ⇒ the reduced number of practicable weather windows available and the consequent need for careful scheduling of the activities;
- ⇒ the chemical-physical properties of the substances with regard to the precautionary measures to be undertaken in case of intervention²⁴

and considering the need for further scientific investigations and *in situ* measurements and observations, the group deems very dangerous for the operators both the pumping of the pollutants and the lifting of the wreck. Thus, calling for a thorough assessment of all risks involved, the gradual and monitored spillage of the products from the ship tanks before to afford the recovery of the bunker should be carefully considered among the intervention options.

For the expert group
Ezio Amato

Roma, December the 14th 2000

²⁴ Handling and storage specifications about styrene monomer include: corrodes copper and copper alloys and dissolves rubber; flow of styrene by pumping may result in the generation of electrostatic charges; carbon steel or stainless steel may be used for piping; metal containers involving the transfer of styrene monomer should be grounded and bonded.

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