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Model S.O.N.I.A.: Application To The Management of Oil Spills At Sea.

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ABSTRACT

What should be done before a damaged oil ship? Should we get away him from the shore in any case, or sometimes it can be more convenient move him to a shelter area , where you can carry out the transfer of fuel on safety conditions?. Three simulations of tanker accidents near the ports of Palma, Maó and Eivissa will serve to develop a usable manual decision-making to this type of disaster. The manual will determine under what condition is better one or the other solution, specify the minimum conditions of security, (infrastructure, services, personnel, etc.), that must have a port or refuge area.

1. Introduction

With approximately 1,200 kilometers of coastline, the Balearic Islands, with the other large islands of the Western Mediterranean (Corsica, Sardinia and Sicily), have a unique heritage in terms of ecosystems which must be preserved in terms of biodiversity. From this point of view these islands can be considered as 'laboratory islands' where biodiversity was maintained until the 60s due to a relatively low population and almost an absence of tourism and industrial complexes.

From the 60s the Balearic Islands have a very important development of tourism, receiving each year 8 million tourists compared to 800,000 residents. The presence of different activities related to tourism makes the Balearic Sea need to have an Integrated Management Plan of their coastal zones, allowing maintenance of tourist resource and the ecology of the area.

2. Models or spillage management systems

This is a series of support systems in managing a spill once it was produced (ie, in the design and implementation of an optimal 'operational plan' of an emergency plan) to minimize its effects at all levels, and to restore affected ecosystems; also they called support systems in the 'decision-making' in emergency situations. These systems, also called 'operational tools' are computer systems that require power and high process speed, and specially designed software. The information required by the model, can be tabulated in databases, but can also be introduced at the level of keyboard. You can refer to both the properties of spilled product as mapping and environmental characteristics of the area or means of combat which are available.

Of a product, we must know his buoyancy, volatility, spreading coefficient, and solubility, and therefore its distribution in the water, in the air and sediments; as well as their levels of lower and upper flammability and under what conditions; also their toxicity in air (with or without fire) and water, including long-term effects, (reactivity in water, air or other products) and sensitivity to sunlight and to the action of microorganisms, also their persistence in the environment and in some cases, their radioactivity.

To decide an intervention we must know the emergency available means, (to control the fire of a spill or ship), and the available means in case of poisoning by inhalation, contact or ingestion. Also we must know the accessibility to the place where the accident occurred, the possibility of transfer the cargo from the ship or from the containment means, as well as the recovery of spilled product and its usability available in the area. Also must know the means of pollution control: barriers, skim-

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mers, dispersants and sorbents are available as well as triggers combustion of oil 'in situ', etc. In addition, the means available for collection and the possibilities of carrying it out, (transport, storage, treatment and disposal of waste) and accessible means of intervention in domestic and foreign stocks.

With good information, a management system should designed or develop an optimal emergency plan quickly, or at least the best possible, given the available resources and the urgency of treatment. To make this design, the software must have access to databases, and simulation models of different types, for make a forecast of the possible effects of the spill and select the type of urgent measures (such as protection areas sensitive, evacuation of population risk of inflammation or toxicity of air, cutting water supplies if aquifers are affected, etc).

The next step is the communication of the decision from the computer environment to the abroad, for which management systems have access to a word processor and a printing system in which the different possibilities for action are clearly indicated, so that the team responsible for making the final decision on this contingency plan and its implementation, can act guaranteeing the maximum number of possible data and the potential impact of their decisions.

Naturally, there are limitations in the use of these management systems, because, on the one hand the limitations of hardware and software, and on the other, (perhaps most important), the inability to quickly validate the information entered into the system and the possible inconsistency between the information databases, by the use of different naming among them.

To this we must add that the models themselves are reductionist, by the inability of any one didn't have logical ability to decide on the best measures for each particular spill with all its peculiarities.

3. Model S.O.N.I.A. (Reporting System Operational Environmental Impacts)

The objective of the model S.O.N.I.A. is managed (as quickly and efficiently), everything related to oil spill at sea.

It consists of a series of simulation models, which can be managed independently, containment through barriers, recovery of spilled oil with skimmers and adsorbents, treatment with dispersants, as well as everything concerning the cleaning and restoration of an environment polluted coastal.

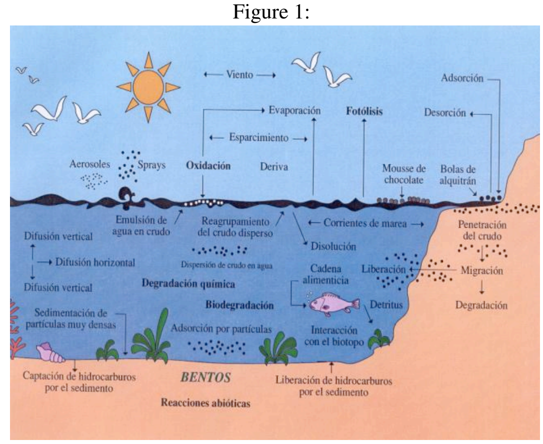
Figure 1 shows the main processes that occur when an oil spill occurs at sea and capable of being managed by SONIA Model.

In addition to the simulation models that manages the S.O.N.I.A., the model allows access to a series of computerized data banks and non-computerized on physical and chemical properties of crude oil and derivatives, and all essential theoretical considerations in the training of personnel responsible for the cleanup and restoration of coastal environments contaminated by Oil.

It also contains information from a number of mock accident cargo terminals and discharge of oil, which can cause discharges to sea. (Bergueiro and Domínguez, 1991)

Some of the main models that manage the S.O.N.I.A are following:

Figure 1:



3.1. *Notification Of Accident. Model. R.A.M.O.N.. (Reporting Oil Modeling Accident Notification)*

It includes a tab by which it can be supplied to the authorities competent, all data on the accident that caused the oil spill into the sea. The hours after a spill it is when decisions must be made most important, of everything related to the accident. The model also includes everything concerning the POLINF, POLREP and POLWARN models. The model also indicates how to graphically notify the area occupied by the spill, the area affected by the oil, the coordinates where the spill occurred and where is the wrecked ship, as well as the buoys signaling the spill and the type of contamination that caused.

3.2. *Estimated Response Times. Model 'TIME'*

To estimate the time required to perform the first observations of a spill, the time required for the ransom of the victims and the time required for the transfer of anti-pollution means (from the place where they are stored, to the spill area). (Bergueiro and Domínguez, 2001)

The inputs and outputs of the model are as follows:

Inputs

- Place where the spill occurred: sea or shore.
- Distance from the place where the incident originated to the place where anti-pollution means: miles or meters.
- Timeslot where you have to perform the procedure: ortho-ortho twilight or sunset.
- Number of people rescued by helicopter: up to four.
- Liters of foam concentrate to use.
- Liters of dispersant to use.

