REGIONAL MARINE POLLUTION EMERGENCY
RESPONSE CENTRE FOR THE MEDITERRANEAN SEA
(REMPEC)

ASSESSMENT OF THE EXISTING SITUATION AND NEEDS OF THE GSP LIBYAN ARAB JAMAHIRIYA REGARDING PORT RECEPTION FACILITIES FOR COLLECTING SHIP-GENERATED GARBAGE, BILGE WATER AND OILY WASTES IN THE PORTS OF TRIPOLI, MISURATA, KHOMS AND ZAWIA TERMINAL

ACTIVITY 1

COLLECTION AND TREATMENT OF SOLID AND LIQUID WASTES

FINAL REPORT

August 2004

ENVIRONMENTAL PROTECTION ENGINEERING S.A.

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This study was executed by Environmental Protection Engineering (E.P.E.) S.A., Greece, contracted by and under the responsibility of REMPEC. E.P.E. S.A. were also contracted by REMPEC to carry out a parallel study on the collection and treatment of oily ballast waters from tankers (Activity 2), which is the subject of a separate report.

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1. GENERAL

1.1 Subject and scope of the Activity 1 of the project

The Activity 1 of the project "***Port Reception Facilities for Collecting Ship-Generated garbage, Bilge water and Oily wastes***" is concerned with the identification of required capacities for collection and treatment of relevant types of solid and liquid wastes at the ports of the GSP Libyan Arab Jamahiriya.

The project specifically aims at promoting, in accordance with the Annexes I and V of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), the installation of port reception facilities for the collection of ship-generated oily wastes and garbage, as well as at identifying the present situation and needs regarding the reception facilities for oily ballast waters in the ports of the country.

The ports that were visited and studied in the framework of the Activity 1 and 2 *(Collection and treatment of oily ballast waters from tankers)* of the project are those of **Tripoli, Misurata, Khoms and Zawia terminal**.

1.2 Definitions

Annex I of MARPOL 73/78 contains certain regulations and interpretations related to procedures for the retention onboard, treatment, discharge at sea and disposal of oily mixtures generated in the machinery spaces of all ships and the cargo areas of oil tankers.

Annex V, similarly, contains regulations dealing with the storage, disposal and management in general of garbage produced onboard ships. The terms used for the purpose of this Report as well as their definitions which are presented below have been extracted by the following sources:

- MARPOL 73/78 Annex I Regulations and unified interpretations.
- MARPOL 73/78 Annex V Regulations.
- IMO Guidelines for the implementation of Annex V of MARPOL 73/78. These Guidelines provide information and guidance to assist vessel personnel in complying with the requirements set forth in Annex V and also port and terminal operators in assessing the need for and providing adequate reception facilities for garbage generated onboard different types of ships.
- IMO Guidelines for systems for handling oily wastes in machinery spaces of ships. These guidelines provide guidance in achieving an

– efficient and effective system for the management of oily bilge-water and oil residues for new buildings and, where applicable and reasonable, for existing ships.

The terms used and the definitions are as follows:

Oil is defined as petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined products other than petrochemicals.

Oily wastes mean oil residues (sludge) and oily bilge-water.

Oil residues (sludge) means:

- separated sludge, which means sludge resulting from purification of fuel and lubricating oil;

- drain and leakage oil, which means oil resulting from drainages and leakages in machinery spaces; and

- exhausted oils, which means exhausted lubricating oil, hydraulic or other hydrocarbon-based liquid which are not suitable for use due to deterioration and contamination.

Oily bilge water means an oil – water mixture containing potentially sea and fresh water, fuel oil, cooling water, leakage and lubricating oil, accumulated either in designated holding tank/s or bilge wells.

Mediterranean Sea area means the Mediterranean Sea including also the gulfs and seas therein with the boundary between the Mediterranean and the Black Sea constituted by the 41^0 N parallel and bounded to the west by the straits of Gibraltar at the meridian of 5^0 36' W.

Sludge tanks means:

- tanks for separated sludge;

- drain and leakage oil tanks; and

- exhausted oil tanks.

Bilge-water holding tanks mean tanks for oily bilge-water.

Oil sludge incinerators are systems serving for incineration of oil sludge generated on board seagoing ships. Sludge incinerators should be main and auxiliary steam boilers with appropriate oil sludge processing systems, incinerators with appropriate oil sludge processing systems designed for sludge incineration, etc..

Harmful Substance means any substance which, if introduced into the sea, is liable to create hazards to human health, harm living resources and marine life, damage amenities or interfere with other legitimate uses of sea. Harmful substances for which MARPOL 73/78 has set discharge limits are oil and oily

mixtures (Annex I), noxious liquid substances in bulk (Annex II), sewage (Annex IV), garbage (Annex V), and air emissions (Annex VI).

Discharge, in relation to harmful substances or effluents containing such substances, means any release, from a ship and includes any escape, disposal, spilling, leaking, pumping, emitting or emptying which is limited for the purpose of this Report to the discharge of oily bilge water and garbage. Discharge does not include dumping, within the meaning of the London Dumping Convention.

Food wastes are any spoiled or unspoiled victual substances, such as fruits, vegetables, poultry, meat products, food scraps, food particles, and all other materials contaminated by such wastes, generated aboard ship, principally in the galley and dining areas.

Plastic means a solid material which contains as an essential ingredient one or more synthetic organic high polymers and which is formed during either manufacture of the polymer or the fabrication into a finished product by heat and/or pressure. Plastics have material properties ranging from hard and brittle to soft and elastic. Plastics are used for a variety of marine purposes including, but not limited to, packaging (vapor-proof barriers, bottles, containers, liners) ship construction (fiberglass and laminated structures, siding, piping, insulation, flooring, carpets, fabrics, paints and finishes, adhesives, electrical and electronic components), disposable eating utensils and cups, bags, sheeting, floats, fishing nets, strapping bands, rope and line.

Domestic wastes mean all types of food wastes and wastes generated in the living spaces on board the ship.

Cargo-associated wastes mean all materials which have become wastes as a result of use on board a ship for cargo stowage and handling. Cargo-associated waste includes but is not limited to dunnage, pallets, lining and packing materials, plywood, paper, cardboard, wire, and steel strapping.

Maintenance wastes mean materials collected by the engine department and the deck department while maintaining and operating the vessel, such as soot, machinery deposits, scraped paint, deck sweeping, wiping wastes, rags, etc.

Operational wastes mean all cargo-associated wastes and maintenance wastes, and cargo residues as defined below.

Cargo residues are defined as the remnants of any cargo material on board that cannot be placed in proper cargo holds (loading excess and spillage) or which remains in cargo holds and elsewhere after unloading procedures are completed (unloading residual and spillage).

Oily rags are rags which have been saturated with oil while contaminated rags are those which have been saturated with a substance defined as a harmful substance including oil.

Ash and clinkers from shipboard incinerators and boilers are operational other garbage in the meaning of Annex V respective regulations.

2. REGULATIONS & RULES

2.1 Oily Mixtures

2.1.1. Criteria for discharging oily mixtures from the machinery spaces of ships at sea

In accordance with Regulation 10 of MARPOL 73/78 Annex I (Methods for the prevention of oil pollution from ships while operating in Special Areas), any discharge into the Mediterranean sea of oil or oily mixtures from any oil tanker and any ships of 400 tons gross tonnage and above other than oil tankers is prohibited.

The abovementioned prohibition does not apply to the discharge of processed bilge water from machinery spaces, provided that all the following conditions are met:

(a) the bilge water does not originate from cargo pump room bilges of an oil tanker,

(b) the bilge water is not mixed with oil cargo residues,

(c) the ship is proceeding en route,

(d) the oil content of the effluent without dilution does not exceed 15 parts per million; and

(e) the ship has in operation equipment as required by Regulation 16 of Annex I. For ships of 10.000 tons gross and above this equipment includes an oil filtering equipment with arrangements for an alarm and for automatically stopping any discharge of oily mixtures when the oil content in the effluent exceeds 15 parts per million. Any ship of 400 gross tons and above but less than 10.000 gross tons should be fitted with an oil filtering equipment. In parallel, any such ship which carries large quantities of oil fuel should similarly be fitted with an approved oil filtering equipment with alarm and automatic stopping arrangements.

For ships of less than 400 tons gross, their Flag State Authority should ensure, that as far as practicable, they shall be equipped so to retain on board oil or oily mixtures to discharge them in accordance with the abovementioned requirements. Ships engaged exclusively on voyages within Special Areas can be relieved from installing and operating oil filtering equipment provided that all the following conditions are met:

- The ship is fitted with a holding tank having a volume adequate, to the satisfaction of its Flag State Authority, for the total retention on board of the oily bilge water,

- All oily bilge water is retained onboard for subsequent discharge to reception facilities,

- The Flag State Authority has determined that adequate reception facilities are available to receive such oily bilge water in a sufficient number of ports and terminals the ship calls at,

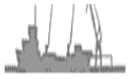
- Appropriate endorsements have been made to those ships' IOPP Certificate and also the quantity, time and port of the discharge are recorded in the Oil Record Book.

The oil residues which cannot be discharged into the sea in compliance with the abovementioned conditions shall be retained on board to be finally disposed of to available port reception facilities. The requirements that oil tankers and other ships should comply with, are presented schematically in the next tables:

OIL TANKERS OF ALL SIZES AND OTHER SHIPS OF 400 GRT AND ABOVE **Control of discharge of oil from machinery spaces**	
Within Special Areas	Any discharge is prohibited, except when, 1. the ship is proceeding en route, and 2. the oil content of the effluent without dilution doesn't exceed 15 ppm, 3. the ship has in operation oil filtering equipment with automatic stopping device 4. bilge water is not mixed with oil cargo residues or cargo pump room bilges (on oil tankers)

SHIPS BELOW 400 GRT OTHER THAN OIL TANKERS **Control of discharge of oil from machinery spaces**	
Within Special Areas	Any discharge is prohibited, except when all the following conditions are satisfied as far as practicable and reasonable: 1. the ship is proceeding en route, and 2. the oil content of the effluent without dilution doesn't exceed 15 ppm, 3. the ship has in operation suitable equipment as required by Regulation 16 of Annex I of MARPOL 73/78

The following table summarizes the requirements related with the installation and operation of appropriate shipboard equipment to process and dispose of oily mixtures produced in the machinery spaces of ships during their normal operation. It has proved that the reliable operation of the integral oily water separating and filtering equipment is critical for the proper discharge of oily water mixtures at sea and the minimization of those mixtures that are likely to be delivered on the existing port reception facilities.