Outputs:

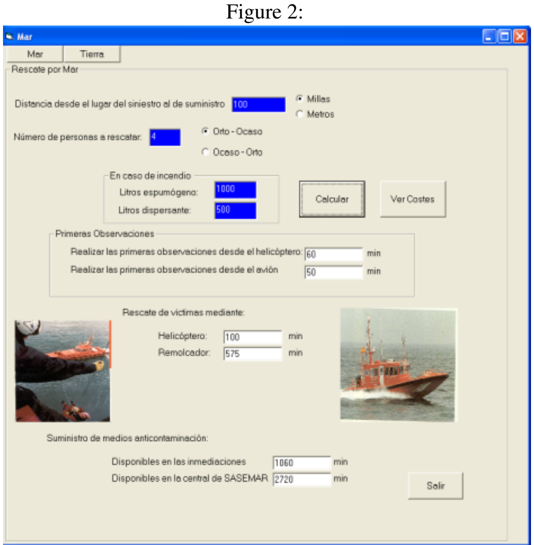
- Estimated time to perform the first observations from a helicopter.
- Estimated time to perform the first observations from an airplane.

- Estimated time to rescue victims by helicopter
- Estimated time for the rescue of the victims by a tow plane.
- Necessary time for the provision of anti-pollution means existing in the Balearic Islands time.
- Necessary time for the provision of anti-pollution means available for SASEMAR in Madrid time.
- Estimated cost of renting the helicopter used.
- Estimated cost of renting the aircraft used.
- Estimated cost of renting a tugboat carrying containment booms and skimmers.
- Estimated cost of renting a tugboat carrying addition to the above-fighting systems.
- Cost of dispersant used and foam used.

The time period in which the services are provided is very important. On the one hand the response times are greater in the sunset strip - ortho in ortho - Sunset and other processing costs of waste in the first time slot typically 30% higher than those of the other strip time.

Figure 2 shows the screen input and output data for a simulation of a spill within 100 miles of Palma de Mallorca where it was necessary to rescue four injured persons, in the time slot Ortho-Sunset, spray 1,000 liters of foam and 500 dispersant.

Figure 2:



3.3. Estimated Cost Of Withdrawal And Preview Of Recovered Sea Oil (Marpol System) Treatment. Model 'MARPOL'

It allows estimate the cost of removal of hydrocarbon mixtures and water from the storage vessel, coupled to the skimmers, and subsequent separation of the phases.

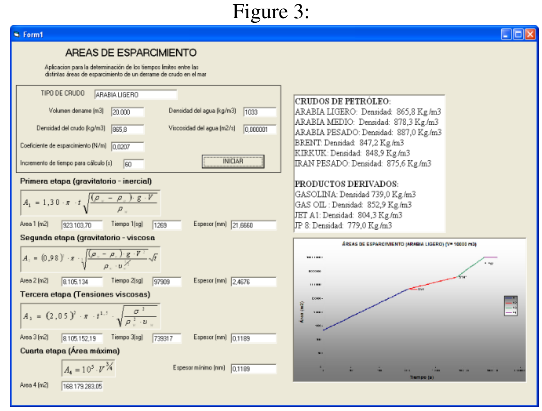
The cost of removal and pretreatment of a spill of 20,000 liters of hydrocarbon mixtures and water in the range of 7 to 21 hours is about 1,336 €, while in the rest of the time slot, the cost is 1,737 €.

3.4. Calculation Of Recreational Areas Of Oil Spilled A Mixture Of At Sea. Model 'AREAS'

It allows estimate the area of the different phases of the spread of a particular volume of oil spilled, and the time of achieving them, the thickness of each and the minimum thickness of the spill.

Figure 3 shows the spreading areas, their completion times and the thickness of a spill of 20,000 m^3 of Saudi Light Crude.

Figure 3:



3.5. Calculation Of Point Of Release

MODEL 'RELEASE'. Some mixtures of hydrocarbons, as they will evaporate and at certain temperatures are not prone to spreading. The model calculates the 'Pour Point' defined as the temperature at which a mixture of hydrocarbons stops flowing.

Input parameters to the model are: point of initial discharge of the mixture of hydrocarbons (C), evaporated fraction (%) and a constant.

If we don't know that constant, we specify for each mixture of hydrocarbons, the value of 1.33.

So for a mixture of hydrocarbons with a pour point of 15ºC without undergoing a process of evaporation increases its pour point up to 21°C when 30% has evaporated.

3.6. Calculation Of Evaporation Of A Mixture Of Hydrocarbons. Model A.V.E (Assessment of Velocity of Evaporation)

It allows estimate the variation of the evaporated fraction, depending on the time, most of the crude oil and its derivatives, and when they are spilled over the sea or beach sand (different grain size for different wind speeds).

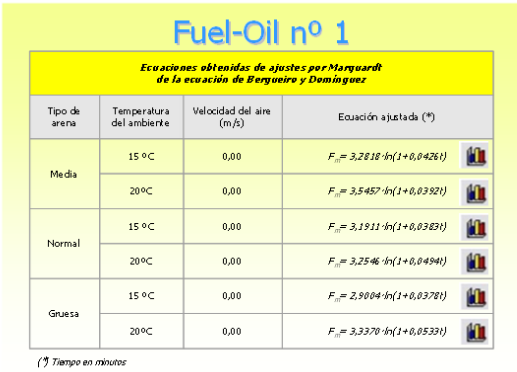
Figure 4 shows the equations proposed by these authors to estimate the variation of the evaporated fraction (versus time) of a Fuel Oil No.1 when it is spilled on beach sand medium, normal and thick type, 15 y 20ºC, in the absence of aeration.

3.7. Toxicity Oil Mixtures Dissolved In Sea Water, Crude Oil And Derivatives, Dispersant And Mixtures Of Thereof

Model E.V.A. (Extension Vapour Assessment)

It allows estimating the bioaccumulation, lethal dose (LD50) and toxicity (according to the judgment of Veith and Brooke),

Figure 4:



of the pure compounds dissolved in seawater, the toxicity of crude oil and oil dispersants and mixtures the same. The Figure 5 shows the results obtained for octane.