PORT RECEPTION FACILITIES FOR COLLECTING SHIP GENERATED GARBAGE, BILGE WATER AND OILY WASTES

Summary of shipboard equipment for processing and disposing of oily water mixtures from machinery spaces

Size of ships	Applicable Annex I Regulations	Equipment installation and performance standards	Equipment requirements
Ships of more than 10.000 grt and ships between 400 and 10.000 grt carrying large quantities of oil fuel	Regulation 16 (1, 2, 5)	MEPC.60 (33) Resolution	• 15 ppm oil water filtering equipment • Bilge alarm and automatic stopping device • Oil content meter
Ships between 400 and 10.000 grt	Regulation 16 (1, 4)	MEPC.60 (33) Resolution	• 15 ppm oil water filtering equipment and oil content meter

2.1.2 Annex I – MARPOL 73/78 Regulations dealing with the provision of Reception Facilities in ports and terminals

The following tables summarize the relevant requirements for the provision of Reception Facilities both for dirty ballast, tank washings from oil tankers as well as for other oily residues and oil mixtures from all ships.

Regulations of Annex I of MARPOL 73/78	Summary of the requirements
Regulation 10 Methods for the prevention of oil pollution from ships while operating in Special Areas	*All oil loading terminals and repair ports within a Special Area should be provided with facilities adequate for the reception and treatment of all the dirty ballast and tank washings from oil tankers.* Such facilities shall have adequate capacity to meet the needs of the ships using them without causing undue delay.
	All ports within a Special Area shall be provided with adequate reception facilities for other residues and oily mixtures from ships. Such facilities shall have adequate capacity to meet the needs of the ships using them without causing undue delay.
Regulation 12 Reception Facilities	Reception facilities adequate to meet the needs of the ships using them without causing undue delay should be provided in: - *All ports and terminals in which crude oil is loaded into oil tankers where such tankers have immediately prior to arrival completed a ballast voyage of not more than 72 hours or not more than 1,200 nautical miles* Crude oil loading terminals shall have efficient reception facilities to receive oil and oily mixtures which cannot be discharged in accordance with the provisions of Regulation 9(1)(a) of Annex I from all oil tankers on voyages as described above. - *All ports and terminals in which oil other than crude oil in bulk is loaded at an average quantity of more than 1,000 metric tons per day* Such loading ports and terminals shall have efficient reception facilities to receive oil and oily mixtures which cannot be discharged in accordance with the provisions of Regulation 9(1)(a) of Annex I from oil tankers which load oil other than crude oil in bulk. - *All ports having ship repair yards or tank cleaning facilities* These ports shall have sufficient reception facilities to receive all residues and oily mixtures which remain on board for disposal from ships prior to entering such yards or facilities.

Regulations of Annex I of MARPOL 73/78	**Summary of the requirements**
Regulation 12 Reception Facilities	In addition reception facilities should be provided in: - *All ports and terminals which handle ships provided with the tank(s) required by Regulation 17 of Annex I.* All facilities provided to the abovementioned ports and terminals shall be sufficient to receive all residues retained according to Regulation 17 from all ships that may reasonably be expected to call at such ports and terminals. - *All ports in respect of bilge waters and other residues, which cannot be discharged in accordance with Regulation 9 of Annex I.* All facilities provided to these ports and terminals shall be sufficient to receive oily bilge waters and other residues which cannot be discharged in accordance with Regulation 9. - *All loading ports for bulk cargoes in respect of oil residues from combination carriers which cannot be discharged in accordance with Regulation 9.*

Ports involved in the project have in principle to provide reception facilities for either oily bilge water and oil residues as long as due to the effect of MARPOL Annex I Regulations which apply to designated Special Areas, the discharge of non – processed oily bilge water and oil residues is prohibited. Ports handling ocean tonnage should be able to accept larger quantities of oily bilge water while proportionately smaller facilities should be provided at ports serving coastal vessels.

Ships equipped with oily-water separating equipment are not expected to require substantial reception facilities if such effluents are allowed to be discharged also in port areas. There is also a need for facilities to receive dirty ballast water from bunker fuel tanks. Although MARPOL 73/78 prohibits "new" ships over certain tonnages from ballasting bunker fuel tanks, except under abnormal conditions, existing ships have to ballast their bunker tanks to maintain stability for safety reasons.

IMO recommends that some 50 to 60 per cent of ships may sometimes be faced to this requirement and facilities for these residues will be needed at the great majority of ports. However, it was not possible during the project through the input provided by the voluntary response of ships that happened to call to the ports involved, to identify cases where oil contaminated ballast water was requested to be delivered from ships other than oil tankers.

2.1.3 Oily mixtures and residues produced in the machinery spaces of ships and management practices implemented onboard

From the normal operation of ships, different oil liquid and semi-liquid wastes are produced in their machinery spaces which can be broadly distinguished to:

- Oil residues from the purification of fuel and lubricating oil
- Oily leakage from machinery spaces
- Exhausted or contaminated oils
- Oily bilge water

Certainly, there are also other almost solid residues such as oily rags, solid deposits from the oil water separating and filtering equipment, residues from scavenging parts, dirty grease including this one originated from other shipboard spaces, etc. which can be dealt with in the framework of Annex V of MARPOL 73/78 (as special garbage items).

Oil residues that originate during storage and treatment of fuel oil and lubricating oil are produced basically:

- in fuel oil storage tanks
- during purification of fuel oil in settling tanks, separators, filters and the daily supply tanks
- in the lubricating oil separating systems

The volume of sludge produced in the engine room of ships, varies depending on the quality of fuel oil and the compatibility of different grades used on board. The use of low grade fuels is invariably resulting to increasing volumes of residues during the purification process. Fuel oil refers to residual fuel oil that remains usually from the atmospheric distillation process. The majority of marine diesel engines uses Intermediate Fuel Oils for propulsion purposes, produced by blending of the residual fuel oils with marine distillate fuels to obtain the required viscosity (the most commonly used fuel oils from ships are the IFO 180 and IFO 380 with viscosities of 180 and 380 centistokes at 50^0C). The ISO 8217 standard distinguishes 13 grades of residual marine fuel oils which practically all of them (apart the first two RM A 10 and RM B 10) require onboard purification in ordinary purifiers/clarifiers or other specially designed separators.

Almost all ships use Marine Diesel Oil, a light distillate without residual fuel oil as fuel in generators and auxiliary equipment in port areas, while specialized types of ships such as high speed ferries can use marine distillates such as Marine Gas Oil. Several efforts are currently made to reduce either the volume of sludge such as new generations of heavy fuel oil purifiers which

have been developed to reduce the volume of sludge and to cope with the increasing density of fuel oils, or in the shipbuilding and designing phase to reduce fuel consumption (such as the optimization of hull form through the incorporation of computational fluid dynamics calculations in hull designing or the use of aluminum which is about half the weight of steel for equal strength in high-speed craft, superstructures in ferries and cruise ships, etc.).

A diesel propelled ship using residual fuel oil may accumulate sludge from the onboard fuel oil processing at a rate normally not exceeding 1 per cent of the fuel consumption. In broad terms, a 10,000 BHP ship at sea under power may accumulate oil sludge at a rate of about 0,25 metric tons per day. Ships are required to be provided with sludge holding tanks of sufficient capacity in conformance with Regulation 17 of Annex I of MARPOL 73/78. These tanks are identified in the Supplement to the International Oil Pollution Certificate. Piping to and from sludge tanks do not have direct connection overboard, other than the standard discharge connection to enable delivery to port reception facilities.

Ocean-going diesel propelled ships with sludge holding tanks of between 5 and 10 metric tons should provide for 15 to 25 days of steaming without having to empty the sludge tanks. Research on the sludge production onboard ships has demonstrated that sludge generation represent 1. 0 – 2.0 % of the daily fuel oil consumption and also represent 0.5 % of the daily Marine Distillate Oil consumption, as presented in the following table:

Quantity of oil residues (sludge) generated during normal operation of ships	
Residues at HFO operated engines	1.0 – 2.0 % of the daily consumption
Residues at MDO operated engines, generators and auxiliary systems	0.5 % of the daily consumption

As it will be explained later in this Report, for simplicity reasons, a sludge production factor equal to 2% of the daily fuel consumption was used in estimating oil residues from both fuel oil and marine diesel oil use.

Tanks for separated sludge are commonly equipped with tank heating systems. The heating system is designed to enable heating of the oil sludge up to 60^{o}C. The suction line from the sludge tank to the pump should be provided with heating tracing. It is also a common practice that the sludge tank is preferred to be located below the heavy fuel oil purifier. In addition to the provision of sludge tanks, another means for the disposal of oil residues could be the approved oil sludge incinerators. Such a system consists of an oil burner, an oil sludge processing system including a tank for

mixing oil residues with fuel oil, an oil sludge preheating system, a filter and a homogenization system as well as tank/s for separated sludge.

The other component of sludge is represented by:

- drainage and leakage oil, which means oil resulting from drainages and leakages in machinery spaces; and

- exhausted oils, which means exhausted lubricating oil, hydraulic or other hydrocarbon-based liquid which are not suitable for use of machinery due to deterioration and contamination.

Exhausted oils are identical to used lubricating oils or waste oils which have gone through their intended use cycle and must be disposed of or treated for re-use. Lubricating oils are complex mixtures of hydrocarbons containing linear and branched paraffins, cyclic alkanes and aromatic hydrocarbons. Used lubricating oils are present in the general oily wastes stream without however, constituting its main component. The collection of separated, exhausted oils in ports where depots or facilities engaged in re-refining processes of waste oils, operate in the proximity of the port area, could contribute to their re-use.

Separate tanks of appropriate size are recommended to be installed onboard ships. If an exhausted oil tank is installed, in addition to the requirements of Regulation 17 of MARPOL 73/78, Annex I, it should be of sufficient capacity to receive lubricating oil or other oils and hydrocarbon-based liquids from engine-room systems being exhausted due to deterioration, contamination or due to maintenance activities. The oil being discharged from the 15ppm equipment may also be discharged to this tank. For main and auxiliary engines, which require a compete change of the lubrication oil at sea, the capacity of the tank should be determined as 1,5m^3 for each 1,000 kW engine rating.

Oily bilge water is a mixture of fuel oil, sea water, fresh water, cooling water, leakage oil and lubricating oil. In practice, bilge water may contain cleaning agents such as boiler additives or additives for cooling water to prevent corrosion, detergents, drainage from handbasins situated in the engine room.