Figure 5:

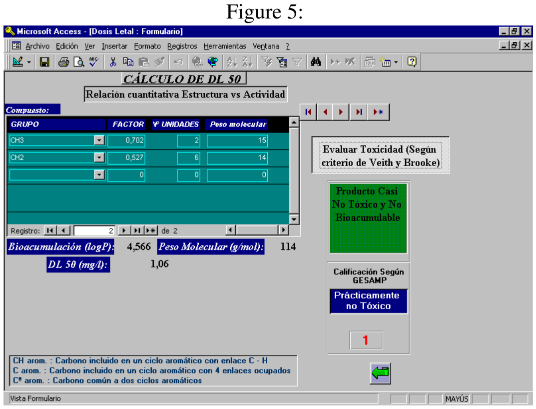


Figure 6:

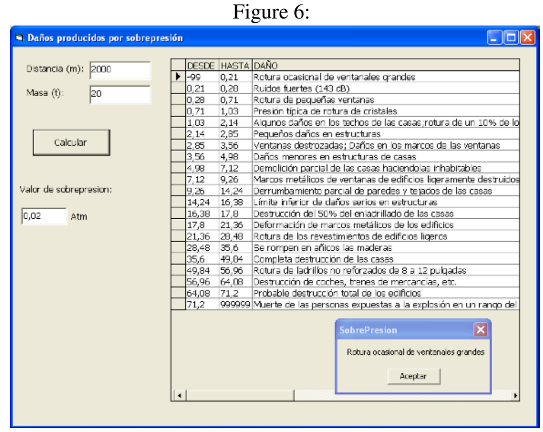
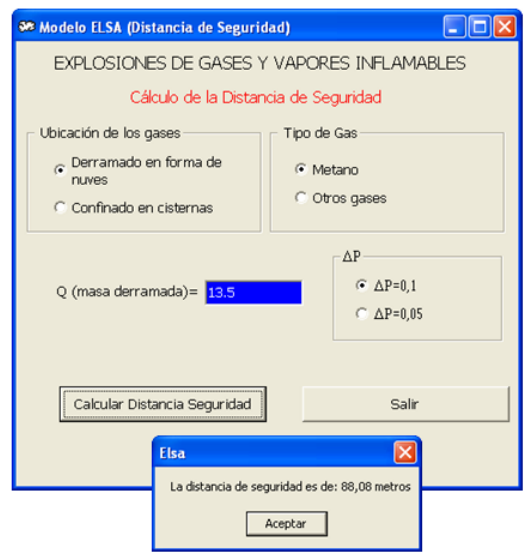


Figure 7:



3.8. Risk Of Explosion Of Oil Mixing Spilled In The Sea

Model E.L.S.A. (Explosion Level Security Assessment)

It allows to know if a certain mixture of spilled oil at sea, (on a certain temperature), can explode in presence of an ignition source. Hydrocarbon mixtures for which you can apply the model are: automotive gasoline 95, 97 and 98 octane aviation gasoline 100 Ll, Gas oils, jet fuel JET A1 and JP8, fuel oil and crude oil Arabian Light, Medium and Heavy.

3.9. Damaged Caused By An Overpressure Explosion. Model 'overpressure'

It is possible to estimate the damage caused by overpressure causes an explosion of a certain amount of methane.

Figure 6 shows the damage caused, to a distance of 2000 meters, the overpressure caused by an explosion of 20 tons of methane.

The model also calculates the safety distance for explosion of methane and other gases, confined in tanks or spilled into clouds. Figure 7 shows the calculation of the safety distance for an explosion of 13.5 Kg. of methane spilled shaped cloud.

The model also allows us to estimate, for an explosion of 13.6 kg. Of a flammable gas, other than methane, the distance to which can cause the outbreak of the lungs of those affected, which originate large Structural damage, and the destruction of the windowpanes as the safety distance (Figure 8).

Finally, the model allows us to estimate the damage caused by the explosion of gas spilled. selected the spill, the model indicates its empirical formula, molecular Weight, its enthalpy of combustion and Performance Factor explosion. Then the amount spilled is introduced (by weight or by volume), and moving the lateral cursor, you can know the distance from the area of maximum danger, the area of high risk, the risk zone and minimal risk, as well of the damage that the explosion may cause in each of these areas (Figure 9).

The program also provides access to a database with considerations about burns first, second and third grade, and information about explosions and detonations.

3.10. Containments Barriers Of Oil Spill At Sea

Model M.O.N.C.H.O.(Model for Notification on Confining Hydrocarbon Operations)

The model manages everything concerning theoretical considerations barriers, fences and interceptors (Scheme 10). It

Figure 8:

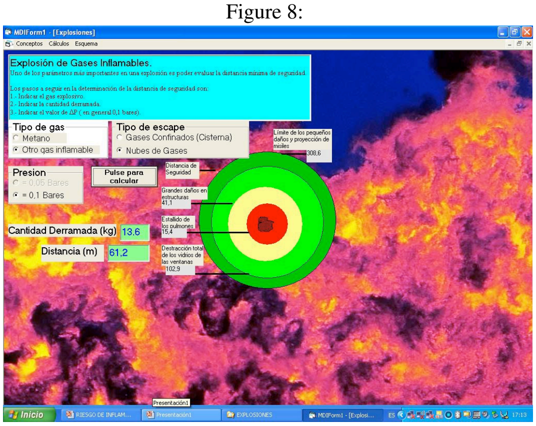
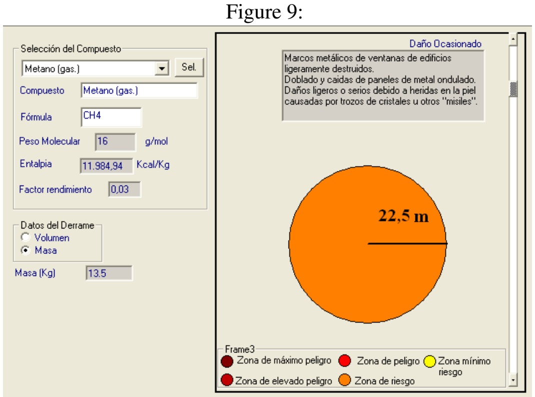


Figure 9:



describes the following points:

- Introduction about the use of the barriers.
- Considerations to take into account.
- Tips and schemes of barriers.
- Tips of floats.
- Elections of barriers.
- Boom deployment: means necessary for deployment, deployment from the ground and from boats.
- Collections of barriers.
- Cleaning, restoration and storage of barriers.
- Fences and interceptors of oil spills.