The quantity of oily bilge water that can be accumulated in the bilge wells or the dedicated holding tanks of a ship depends on:

- The type, age and maintenance condition of main and auxiliary engines

- The cleaning and repair intervals

- The technical operations performed in the machinery spaces

- The motivation, awareness and qualification of ships personnel

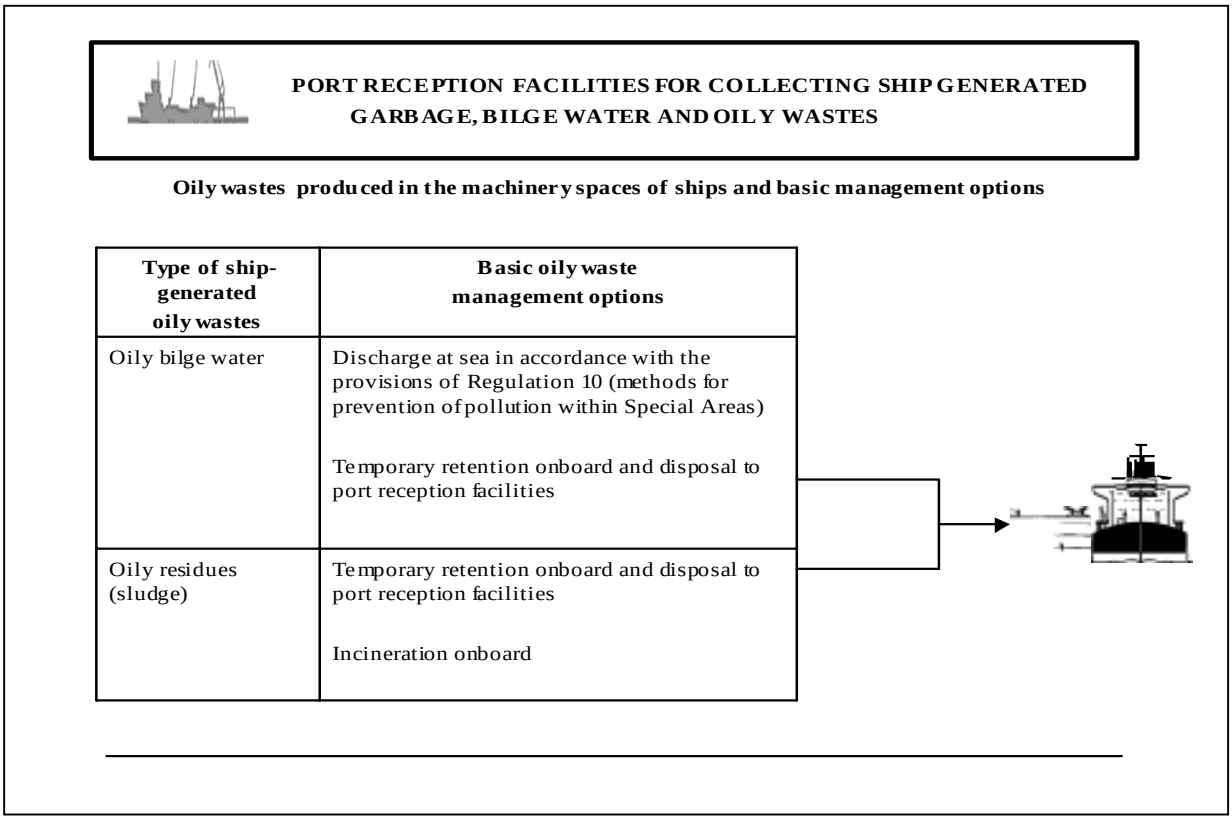
Research on this field has shown that the quantity of oily bilge water in the range of 1 – 10 cubic meters on medium and large vessels per day and 0.1 – 3 cubic meters on ships engaged in near coastal voyages. A bilge-water

holding tank is arranged to receive the daily generation of bilge-water before this water is discharged through the 15 ppm overboard.

A bilge-water holding tank enable ships to operate safely during ports visits, during operation in special areas and coastal waters and during periods of maintenance of the oily water filtering equipment. It has also proved that a bilge-water holding tank also provides additional safeguards in the purification of oily bilge-water when quick-separating detergents are used for cleaning purposes. Bilge-water holding tanks, if fitted, usually have a capacity that provides the ship with the flexibility of operation in ports, coastal waters and special areas, without the need to discharge oil bilge water overboard. Since the average main engines power rating of ships calling normally at the ports of the project was not intended to be reflected in the questionnaires used, a correlation between the gross tonnage of diesel engine ships and the potentially estimated volume of oily bilge water that could be accumulated on a daily basis for water and oil cooling/lubricating shafts was used *(Hellenic Ministry of Merchant Marine, Marine Environment Protection Directorate, 1990).*

Gross Tonnage (grt)	**Estimated daily volume of oily bilge water (lts/day)**		
	Water based cooling/lubricating engine shaft	Oil based lubricating engine shaft	Volume used in the calculations for tonnage scales
< 400	100	50	75
400 – 3.000	100 – 500	50 – 250	375
3.000 – 5.000	500 – 1.500	250 – 750	1.125
5.000 – 7.000	1.500 – 2.500	750 – 1.250	1.875
7.000 – 10.000	2.500 – 4.000	1.250 – 2.000	3.000
> 10.000	>4.000	> 2.000	5.000

In the following diagram, the basic management options for both oily bilge water and oil residues are schematically presented:



2.1.4 Calculation basis for oily wastes streams volumes

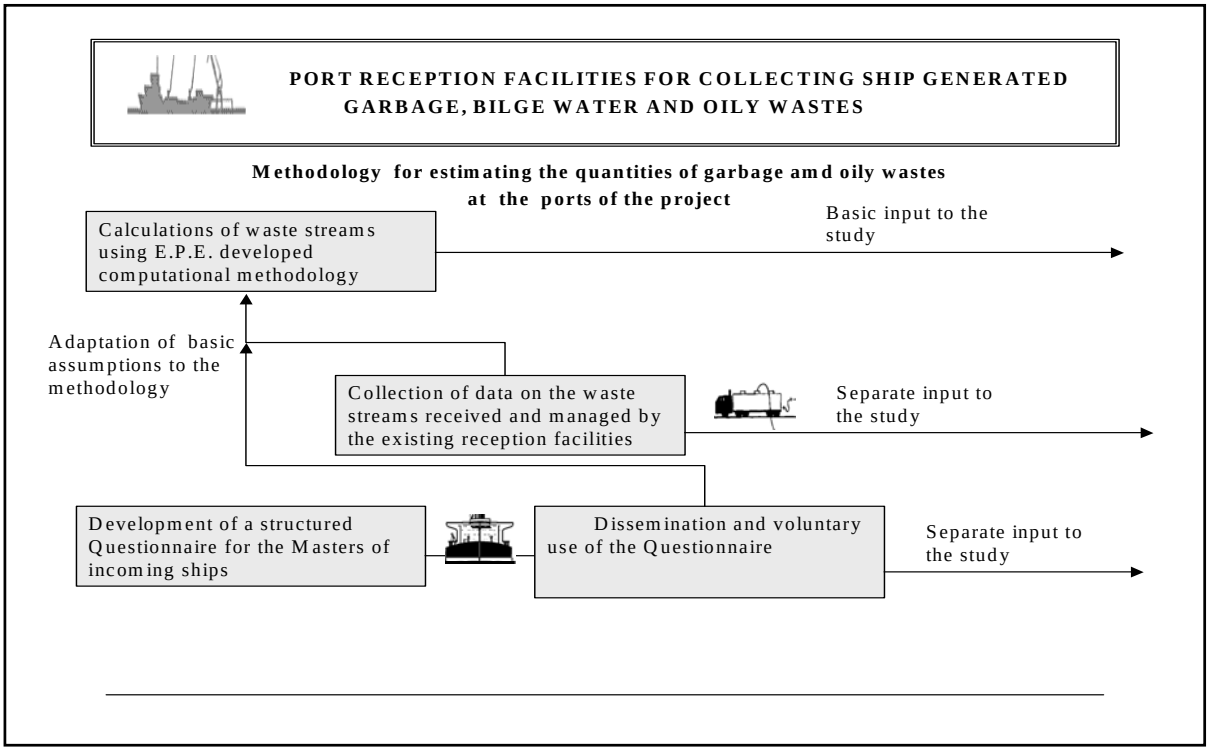
In estimating the quantities that are likely to be collected at ports, the following basic assumptions and criteria were used:

- The ships calling at the ports of the project take all necessary steps to ensure that residues on arrival are reduced as far as possible, in compliance with the relevant provisions of Annex I of MARPOL 73/78 related with the retention of oil onboard and discharge requirements,

- The waste production factors for oily bilge water and oil residues used in the calculations are those provided before, adapted appropriately according to the feedback offered by the voluntary response of the Masters of ships that happened to call at the ports during the project. Apart any necessary adaptations, data received either from the waste handling contractors, port authorities, terminal operators and the Masters of ships are provided as a separate input, as shown in the following diagram.

- The average duration of ships' transit and stay at a port area which is an important variable in estimating the volume of oily wastes to be collected, was extracted from the completed questionnaires.

The methodology used is schematically shown below:



The formulas as well as the basic assumptions used in estimating the production of oil residues and oily bilge water are as follows:

$$Q_t = Q_{sl} + Q_m \quad (m^3/day)$$

$$Q_{sl} = \frac{N_1 * P_{sl} * T}{365}$$

$$Q_m = \frac{N_2 * P_m * T}{365}$$

where:

Q_t = Volume of oily wastes from the machinery spaces of ships to be received (m^3/day)

Q_{sl} = Volume of oil residues (sludge) to be received (m^3/day)

Q_m = Volume of oily bilge water to be received (m^3/day)

N_1 = Number of ships calling at the port annually

N_2 = Number of ships without oily bilge water separating and filtering equipment (with only bilge holding tanks) calling at the port on an annual basis

P_{sl} = Oil residues daily production (0.02 x fuel oil daily consumption per day *(gr/HP * hr)* of voyage (m^3/day)

P_m = Oily bilge water production per sailing day from N_2 ships calling at the port (m^3/day)

T = Average duration of voyage before calling at the port and stay at the port area (days)

For the needs of the project, the daily oil residues production was estimated as a function of the residual fuel consumption using 0.02 as coefficient factor. There is no doubt that marine diesel engines are the predominant type of power unit in the maritime industry for propulsion and auxiliary power generation. In 1991, diesel engine ships accounted for about 98% of the world merchant fleet while the remaining 2% used steam plants (Lloyd's Register 1993). As fuel consumption is related with the engine horse power (considering for simplicity reasons that the consumption remains the same for both cruising underway and maneuvering), the engine horsepower of ships calling at the ports of the project was correlated to their deadweight tonnage by using the equation *HP = Dwt * Dwt Coef + b* (where *Dwt Coef* corresponds to a coefficient factor for different types of ships and b an intercept, both calculated from regressions made by E.P.A. (2000).

In accordance with the requested information by the Port Authorities and Terminal Operators on the ports traffic, the major types of ships were given an estimated horsepower from which the daily production of oil residues was calculated.

Type of ship	***Dwt coefficient***	***b***
Bulk carrier	0.0985	6726
Tanker	0.183	6579
General cargo ship	0.288	3046
Container ship	0.800	-749.4
Passenger ship	6.810	- 4877

The abovementioned approach was considered to be more realistic since a number or dedicated terminals normally accommodate uniform ships' sizes with high main engine outputs and consequently potentially higher fuel oil

consumption rates. This is particularly true for the large container ships (more than 2.500 TEU) with engines output to be up to 60.000 BHP or similarly for large displacement cargo ships.

2.2 Garbage

2.2.1 Criteria for discharging garbage from ships into the Mediterranean Sea

Regulation 5 of Annex V of MARPOL 73/78 provides requirements for the disposal of garbage within Special Areas.

In accordance with the provisions of this Regulation, disposal into the sea of the following items is prohibited:

- all plastics, including but not limited to synthetics ropes, synthetic fishing nets, plastic garbage bags and incinerator ashes from plastic products which may contain toxic or heavy metal residues; and

- all other garbage, including paper products, rags, glass, metal, bottles, crockery, dunnage, lining and packing materials;

Disposal into the sea of food wastes shall be made as far as practicable from land, but in any case not less than 12 nautical miles from the nearest land which is the baseline from which the territorial sea under the jurisdiction of each coastal state is measured. The garbage disposal requirements from ships within and outside Special Areas are presented in the following table:

Type of garbage	Garbage Disposal from Ships	
	Outside Special Areas	**Within Special Areas**
Plastics, including synthetic ropes, fishing nets and plastic garbage bags.	Disposal Prohibited	Disposal Prohibited
Floating dunnage, lining and packing materials.	> 25 miles offshore	Disposal Prohibited
Paper, rags, glass, metal, bottles, crockery and similar refuse.	> 12 miles	Disposal Prohibited
All other garbage including paper, rags, glass, etc. comminuted or ground.	> 3 miles	Disposal Prohibited
Food waste not comminuted or ground.	>12 miles	>12 miles
* Food waste comminuted or ground.	> 3 miles	> 12 miles
Mixed refuse types.	**	**

* Comminuted or ground garbage must be able to pass through a screen with mesh size no larger than 25mm.

****** When garbage is mixed with other harmful substances having different disposal or discharge requirements, the more stringent disposal requirements shall apply.

The abovementioned requirements do not apply to:

(a) the disposal of garbage from a ship necessary for the purpose of securing the safety of a ship and those on board or saving life at sea; or

(b) the escape of garbage resulting from damage to a ship or its equipment provided all reasonable precautions have been taken before and after the occurrence of the damage, for the purpose of preventing or minimizing the escape; or

(c) the accidental loss of synthetic fishing nets, provided that all reasonable precautions have been taken to prevent such loss.

2.2.2 Annex V – MARPOL 73/78 Regulations dealing with the provision of Reception Facilities in ports

Regulations 5 and 7 provide requirements with respect to the establishment and operation of port facilities for receiving garbage from ships.

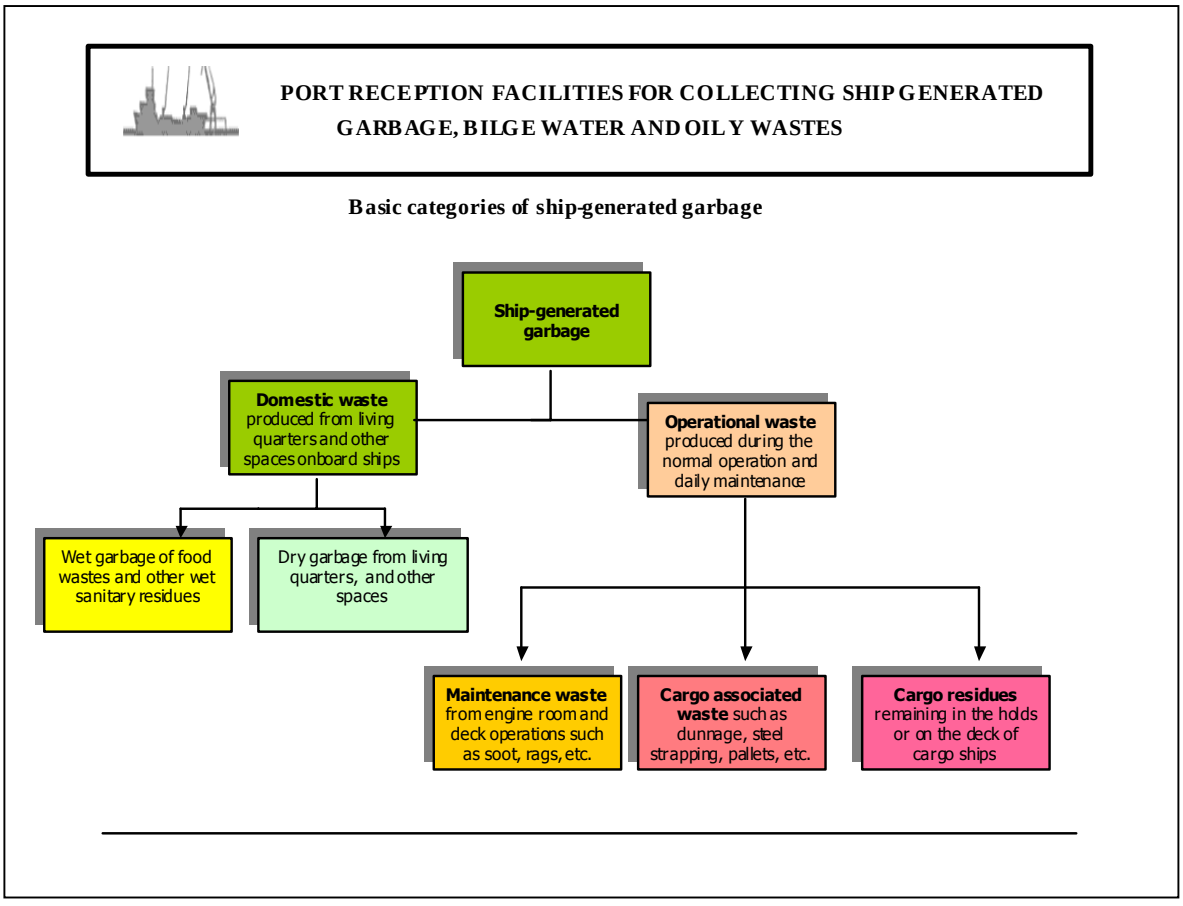
Regulations of Annex V of MARPOL 73/78	Summary of the requirements
Regulation 5 ***Disposal for garbage within Special Areas***	The Government of each Party to the Convention, the coastline of which borders a special area, undertakes to ensure that as soon as possible in all ports within a special area adequate reception facilities are provided in accordance with the Regulation 7, taking into account the special needs of ships operating in these areas.
Regulation 7 ***Reception Facilities***	The Government of each Party to the Convention undertakes to ensure the provision of facilities at ports and terminals for the reception of garbage, without causing undue delay to ships, and according to the needs of the ships using them.

2.2.3 Ship – generated garbage and current management practices implemented onboard

Ship-generated garbage can be divided into the following categories:

Domestic wastes including wet and dry garbage, represent all types of food waste and wastes generated in the living quarters of a ship such as paper products, textiles, glass, rags, bottles, plastics, etc. Domestic wastes consists of food wastes generated in the galley and dining rooms and of all materials contaminated by such waste and disposed of as solid materials and also of refuse produced in living spaces of crew and passengers including paper products, textiles, glass, rags, bottles, plastic items, etc. Garbage of this type can also originate from medical spaces including expired medicines, lining and packing material, sweepings, etc.

Operational wastes that consists of *cargo-associated wastes* originated from cargo stowage and handling works in general and *maintenance wastes* collected by the engine department and the deck department while maintaining and operating the vessel. In this category, also small quantities of solid cargo residues are included. Usually about 1.5 – 2.5 kgs of domestic waste is generated on a daily basis per person on a commercial, cargo ship and about twice as much on a passenger ship. On average, 75% per weight and 10% per volume of domestic waste is food waste and the remaining 25% per weight and 90% per volume is refuse as delineated before.



In respect of the cargo-associated waste, there is no doubt that both the increase of the containerization of maritime transport and also the need for more efficient and clean loading unloading operations have reduced the quantities of this type of waste. Waste due to break bulk cargo operations remains the largest source of shipboard solid waste in both volume and weight.

Such waste consists of dunnage, pallets, paper and cardboard material, wire and steel strapping, etc.