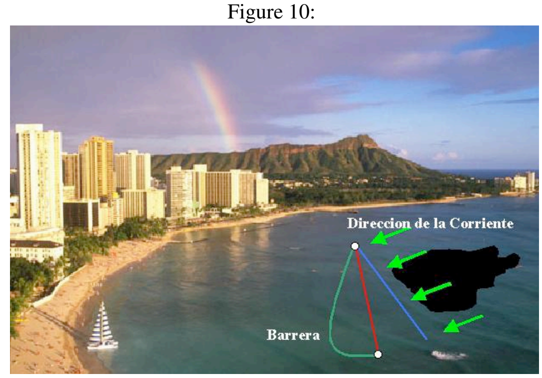
Figure 10 shows the deployment of a J-shaped barrier to prevent the effect of the waves and the sea current to pass hydrocarbons freeboard above or below the skirt.

3.11. Calculation Of Barriers

Model A.L.F.O.N.S.O. (Anchorage Length and Force tasks Operational Notification for Sweeping Operations at sea)

Calculates the limits of cost of a barrier, needed to store the reel, the length of the anchor line, the buoy and separation distance of a double barrier. Figure 11 shows the calculations for a barrier 300 m. long, the cost of the reel, the length of anchor line and its buoy, to a water depth of 40 meters and calculating the separation distance of a double barrier, to contain more effectively hydrocarbons spills, when oil losses occur by the first barrier. (Bergueiro and Domínguez, 2002)

Figure 10:



Inputs:

- Length of the barrier.
- Depth of the water layer.
- Length and breadth of the tanker who?s going to be protected.
- Width of the port to protect.
- Number of skimmers deployed for recovering hydrocarbons.
- Width of the river or canal to protect.
- Velocity of the current.
- Wavelength of the waves.
- Velocity of the wind.

Outputs:

- Cost of the barriers.
- Cost of the spool to keep the barrier.
- Length of the anchor cape.
- Length of the cape buoy.
- Distance between two barriers.
- Total length necessary to protect the oil barrier.
- Total length of the barrier to surround the skimmers.
- Inflation time of the barrier by a conventional blower.
- Inflation time barrier by a blower backpack.
- Barrier efficiency against the wavelength of the waves.
- Possible damage caused by the sea current in the barrier.

- Possible damage caused by the wind on the barrier deployed.
- Recovery time barrier, cleaning time and time needed for storage.

Figure 11 shows the calculation of time required for the deployment of a barrier 150 meters long and recovery, cleaning and storage of thereof.

Figure 11:

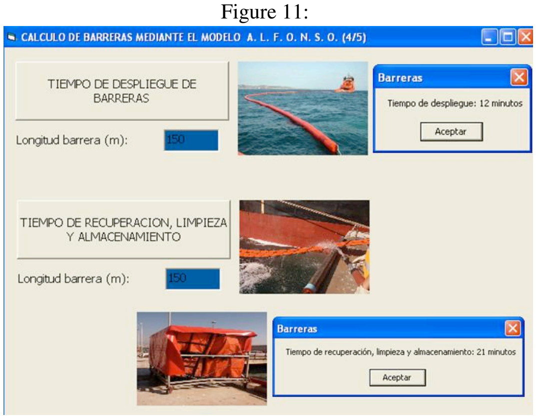
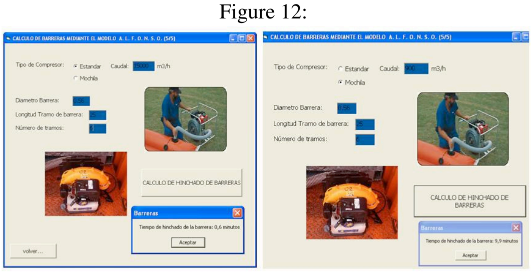


Figure 12 shows the results of the inflation time of a barrier, with air float, by a conventional blower and the blower through a small backpack.

Figure 12:



The model also calculates the length of a barrier, including its curvature, the angle of inclination thereof and the force winds and currents have on its skirt and freeboard. Figure 13 shows the calculation of the actual length of a barrier, including its curvature to contain a spill, its angle of inclination and the winds and currents force exerted on the skirt and the freeboard. For systems of anchoring that are not suffice, this model indicates the dimensions of the concrete blocks required for proper anchoring of the barrier, and prevent that the anchor points be displaced.

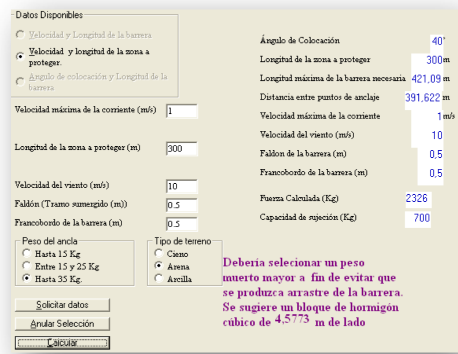
The model inputs are:

- Maximum speed of the current.
- Length of the zone to be protected.
- Wind speed.
- Width of the skirt and the freeboard.
- The weight of the anchors used and the type of terrain that are intended to anchor said anchors (mud, sand or clay).

The outputs of the model are:

- Angle of the barrier.
- The maximum length of barrier required.
- Distance between anchor points.
- The force exerted by the wind and current on the barrier and holding power anchors

Figure 13:



3.12. Recovery Of Oil Spilled Into The Sea

Model R.O.G.E.R. (Oil and fat Regional Emergency Recovery)

The first treatment of an oil spill should consist recovery thereof by mechanical means. The model R.O.G.E.R. It includes all theoretical considerations concerning the recovery of spilled oil at sea by skimmers.

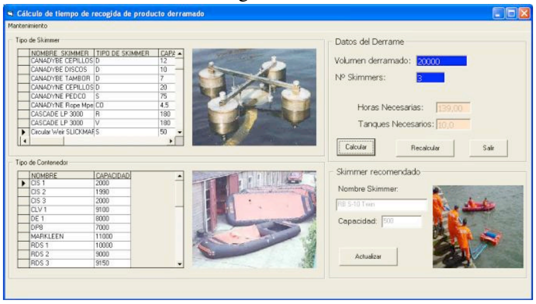
Selecting transfer systems hydrocarbons can be performed by a process with a matrix, depending on the viscosity of the type of spilled fluid, tolerance of the skimmer from waste, like another set of criteria such as speed transfer, if it is easy to operate continuously and the cost.

3.13. Calculation Of Skimmers. Model S.I.R.A. (Skimmers Application for Immediate Recovery)

It calculates the number of hours required to recover a spill and the number of tanks to store water mixtures and recovered oil. Also selects the best skimmer to effect recovery in the shortest possible time. Figure 14 shows the calculations for sea recover a spill of 20,000 liters of oil, through a specific skimmer.

Likewise, the model allows estimate (of all skimmers database), which is the greater recovering hydrocarbons with speed and efficiency, which is best recovering mixtures of more viscous hydrocarbons, and recovering hydrocarbons in the presence of small solid waste, and which has the best propulsion system and storage.

Figure 14:



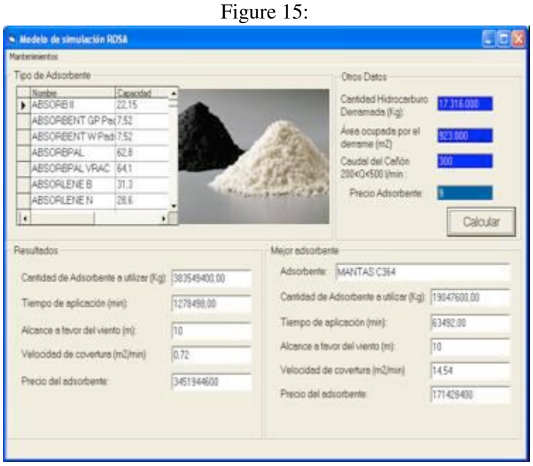
3.14. Recovery Of Spilled Oil At Sea By Adsorbents

Model R.O.S.A.(Recovery by Oil Sorbent Application)

It allows estimate the amount and cost of an adsorbent that is necessary to spray on an oil spill to recover from the surface of the sea. It also allows estimating the amount and cost of the best adsorbent that can be used to recover the mixture of hydrocarbons and the economic savings obtained.

Figure 15 shows the amount of adsorbent to be applied on a spill of 17,316,000 kg. Of Arabian light crude oil which occupies an area of 923,000 m^2, when sprayed through a canyon with a flow rate of 300 L/min. This scheme also shows the time required for implementation of the adsorbent, the scope of the barrel downwind, the velocity of coverage (m^2/min.), And the price of the adsorbent. These results are compared with those obtained with the best available adsorbent in the database.

Figure 15:



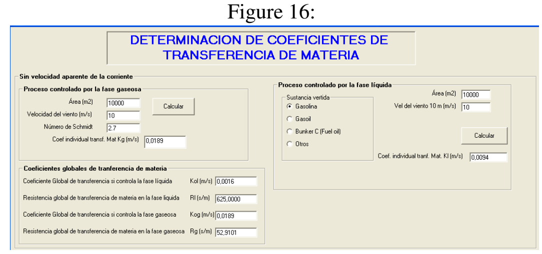
3.15. Determination Of Rate Transfer

Model CO.TRA.MA. One time that an oil spill happen at sea, the most volatile fractions begins to evaporate, from the liquid phase to the interface, and then through the interface to the nearest atmosphere.

The model CO.TRA.MA calculate the mass transfer coefficient (Kg/h), depending on the diameter of the spill (m), wind speed (m/s), the Schmidt number (dimensionless) and a constant.

The proportionality constant normally used worth is 0.0048. If we do not know the Schmidt number, the model catch the value of 2.7, obtained experimentally for evaporation of Cumene (Figure 16).

Figure 16:



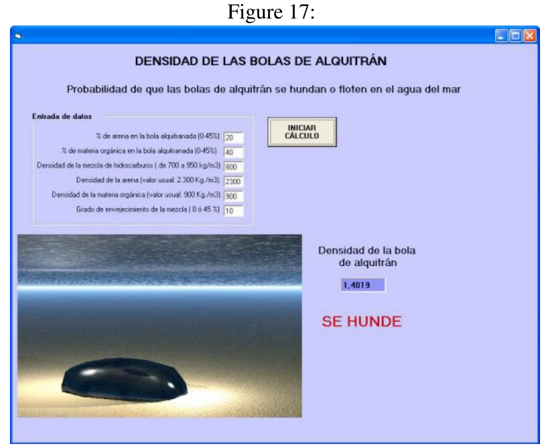
3.16. Formation Of Tarry Balls

Model of tarry balls

It allows estimate the density of a tarry ball depending on the percentage of sand, organic matter, the densities of the mixture of hydrocarbons and other organic matter accompanying hydrocarbons, as the degree of aging. The program calculates the density of the ball and compares it to the density of sea water and whether that ball can sink, float or be gabled, then moving depending on ocean currents.

Figure **??** shows the results for a simulation of a tar ball formed by 20% of beach sand and 40% organic matter with densities of hydrocarbon mixtures and matter other organic matter accompanying hydrocarbons Kg/m^3 respectivamente 800 and 900 and a degree of aging of 10%.

Figure 17:

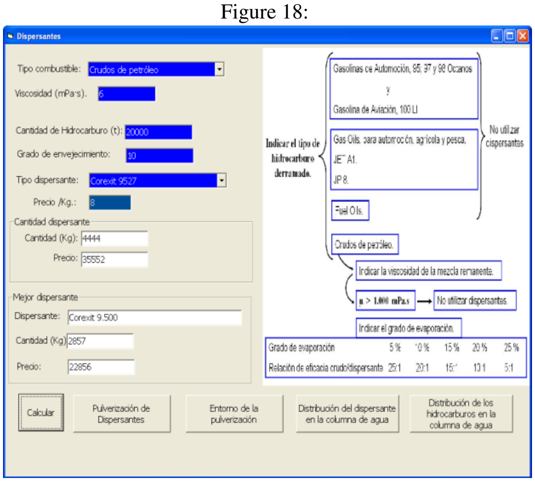


3.17. Treatment Of Hydrocarbons By Dispersants

Model D.I.A. (Investment Dispersion Assessment)

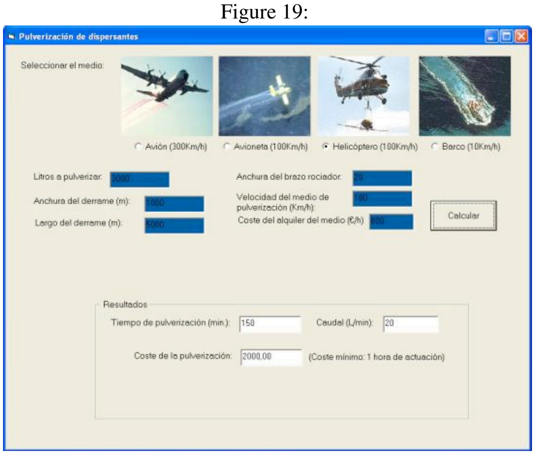
It Estimates the optimum amount of dispersant to be used for the treatment of a spill into the sea, with a certain degree of aging. The model input parameters are: type of oil spilled, viscosity, amount spilled, aging and dispersant spraying. The output parameters of the model are: amount of dispersant to use and cost thereof. These amounts are compared to the best dispersant registered in the database. The results of treatment of 20,000 tons of crude oil viscosity 6 mPa.s, 10% aged shown in Figure 19.