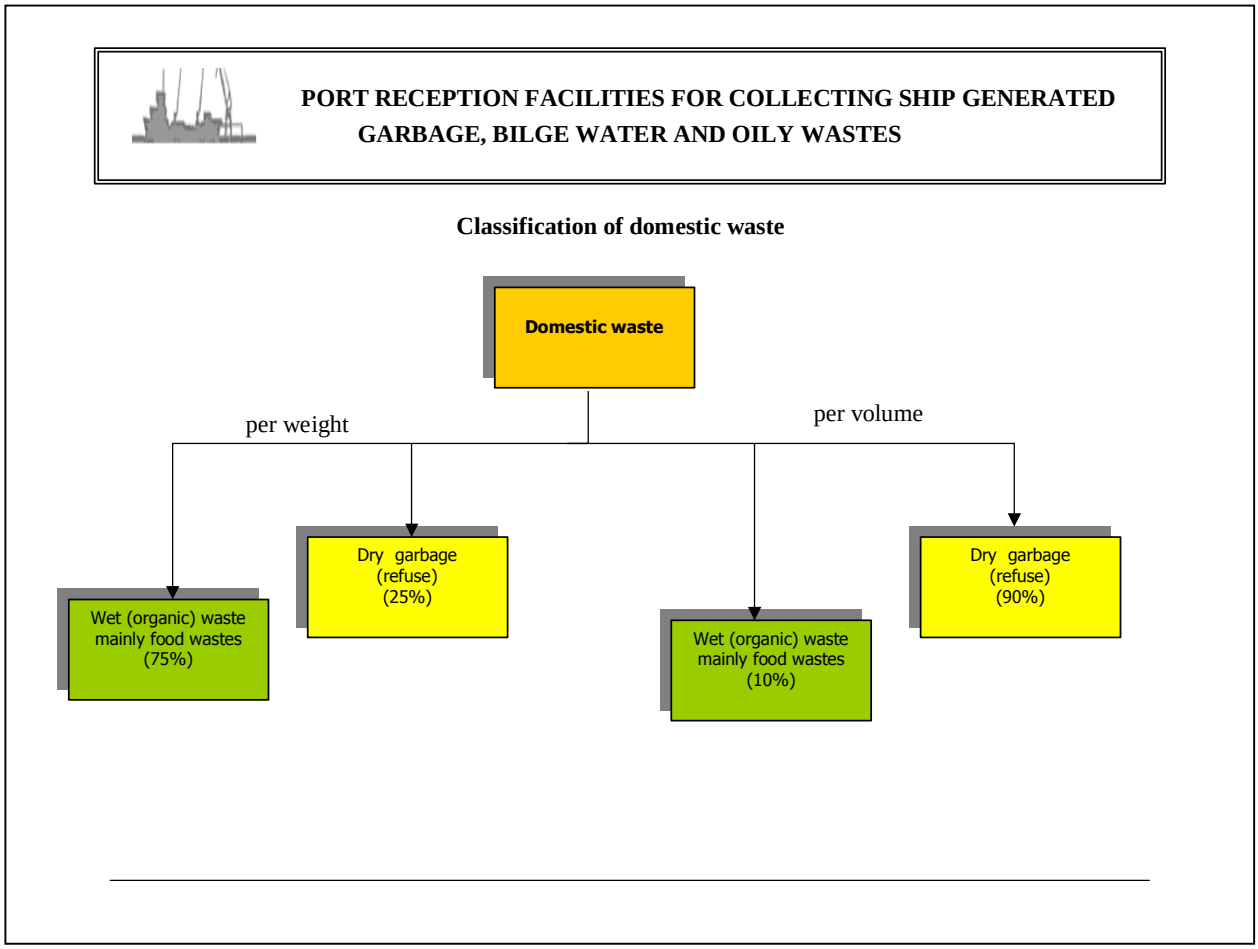
A variety of works carried out onboard ships normally, such as cleaning of boilers, tanks, decks and platforms result in the production of maintenance wastes, the quantity of which that can be accumulated on a large sea-going ship could exceed 20 kgs daily.

Other than routine maintenance, carried out in port including major and overhaul work would be additional to the abovementioned figure.

The table below provides some average figures of wastes generated by the engine and deck department while operating and maintaining a vessel, provided by the IMO respective Guidelines mentioned in the beginning of this Report.

Maintenance waste per day on a medium sized ship	
Kind/origin of waste	**Quantity (kgs/day)**
Soot and machinery deposits	4
Paint scraping waste	3
Wiping wastes and rags	3
Sweepings	1

The composition of domestic waste is schematically presented in the following diagram.



The following table provides an arbitrary estimate of cargo associated waste per kind of cargo handled in a port.

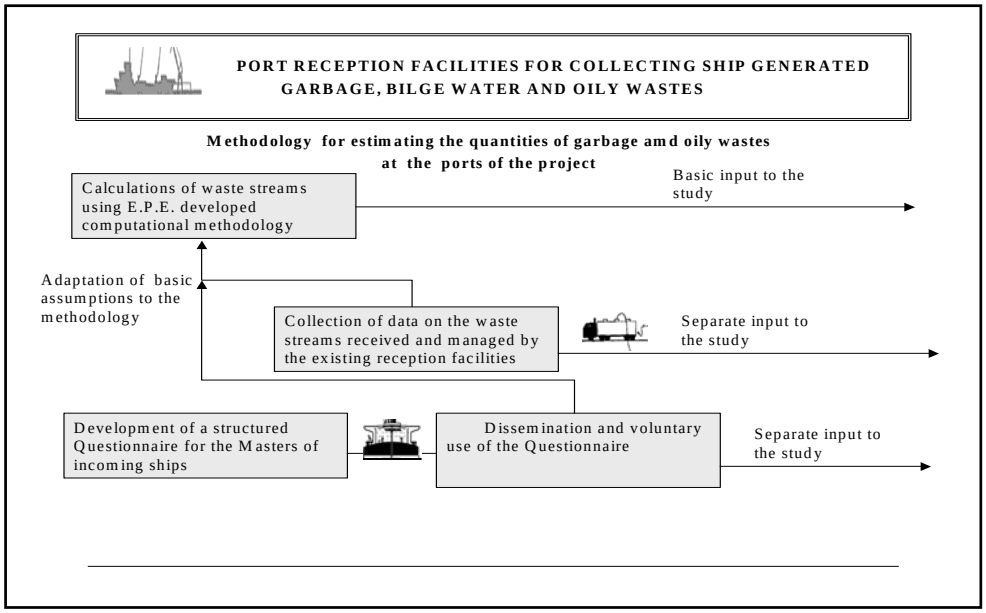
Quantities of cargo- associated waste	
Kind of cargoes	**Cargo generation factor(tons of waste per quantity of cargo)**
Break bulk cargoes	1 : 123
Dry bulk cargoes	1 : 10.000
Containerized cargoes	1: 25.000

2.2.4 Calculation basis for garbage streams volumes

The calculation of the volumes of garbage that are likely to be collected at a port reception facility was based on the following assumptions and criteria:

- Ships calling at the ports of the project take steps to ensure that garbage is collected in a manner consistent with the requirements of Annex V of MARPOL 73/78 and predominantly that illegal discharges do not occur at sea while engaged in voyages within the Mediterranean sea or other navigable areas.

- Garbage production factors used in the formulas which are presented below are those described before, adapted appropriately according to the feedback offered by the voluntary response of Masters of ships that happened to call the ports of the project. Apart any necessary adaptation, data received either from the waste handling contractors, port authorities, terminal operators and the Masters of the ships are provided as a separate input, as shown in the following diagram.



- The average duration of ships' transit and stay at the port area was extracted from the completed questionnaires.

The volumes of domestic, maintenance and cargo – associated waste are calculated from the following formula:

$$G = G_D + G_M + G_C \quad \text{(kg/week)}$$

or

$$G = G_D + G_M + G_C / \rho \quad \text{(m}^3\text{/week)}$$

(where ρ=250 kg/ m^3 the average density of shipboard garbage)

where:

G = the quantity of garbage received in peak seven day period (kg/week)

G_D = the quantity of domestic solid waste received in a peak seven day period (kg/week)

G_M = the quantity of maintenance solid wastes received in a peak seven day period (kg/week)

G_C = the quantity of cargo associated waste received in a peak seven day period (kg/week)

Quantity of domestic waste

$$G_D = G_B + G_P + G_H$$

$$G_B = N_B * T_B * Q_B * P_B$$

where

G_B = quantity of domestic garbage received in peak seven day period from sea-going cargo ships (kg/week)

N_B = number of cargo ships calling at the port in the same period

T_B = average duration of voyage and stay at the port of sea going cargo ships (days)

Q_B = average daily domestic garbage generation rate on sea-going cargo ships (2.0 kg/person and day)

P_B = average number of persons onboard a typical sea-going cargo ship (persons/vessel)

$$G_P = N_P * T_P * Q_P * P_P$$

where

N_P = number of passenger ships calling at the port in the same period

G_P = quantity of domestic garbage received in peak seven day period from passenger ships (kg/week)

T_P = average duration of voyage and stay at the port this kind of ships (days)

Q_P = average daily domestic garbage generation rate on passenger ships (3.0 kg / person and day)

P_P = average number of persons onboard a typical passenger ship (persons/vessel)

$G_H = N_H * T_H * Q_H * P_H$

where

N_H = number of harbour craft engaged in the port operation

G_H = quantity of domestic garbage received in peak seven day period from harbour craft (kg/week)

T_H = average duration of voyage and stay at the port of harbour craft (7 days)

Q_H = average daily domestic garbage generation rate on harbour chart (1.0 kg/person and day)

P_H = average number of persons onboard a typical harbour craft (persons/vessel)

Quantity of maintenance waste

$G_M = N * T * M$

N = number of vessels in port during a peak seven-day period (vessels/week);

T = average duration of ships' transit and stay at the port area (days);

M = average quantity of maintenance solid wastes generated daily from a typical vessel (11 kg/vessel-day)

Quantity of cargo – associated waste

$$\mathbf{G_C = C_B + C_D + C_C}$$

where:

$\mathbf{C_B}$ = W_B * 1/123 = quantity of break bulk cargo solid wastes received in a peak seven-day period (kg/week);

$\mathbf{W_B}$ = quantity of break bulk cargo received in a peak seven-day period (kg/week);

1 / 123 = break bulk cargo waste generation factor;

$\mathbf{C_D}$ = W_D * 1/10,000 = quantity of dry bulk cargo solid wastes received in a peak seven-day period (kg/week);

$\mathbf{W_D}$ = quantity of dry bulk cargo received in a peak seven-day period (kg/week);

1/10,000 = dry bulk cargo waste generation factor;

$\mathbf{C_C}$ = W_C 1/25,000 = quantity of container cargo solid wastes received in a peak seven-day period (kg/week);

$\mathbf{W_C}$ = quantity of container cargo received in a peak seven-day period (kg/week);

1/25,000 = container cargo waste generation factor.

2.2.5 Projection of wastes production and collection

The quantity of wastes generated during the normal operation of ships is influenced by a variety of circumstances and factors which are either related directly to the cargoes' carriage process (representing the material input from which wastes are produced or to the daily operation of ships in combination with any waste prevention efforts dictated by their management including planned maintenance, use of new environmentally sound marine technologies, etc.

It's really difficult to develop and apply a projection scheme for ship-generated wastes production as it has been conceived and used in the case of land-based waste streams such as municipal waste or specific industrial wastes for which close links between the economic or production activity and wastes generation has been demonstrated.

It is a fact that reliable and comprehensive information on waste produced by ships is even today not sufficient making the analysis and forecast of future developments on waste generation more difficult.

The use of waste generation factors for both oily wastes and garbage from ships in estimating the potential volume produced from the last port of call or from the last port where wastes were delivered in conjunction with the actual number of ships calling at a port led to the argument to correlate the future volumes of waste streams with the anticipated growth or decline of traffic at each port (as estimated from the last three years period data).

The projection of volumes of wastes that could be collected at each port was based on the following assumption which excludes the effect of a number of factors (waste prevention measures, port state control procedures, charging systems, etc) :

$W_t = f(W_{bs}, T_i)$ = average annual change of traffic (%) X W_{bs}

where
(*f*) underlines the simple linear function of waste production onboard ships with the port traffic development, so that a 5 % increase of the number of ships calling at a port annually increases proportionally 5% the wastes produced that could be delivered to the port reception facilities, and

(W_t) is the estimated volume of the two major waste streams, oily wastes and garbage in the near future *t*

(W_{bs}) is the baseline estimate of both oily wastes and garbage streams which is also considered as identical for 2003 due to the uncertainty of the port traffic progress in relation with the last three years period.

It should be noted that the abovementioned approach is subject to considerable margins of error due to the quality of data used and the exclusion of factors outlined before.

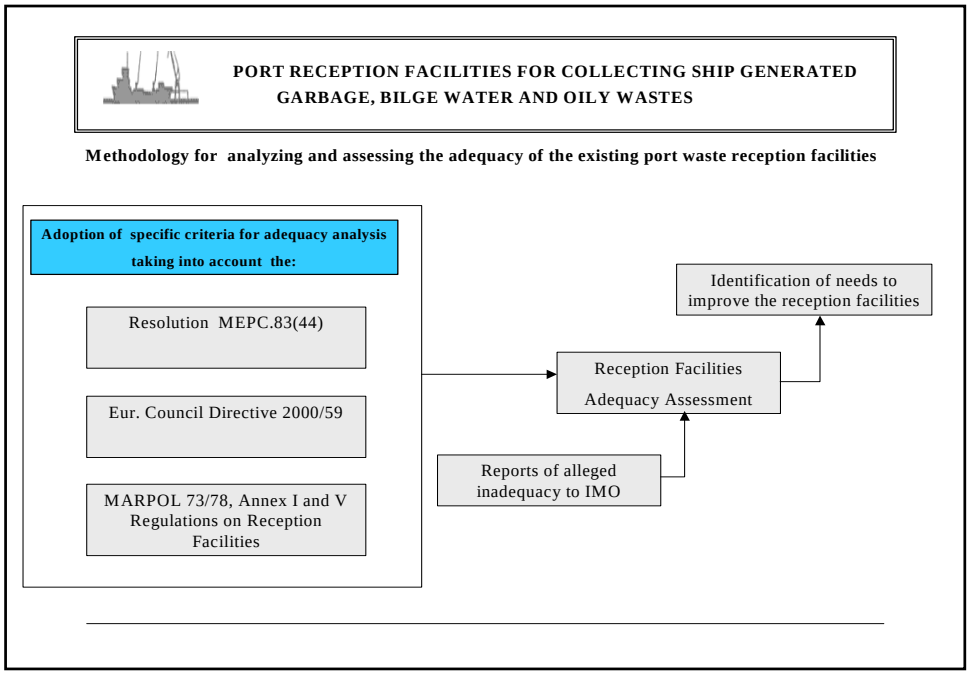
3. METHODOLOGY

3.1 Maritime traffic data and analysis

The collection and analysis of information regarding the maritime traffic and the carriage of cargo or passengers at each port, was essential for the preparation of the variables used in the formulas to estimate the potential for delivery volumes of ship-generated waste. The methodology used for the collection and analysis of these data consisted of the collection of data through the No.2 and 3 questionnaires (developed for oil terminals and ports respectively) as well as from other sources.

3.2 Methodology for analyzing and assessing the adequacy of existing reception facilities

Criteria for assessing the adequacy of the capacity and the whole operation of the existing port waste reception facilities were adopted for audit purposes, taking into account the IMO relevant Guidelines provided with the Resolution MEPC.83(44), the requirements of the European Council Directive 2000/59/EC, and the provisions of those MARPOL 73/78 Regulations of Annex I and V that deal with the establishment and operation of port reception facilities within Special Areas. As explained later, the Sample Assessment Procedure annexed in the abovementioned Resolution was adapted for use during the port surveys and data collection phases, taking also into account the preceding preparatory work. Recent documentation on the reports of alleged inadequacy provided to IMO by Flag States was requested by the Organization in reviewing and capturing information regarding the ports of the project to enable the further assessment of the adequacy of the existing reception facilities. The methodology used is presented schematically below:



Resolution MEPC.83(44), provides Guidelines for ensuring the Adequacy of Port Waste Reception Facilities, with the aim:

- to assist Member States in planning and providing adequate port waste reception facilities and,

- to encourage them to develop environmentally appropriate methods of disposing ship – generated waste ashore.

These Guidelines which complement the IMO Comprehensive Manual on Port Reception Facilities, provide information relating to the on-going management of existing facilities but also for the planning and establishment of new facilities. The Guidelines have incorporated an Assessment Form as an Appendix (Sample Assessment Procedure for Ports - Management/Strategy for waste reception facilities at ports, marinas, and boats harbours), the use of which is encouraged by the responsible State Authorities, independent bodies or assessors. The procedure provides an example of a detailed audit that might be conducted by a consultant, offering a systematic check list of questions designed to obtain information with respect to existing port waste reception facilities, the level of waste collection service provided to port users, the level of environmentally sound waste handling, valorization and final disposal practices and methods, etc.

It was deemed as advisable to use in a properly adapted way for the scope of the project, the abovementioned assessment procedure, as an integral element of both the collection of data process as well as of the site surveys at the areas of the ports and oil terminals of the project.

Since, the operation of fixed ship-generated waste reception facilities or more flexible collection and management schemes in the port area is not isolated from the rest of the port infrastructure and the services provided by the ports authorities and operators, many of the Sample Assessment items were incorporated among other things within the two port - specific questionnaires No. 2 (Questionnaire for Oil Terminals involved in the Project) and No. 3 (Questionnaire for Ports involved in the Project) which represent the basic means for collecting input for most of the needs of the project.

- **Criteria for assessing the adequacy of the existing reception facilities**

Two major sets of criteria were identified as more suitable and at the same time critical to assess the adequacy of the existing reception facilities, one dealing with the ship-port interface and a second dealing with the protection of the environment from the secondary wastes or potential pollution produced by the waste collection, treatment and disposal processes.

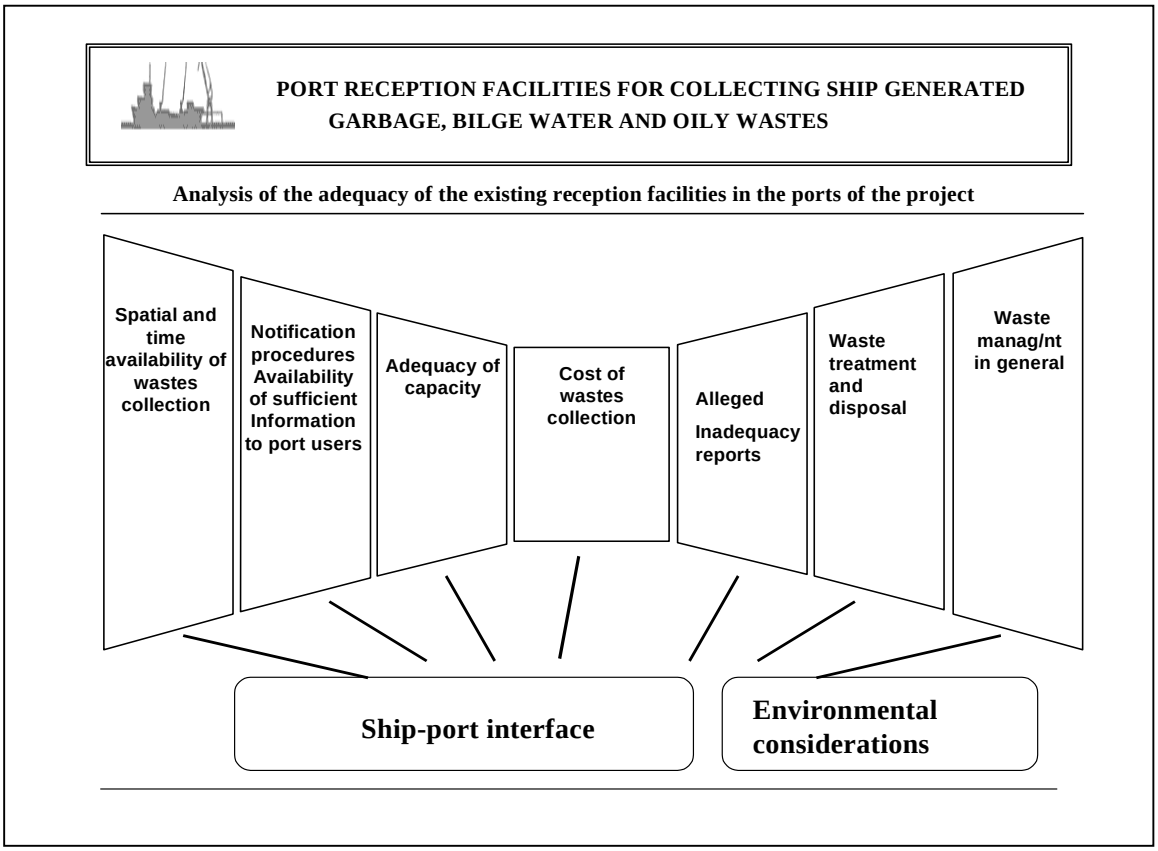
The first set provides a series of criteria emphasizing on the operational needs of ships normally calling at the ports and terminal of the project. There is no doubt that a port to become successful and adequate in providing reception facilities for ship-generated waste, should have regard to the

operational needs of its users supplying all the appropriate means to collect and further manage the different types and volumes of wastes from ships normally engaged in operation at its terminals or wider area such as designated anchorages, etc. In parallel, the operation and the management of the existing facilities should not provide any disincentives for incoming ships to use them.

The second set of criteria concentrates on environmental and technical considerations regarding the way that waste collected is managed and finally disposed of, including procedures enabling the wastes traceability, procedures for complying with national or other standards related with the discharge of effluent water, etc.

The second series of criteria used to enable the assessment of the adequacy of the existing reception facilities, supplements the first one related with the provision of sufficient services to shipping, by attempting to identify whether or not the waste management after the collection in the port or the terminal area is environmentally sound. Whenever, during the missions in the beneficiary countries or during the information collection process, details of the local or wider waste management strategy and relevant requirements were known, it was almost always feasible to result in safe conclusions on that.

The criteria used to assess the adequacy of the existing reception facilities are schematically presented in the following diagram:



- **Spatial and time availability of wastes collection**

This criterion can apply to both dock side port areas as well as to jetties, SPMs or other type of berthing or mooring systems provided in a port or an oil terminal, simply determining the availability of reception facilities in terms of the nominal berthing sites and the immediacy of wastes collection upon the request of a ship to deliver its wastes or residues.

A dirty or clean ballast reception line provided, ideally, at each one of the buoys of a terminal where deballasting can normally take place in parallel to the loading of crude oil or oil products represents an example of adequate availability of reception facilities.

In commercial and multipurpose ports this availability can be achieved when almost every nominal berthing place can operate as a site where reception of oily wastes or garbage can take place by either navigable or land-based mobile means.