Figure 18:



The model calculates the time and spray rate, and the cost of the operation. Input parameters to the model are: liters of dispersant spraying, width effusion (m), along the stroke (m), width of the spray arm (m), average speed of the medium used for spraying (large airplanes, small airplanes, helicopters and tugboats) and the cost of renting the average (€/h). Figure 19 shows the calculations for spraying 3,000 gallons of dispersant from a helicopter over a spill of 1000 meters wide and 5000 meters long, using a helicopter provided with a spray arm 20 meters wide.

Figure 19:



Then the model to estimate the adequacy, of sprays dispersants in a particular marine area, depending on the distance from shore and depth of the water layer. These estimates can be made for two environments, for the Mediterranean Sea and the Atlantic Ocean. Also the model estimates the change in concentration of the mixture of dispersed oil and the dispersant in the water column. Figures 20 and 21 show the distribution of the hydrocarbon mixture and the dispersant in the water column for discharge of 20000 Kg. Of crude petroleum aged 10%, on which have been sprayed 2857 Kg of dispersant.

For not apply dispersants, or they not be effective, the drops which can be dispersed by effect of the energy supply can mixture, the waves tend to meet each other and ascend to the sur-

Figure 20:

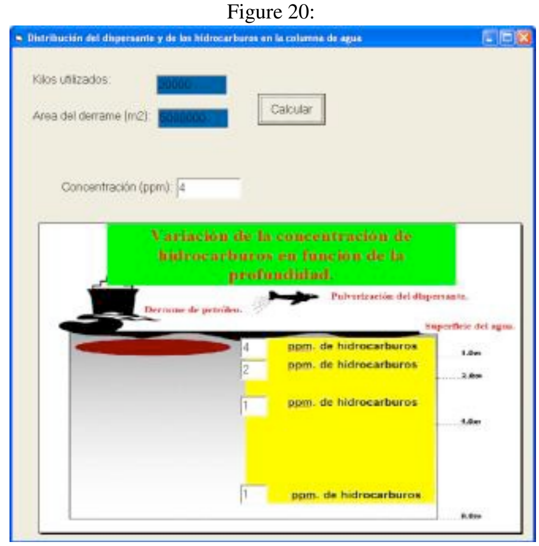
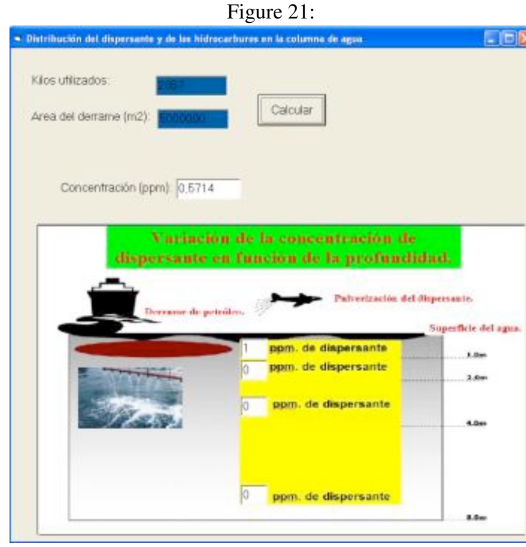


Figure 21:



face. The DROPS model allows estimating the rate of rise of oil drops. Input parameters of the model are: drop diameter of the hydrocarbon (m), density of the hydrocarbon mixture (Kg/m^3), density of seawater (Kg/m^3) and sea water viscosity (m^2/s). The model output parameter is the speed of ascent drops hydrocarbon (m/s). Once the spilled occurs, a series of processes produce the change of the properties of the hydrocarbon mixture spilled, over time. VISCOSITY MODEL estimates the variation of viscosity of a hydrocarbon mixture with the evaporated fraction. Input parameters of the model are the initial viscosity of the hydrocarbon mixture (cP) and evaporated fraction (%).Sometimes when aging hydrocarbon mixtures have spilled, due to the agitation of the waves can form emulsions, known as 'chocolate mousse'. The viscosity of such emulsions (cP) can be estimated using the MODEL EMULSIONS. Input parameters to the model are the initial viscosity of the hydrocarbon mixture (cP), the water content of the emulsion (mass fraction) and a constant emulsification. If we do not know the constant value, the model takes a constant value of 0.654. Similarly the model estimates the density of the formed emulsion (Kg/m^3) depending on the water content of the emulsion (%), the density of seawater (Kg/m^3) and the density of the mixture hydrocarbon (Kg/m^3).

3.18. *Biodegradation Of Crude Oil And Dispersant*

Model Biodegradation

It allows estimate the removal, by a process of bacterial degradation of crude oil scattered on the sea water, dispersants and mixtures thereof. Since in many marine environments there are deficits of nutrients that the model includes on the effect of biodegradation accelerator Inipol EAP 22 in the biodegradation process. As bacterial consortium was used PUTIDOIL both with and without nutrients. Also it has studied the effect of zealots and sandy beach in the derivative process.

Impairments have been made in thermo stated cylindrical reactor provided with propeller with magnetic stirring reactors and reactors with simulated waves. Figures 22 and 23 shows the concentration variation with time of the dispersant Rehenes 714, the dispersant RENEX 714 in the presence of crude oil KIRKUK type, crude oil KIRKLUK in the presence of the dispersant RENEX 714 and crude KIRKUK oil type in the absence of dispersant RENEX 714.

Figure 22:

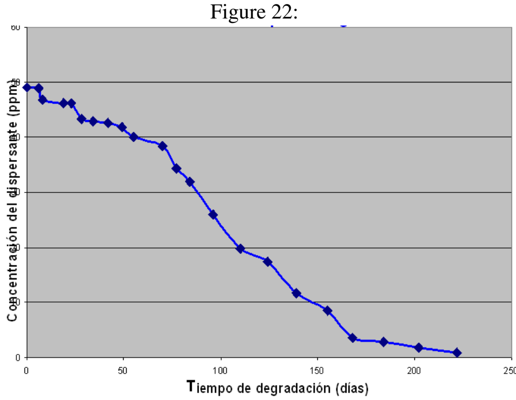


Figure 23:

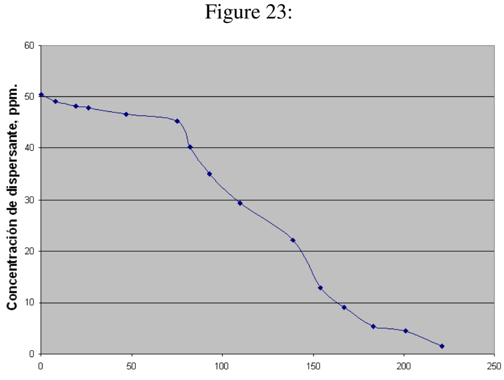


Figure 24:

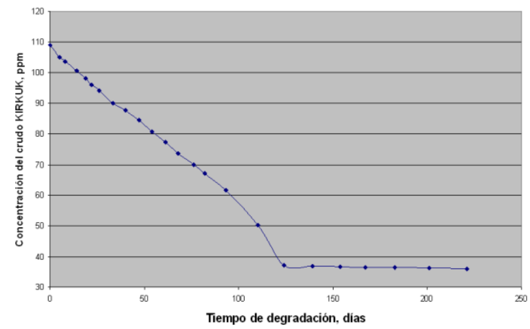
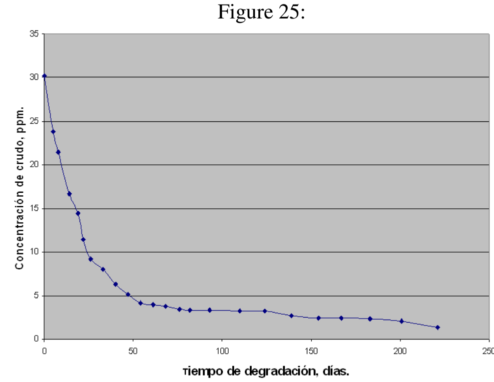


Figure 25:



3.19. *Burning Highly Aged Oil Spilled At Sea*

Model U.E.F.G.O. (Fast Use Effective Goal by Oil burning)

It allows estimate the speed of burning a mixture of highly aged hydrocarbons. Input parameters to the model are: diameter of spill containment type open U or U fireproof closed and stretch ratio to the total length of the barrier.

The output parameters of the model are: spacing between the tugs, total length of the barrier, spill area, volume occupied by the minimum area of the ?burning spill, burn rate, elimination rate, burn time, safety distance, heat flow and temperature of the gases formed.

Figure 26 shows the results obtained for burning a mixture of aged hydrocarbons with 380 meters in diameter. To make the burnt first is sprayed onto the gelled gasoline spill to prevent quickly evaporate.

Then you apply darts arsonists to start burning the waste oil. Experimental data it is known that the maximum width of the spill is 380 meters and the minimum thickness of 2 mm.

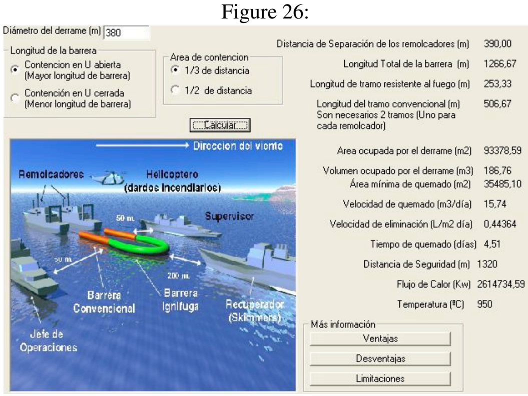
The program also allows you to query the advantages, disadvantages and limitations of this method of removing oil spilled into the sea highly aged.

3.20. *Put Off A Small Tanker Burned By Foam*

Model FOAM

To calculate the flow rate of foam required for a burning tanker. The model input parameters are: length and beam of the oil, greater width of the tank, foam price and time of application. The output parameters of the model are: spraying foam flow based on the total area of the boat, in the area larger tank

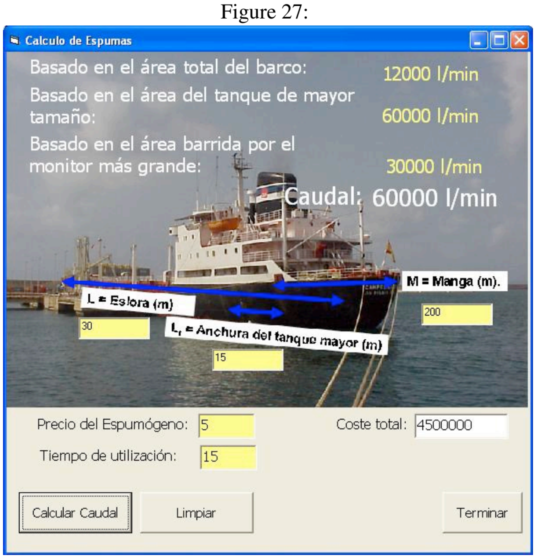
Figure 26:



and the area swept by the larger monitor. The model propose the flow of concentrate foam , the major of the results and the total cost of the operation.

Figure 27 shows the results for a simulation of an oil tanker of 200 m. long, 30 m. wide, 15 meters wide of the largest tank, an application time of 15 minutes and a foam price of 5 €/liter.

Figure 27:



3.21. Mapping Of The Balearic Islands

Model MAPPING

The model allows access to the main charts of the Balearic Islands and their surroundings. Through these maps you can obtain a series of data needed to perform simulations of displacement of oil at sea.

3.22. Estimated Cost Of Cleaning And Restoration Of A Coastal Environment Polluted By Oil Spill

Model O.C.T.S.E.S. (Cost for On Scene Treatments, Evaluation and Survey)

It allows a first estimate of the costs of cleaning and restoration of a coastal environment polluted by an oil spill.

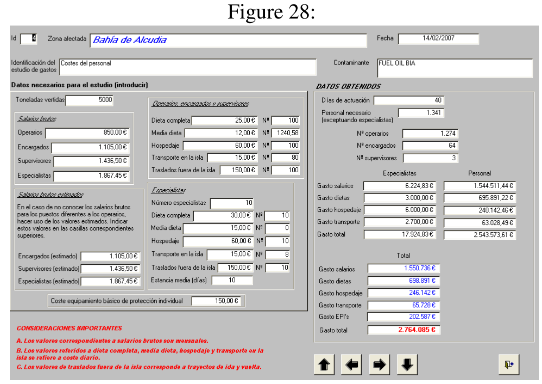
The model input parameters are: the amount spilled (tonnes) and the average wage of employees (€/day).

The output parameters of the model are: estimated cleaning time, the number of employees needed and the cost of salaries of such employees.

A second part of the model to estimate the total cost broken down wage costs, per diem expenses, lodging expenses, transportation costs, costs of PPE (personal protective equipment) and total cost.