It's important for ships that wish to deliver wastes to an existing reception facility, that the collection process does not entail any undue delays forcing the ships to change berthing site or in general to spend time beyond the time of their port operation since it is unlikely that a ship would enter a port solely to deliver wastes.

- **Notification procedures – Availability of sufficient information**

Those that provide collection of ship-generated wastes in the ports areas, require, in principle, advance notification of the intention to use the existing facilities, in particular, when a number of qualified and licensed, privately operating, waste contractors provide some or all of the port's waste collection services. Providing advance notification of the type and quantity of wastes onboard for delivery to a reception facility should minimize the risk of undue delay to ships.

The importance of prior notification has been already acknowledged in the relevant legislation of the European Communities, resulting in the development and use of a uniform system by the Masters of ships bound for a port located in the Eur. Community.

Prior notification in the form of a standard message (incorporated as Annex II of the 2000/59/EC Directive) should be provided to the port authority or other entity designated to receive this information. It was witnessed during the missions in the ports of the project, that several port authorities have adopted some kind of notification both to provide and receive information from ships with respect to the potential receipt of wastes from them. In any case, it is considered as essential for the Masters of ships that call to a port, to receive information well in advance on the availability or reception facilities, any perhaps operational or waste transfer requirements, fees incurred, etc.

- **Adequacy of collection capacity**

The initial reception capacity which represents the volume of liquid or solid waste that can be received from a ship without causing undue delay, is of predominant importance for ships wishing to deliver their wastes at a port. While the type and characteristics of ship-generated waste determine in principle which treatment method should be applied, the type and volume of wastes expected to receive at a port determine the capacity of the reception facility. Since, the inflow of ship-generated waste is not constant, the abovementioned capacity, in particular for fixed reception facilities reflects the volume of holding tanks or buffering and equalization tanks in which massive oily wastes such as dirty ballast or tank washings are collected before treatment. The holding capacity of these tanks is determined by the average or peak inflows and also the capacity of the subsequent treatment process.

In respect of ship-generated garbage, the collection capacity invariably should match the volumes requested to be delivered and also the segregated kinds of solid wastes as a result of the daily garbage management practices onboard ships or of the port requirements for hygiene or sorting and recycling purposes. In the same criterion, it is also taken into consideration the interface between the ship and the reception facility to permit a timely delivery of wastes.

- **Cost of waste collection service**

One of the demanding financial aspects of the establishment and operation of reception facilities for collecting ship-generated waste, is the ships' charging system and in general the operational cost. Two principles dominate the basis on which a charging system is built and operates, the selection and use of which requires due consideration of several, mainly local factors.

The first one is the "polluter pays" principle which implies that those produce the wastes should pay for their reception, treatment and disposal and the second one is the "shared costs" that implies that all costs are covered by governmental financing and other contributions which clearly does not represent a cost recovery scheme. In line with "the polluter pays" principle, the new European Community legislation on port reception facilities, requires the establishment of a fair, transparent and reasonable cost recovery system through which fees collected from ships would be able to cover the cost of the port reception facilities including the treatment and disposal of wastes.

To ensure that the cost recovery systems do not provide any incentives for ships to discharge illegally their waste at sea polluting the marine and coastal environment, three basic rules are adopted to apply to all ocean going ships calling at a port in the area of a Member State jurisdiction, which are as follows:

Fees for ship-generated waste *(in accordance with Article 8 of the 2000/59/EC Directive)*
▪ All ships calling at a port of a Member State shall contribute significantly to the costs of reception facilities including the treatment and the disposal of waste received, irrespective of the actual use of the facilities. Arrangements to this effect, may include incorporation of the fee in the port dues or a separate standard waste fee. The fees, may be differentiated with respect to factors such as the category, type, size of the incoming ships, etc. ▪ The part of the costs which is not covered by the abovementioned fee, if any, shall be covered on the basis of the types and quantities of ship-generated waste actually delivered by the ships. ▪ Fees may be reduced if the ship's environmental management, design, equipment and operation are such that the Master of the ship can demonstrate that it produces reduced quantities of ship-generated waste.

In the adequacy assessment procedure, it was not intended to assess or comment on the current charging system at the ports of the project, since numerous, local factors (economic, social, administrative, etc.) should be taken into account to determine whether or not fees collected by ships are reasonable and effective for the level and adequacy of the service provided.

However, in every case, where completed questionnaires from ships were collected with the assistance of Port Authorities and analyzed, the judgement of their Masters with respect to the sensibility of the fees was only taken into account to provide an input to the assessment.

- **Reports of alleged inadequacy of reception facilities**

The International Maritime Organization has established a reporting system for alleged inadequacies and observed lack of adequate reception facilities under the provisions of MARPOL 73/78. All Parties to MARPOL 73/78, apart from their obligations to communicate to the International Maritime Organization a list of the existing reception facilities in their ports and territories able to collect wastes from ships as defined in the Annexes I and II (in accordance with the Article 11(1)(d) of the Convention), are also recommended to notify the Organization for subsequent transmission to the Parties concerned, of all cases where facilities are alleged to be inadequate.

The format currently used by Flag States for reporting alleged inadequacies of port reception facilities is provided in the MEPC/Circ.349 that revised the previous MEPC/Circ.318. In practice, Flag States are encouraged to distribute the abovementioned format to ships, recommending to Masters to use it to

report to their Administration, and preferably to the Authorities of the Port State. Flag States are required to notify IMO of any case where facilities were alleged to be inadequate.

- **Serious operational restrictions**

Under this criterion, an effort was made to identify and assess serious operational restrictions (other than those related with the initial reception capacity of the facilities) that could influence the waste collection service provided to ships that normally call at a port. The disposal of oil residues containing for instance lead compounds, which can be found in some refined oil products or concentrations of tank cleaning chemicals, entails an advanced treatment which is not always available at the existing reception facilities.

- **Port – based waste treatment**

The collection predominantly, and any subsequent waste management activity in a port area should be carried out in such a way as to prevent pollution of the environment and enhance its protection from secondary pollutants produced during the waste storage and pre-treatment phases that can take place in the port area before the transportation and final disposal of wastes.

The operation of a port facility for collecting oily wastes or garbage from ships should ensure that, in particular, the pre-treatment, or even disposal should be carried out in accordance with any applicable local, national or regional requirements. For the candidate countries to join the Eur. Union, the coherent European Community legislative framework dealing with the disposal of waste oils, the management of hazardous waste and non-hazardous waste, provides already those requirements, standards and recommended options that the treatment, recovery or disposal of ship-generated waste and cargo residues should meet.

As expected, oily wastes reception in most of the ports and oil terminals of the project, was combined with storage, primary separation and treatment aimed to remove oil from water to produce a water effluent that could be discharged at sea provided that any applicable discharge standards are met. At the same time, the second objective of the port passed treatment was the recovery of oil for recycling or re-use. Appropriate technologies or sequences of water effluent treatment steps, can, invariably, ensure the preferable compliance with local or national regulations since discharge of oily wastes into surface waters or in general uncontrolled discharge is prohibited in every country of the project.

While, reception facilities for ship-generated garbage act as a link between the incoming ships to a port and the final disposal sites of the nearby area, oily wastes collection at on-shore facilities and in navigable means such as barges, is combined with storage and primary treatment.

What was really assessed to indicate the adequacy of the treatment of oily wastes in a port, was the efficiency of the method and the infrastructure used in relation to the identity of the type of oily wastes collected and processed.

It is widely known that oil derived liquid wastes such clean or dirty ballast, washings from tanks where crude oil or oil products carried, oily bilge water, sludge mainly produced from fuel and lubricating oils purification, used lubricants, etc. make particularly demanding the collection and treatment process since the above mentioned types of oily wastes may include numerous chemical compounds and may have different physical and chemical properties.

Generally speaking, only free oil in oily water mixtures can be removed through simple buoyancy separation techniques while it has been demonstrated that mechanically (produced by mechanical shear forces during mixing or pumping) or chemically emulsified oil (produced due to chemical bonding from the use of surfactants or cleaning agents) needs further treatment.

It was witnessed during the missions that some fixed port based facilities for collecting and treating oily wastes were faced with operational problems due to the incompatibility of the applicable treatment method and the nature of the treated mixtures.

- **Waste final disposal and valorisation**

Since, disposal of wastes collected from ships is an integral component of the entire waste management system applied in a port or a wider area, the identification and assessment of the existing uses of recovered oil and separated garbage able to be recycled, along with their final disposal, were the objectives set upon the incorporation of this criterion to the assessment process.

Recovered oil can be used with or without blending with regular fuel oils (provided that its quality meets specific criteria related with the intended use) as supplementary fuel for either the land-based industry or shipping.

The co-existence of treatment facilities with bunkering stations in the port areas, makes possible the blending of recovered oil with standard types of marine fuels and therefore the supply of a recovered oil based fuel oil, provided that it's accepted from an environmental point of view (absence of hazardous substances the combustion of which could result in harmful air emissions, etc.) and also from a operational safety point of view (e.g. production of potentially corrosive mixtures and sub-products during the combustion process that could cause significant failure at the ships engines and fuel distribution systems).

It's worth mentioning that a trend is appearing, initiated by national standardization bodies (e.g. ASTM) to provide standard compositional specifications for recycled oils that are intended to be used as fuel oils.

The fact that modern ships are provided with tanks for retaining used lubricating oils segregated from other oily wastes holding tanks, enables the separate collection and regeneration of used lubricating oils that have gone through their intended use cycle, in areas where local or central infrastructure exists for waste oils re-refining to produce mineral based oils with similar characteristics as the original base oils. Additionally, other requirements are provided with respect to the authorization of those disposing waste oils, the operation of treatment plants, etc.

A look at the waste oils management in the European Union countries, demonstrates that 75% of the waste oils generated are collected (including waste oils collected in ports from marine sources), with 50% (of the generated volume) to be used in combustion with energy recovery and the 25% in regeneration processes *(European Topic Centre on Waste and Material Flows, E.E.A., 2002).*

Disposal of oily semi-solid sludge produced either as a secondary waste from treatment processes or, as heavy scale and sludge from tank cleaning activities collected in port areas (in particular in ship repairing zones and tank cleaning facilities) was another issue to which the assessment concentrated, attempting to verify the compliance of disposal options with the existing legal requirements.

In respect of garbage collected from ships, it was endeavored to identify and assess the disposal route in relation with the available locally recycling options and controlled land-filling facilities since the disposal of garbage is strongly associated with the municipal domestic collection, transportation and disposal systems. The option that dominates the final disposal of the non-hazardous ship-generated garbage in the ports of the project is land-filling in the nearby area around the port.