Figure 28 shows the total cost of staff responsible for cleaning and restoration of a coastal environment of the Balearic Islands contaminated by a spill of 5,000 tonnes of fuel oil BIA.

Figure 28:



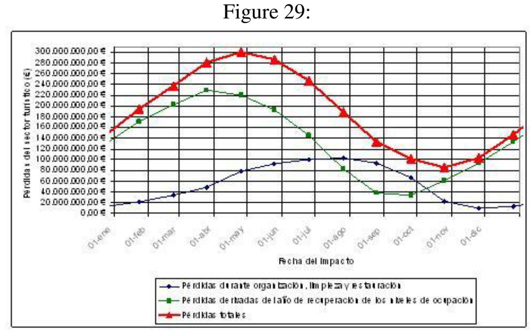
The model compares the results obtained with the model provided by the Texas A & M University.

3.23. Estimated Losses Caused By An Oil Spill On The Touristic Sector

Model IN.CO.TUR

It allows estimating the losses in the tourism sector can cause a certain amount and type of oil spilled, depending on the time of year when the discharge occurred. Figure 29 shows the losses in the tourism sector in Palma de Mallorca caused by a spill of 500 tons of fuel oil depending on the date of the impact.

Figure 29:



3.24. Compensation Funds By Hodrcarburos Spills At Sea

Model FUNDS

The model allows access to all information of International Funds Compensation and Damages due to sea by Oil Pollution (IOPC). The three organizations that form the IOPC have a joint secretariat based in London. The owner of a tanker is obliged to cover all compensation up to a certain limit, which could cause an oil spill. If that amount does not cover all eligible claims there is additional compensation covering the 1992 IOPC long as the damage occurs in a State that is a member of the fund. There were three IOPC Funds. The first is the 1971 Fund, the 1992 Fund second and third Supplementary Fund. These three funds were established in 1971, 1992 and 2005. The Supplementary Fund was established to supplement the compensation available under the Civil Liability Conventions and the 1992 Fund with a third level of additional compensation. Due to a series of problems the 1971 Fund Convention ceased to be in force on 24th May 2002. Therefore it does not have Member States but continues to deal with all incidents that occurred in the Member States of the Fund before that date. Membership of the Supplementary Fund is optional and any State which is a Member of the 1992 Fund may join.

The IOPC Funds are financed by levies on certain types of oil carried by sea. These collections usually pay the entities receiving oil carried by sea.

Any person or institution who has suffered damage caused by an oil spill can file a claim for compensation against the IOPC Funds. The FUNDS model allows access to all information regarding the types of claims that can be ordered (manual claims), the General Explanatory Notes, the Annual Report of the IOPC Fund and how to access the manual claims.

3.25. *End Of The Contingency Plan*

Model A.D.I.O.S (Abandon Decision Impact Oil Simulated)

Before to terminate a Contingency Plan, designed for cleaning and restoration of contaminated coastal oil is necessary to make a number of estimates, in order to check the degree of accuracy of all decisions taken.

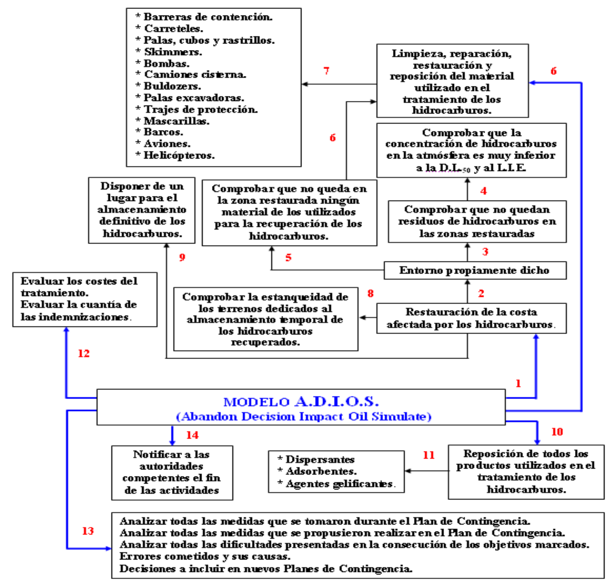
The first thing is recommended that once intended to conclude the proceedings, is a visual inspection whose purpose is to check whether in the coastal area affected by the oil, if a small debris continues in the middle. If so, the possibility to recover the more efficient will be studied.

In case that is not possible to make its recovery, we will decide what treatment is advisable to perform and it will be indicated by signs placed in conspicuous places. It is also necessary to check for residues of volatile hydrocarbons in the air and in the water near the affected area. If the study of the analyzes indicated the presence of hydrocarbons would be necessary to determine the lethal dose for man and for the flora and fauna, as well as decide whether this area should be closed to the public. If detected hydrocarbons in the air, it is necessary to know if the concentration is above or below the Lower Limit of Explosion (L. I. E.). If the concentration is above the LEL, it will be necessary to evacuate all the personal in that area and deny entry until the concentration of hydrocarbons is below the LEL, what usually happens in a period of relative short time, mainly in coastal areas affected winds or sea breezes.

If available simulation models can estimate the time required for a given oil concentration drops below the L. I. E. like the likely movement of said gases depending on the intensity of the prevailing winds.

Adequacy is installed in the affected area explosiometers that give precise information about the concentration of hydrocarbons in the atmosphere. Then we will check if all the utensils used in the cleanup and restoration have been thoroughly cleaned. If there was breakage or damage should proceed to full restoration prior to storage.

Figure 30:



Before making the storage of personal protective suits, masks, and rakes and forks as well as containment booms and skimmers or reels, you must also clean are dry. Storage shall be carried out in dry and ventilated places, away from insects and rodents that could cause deterioration of some of its parts, mainly in the containment barriers. In coming to the affected area you need to check the tightness of them, to prevent leakage of oil. It is also necessary to have a suitable place for the final storage of hydrocarbons.

Then it will be checked if they have spare all products used in the treatment of hydrocarbons, such as adsorbents, dispersants, gelling agents, etc. The next step is the evaluation of all costs of treatment and the amount of compensation required to be paid, taking into account the international conventions on compensation for damage caused by oil spills. It is also necessary to do the following:

- A thorough analysis of all measures taken during the implementation of the Contingency Plan.
- An analysis of all proposed measures made and that for some reason have not been able to take.
- An analysis of all the difficulties encountered in achieving the goals that they had set.
- An analysis of all the errors and their causes.
- An analysis of the decisions to be included in future plans Continence, in the light of the mistakes and experiences of previous plans.

The last action to take is to notify the competent authorities in order to all activities.

The Figure 30 shows a flow chart BYE model with all the checks to be carried out before closing a contingency plan.

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