- **Waste management in general**

Under this last criterion, a number of issues that compose an environmentally sound waste management were attempted to be identified and assessed jointly or on a separate basis, including at least:

- Permit requirements for those that collect, transport, treat and dispose of ship-generated waste collected in ports,
- Procedures for performing surveys of the waste collection providers that operate in the port area,
- Procedures for recordkeeping requests from ships to deliver wastes at the port, quantities and types of wastes received and handled,
- Procedures for enabling the traceability of wastes collected from the area of their reception to their final disposal site.

The Directive 2000/59/EC places emphasis on the continuous improvement of the adequacy of facilities by up-to-date waste reception and handling plans in consultation with all relevant parties in particular the port users.

In addition, it is recommended that the procedures carried out for the reception, collection, storage, treatment and disposal should conform in all respects to an environmental management scheme suitable for the progressive reduction of the environmental impact of waste handling activities.

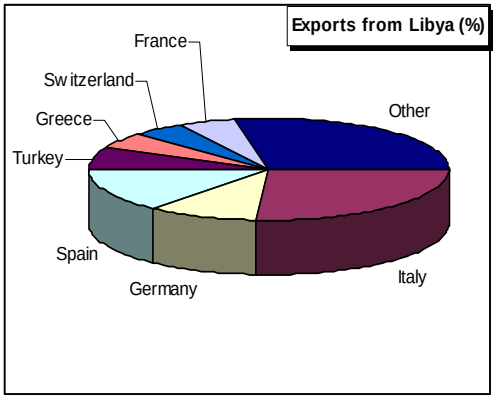
4. ANALYSIS & RESULTS

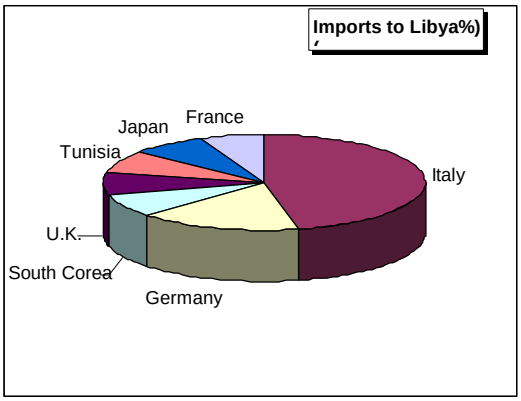
4.1 INTRODUCTION

Since 1969 when the government of Libya, officially Great Socialist People's Libyan Arab Jamahirya, reformed the national industry including production and manufacturing by adopting and implementing a new policy, the country has been constantly developing to a predominantly, major producer of crude oil and natural gas. The maritime trade from/towards the main ports of the country reflects perfectly the fact that crude oil and petroleum products account for around 90% of the exports contributing significantly to the national income.

This export activity is expected to increase in the near future following the planning of the development of a number of oil and natural gas offshore fields off the Libyan coastline resulting in the delivery of crude oil and natural gas to coastal terminals or directly through pipelines to neighboring or remote countries. So far, European countries seem to be the most important import and export partners for Libya, providing machinery, transport equipment, food and manufactured goods and receiving crude oil as well as refined petroleum products. Libya, currently exports about 1.2 million bbl/day of oil with nearly all (about 90% of which) to be sold to European countries like Italy, Germany, France, Spain and Greece.

The following two diagrams illustrate the current export/import patterns for Libya:





Further industrial development after 1985 diversified the range of products destined for exports from the country such as textiles, petrochemicals, and other manufactured goods.

Information with regard to the existing legislative framework of the country relating in general to the policy and the regulations for the protection of the environment, the administration of the ports and the responsibilities for the prevention of pollution from ships was provided from Dr. M. M. Amer, Head of the Office of Planning and Emergency Committee of the Environment General Authority. The Environment General Authority has a leading role in

the process of setting up and maintaining a framework for integrating the country into international and regional agreements dealing with the protection of the environment from land based and maritime sources.

Libya is not a Signatory Party to the international Convention of MARPOL 73/78 and its Protocols up to now. It was reported to the Consultant during the mission that the government of Libya through the concerted action of the Administration of Maritime Transport and Ports and the Environment General Authority has been examining the possibility to ratify the Convention. The potential implications to the port industry with respect to their waste handling and management as far as the ship - generated waste is concerned, are not seen as a constraint.

Sustainable development in Libya during the ongoing phase of transition and economic reform was understood to be a strategic target for the Environmental General Authority, making necessary a planning for addressing the issues of ratification and enforcement of international treaties, for delivering changes in the policy and legislative framework and setting certain objectives.

Libya has ratified, by approval, since June 6th 1983 the Protocol for the Protection of the Mediterranean Sea against Pollution from Land – Based Sources and Activities that entered into force on June 17th 1983. It is worth mentioning that Libya as a Party of this Protocol has undertaken, among others, to take a series of measures that are strongly related to the operation of land-based facilities engaged in receiving and treating of hazardous wastes or managing solid waste.

That means that sectors of activity such as port operations, the waste treatment and recycling industry, etc., need to be provided with action plans aimed at controlling any point source discharges at sea, at identifying and selecting for use sound methods of waste treatment and disposal, and in general, at steering their efforts to ensure the environmental sound character of their operations.

It should be mentioned that used lubricating oils and litter regardless of their origin have been incorporated in the list of substances of the Annex I of the Protocol, which provides a reference basis for those substances, the development and implementation of action plans and measures for which is necessary.

Libya has also signed and ratified the Protocol on the Prevention of Pollution of the Mediterranean Sea by Transboundary movements of hazardous wastes and their Disposal. It should be stressed that the Protocol provides a coherent framework for the country to institutionally and legislatively deal with the management and disposal of hazardous waste. Although, wastes produced during the routine operation of ships are out of the scope of the Protocol, its provisions with regard to the safe and environmental disposal of wastes produced from the treatment of ship-generated wastes in authorized reception and treatment facilities could certainly have a significant impact in guiding the responsible Authorities of the country to establish a proper

system for controlling the hazardous wastes final disposal and export operations.

Port Authorities and oil terminal Operators are basically responsible to provide reception facilities for ship-generated waste in the country.

The ports of Tripoli, Misurata, Khoms and the Zawia oil terminal are analyzed in this Report, the operational status of which, is indicated in the following table:

Port	**Port**		**Oil Terminal**			
	Commercial Port	Port with major ship - repairing and/or tank cleaning facilities	Crude oil		Oil Products	
			Loading terminal	Unloading terminal	Loading terminal	Unloading terminal
Tripoli	✔					
Misurata	✔					✔
Khoms	✔					
Zawia				✔	✔	✔

4.2 ANALYSIS OF PORTS

4.2.1 Port of Tripoli

4.2.1.1 Type and operation

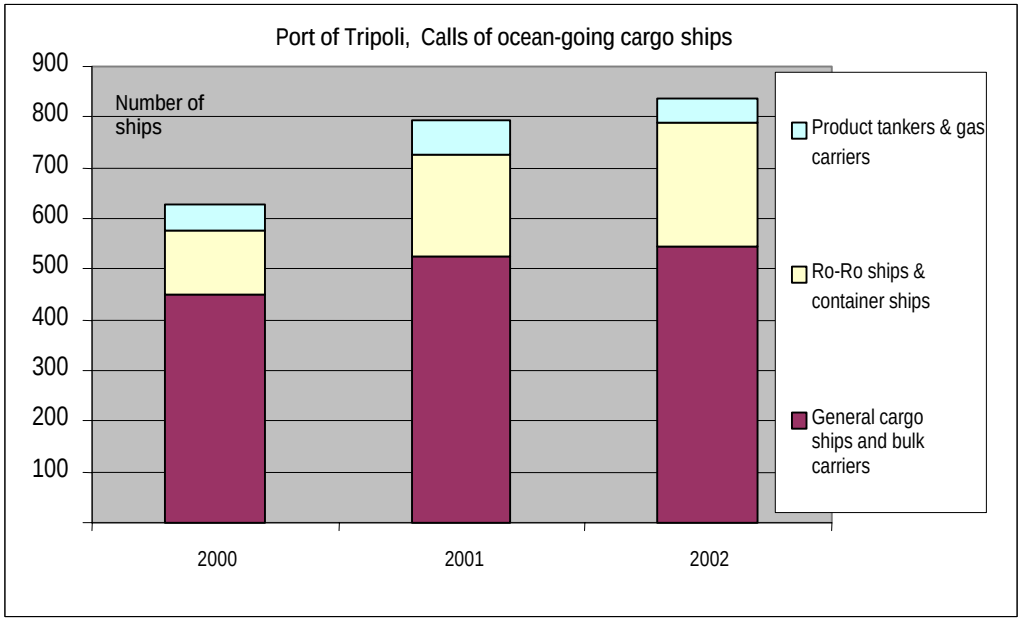
The port of Tripoli is located in the north - western area of the country, at $32^0$54′ N and $13^0$11′ E and is operated by the General Ports and Lights Authority. It constitutes a principal import centre for edible goods, textiles, metal, raw materials, machinery, ect. and an export one for construction materials and domestic ready products, enhancing the commercial and manufacturing activity of the country's largest city.

The anchorage area of the port lies approximately 1.5 n. miles north of its entrance while its' berthing area is approximately 4.760 meters long, the various depths and lengths of which are presented below:

Berths	**Depth** (m)	**Length (m)**	**Type of ships normally accommodated**
5A – 5B	7,5	68	Small draft general cargo and Ro-Ro cargo ships
6 - 9	8 - 9	460	General cargo and Ro-Ro cargo ships
10 - 14	7,5	718	General cargo and Ro-Ro cargo ships
15 - 22	10 – 12	1.135	General cargo and Ro-Ro cargo ships
23 - 30	12	1.169	Bulk carriers, general cargo ships, reefer ships and Ro-Ro cargo ships. A floating dock of 5.000 tons and 2 slips for vessels up to 500 tons are operated by the port Authority
1 – 2 k (Karamanly)	9	150	Oil tankers and gas carriers
3 – 8 k (Karamanly)	9	757	Small draft vessels
1M , 2M	7	300	Passenger ships, harbour tugs, etc.

On average, 1.500 ships call at the port annually, 70% of which are ocean-going ships, basically general cargo ships and Ro-Ro cargo ships. The traffic at the port has been remaining almost constant in the last three years period with some minor fluctuations in the traffic of passenger ships, livestock cargo

ships, etc. On average, 500 general and cargo ships call at the port annually, spending on average a considerable time for discharge and loading activities (5 – 8 days). The traffic at the port in the 2000 – 2002 period, related to the calls of cargo ships, Ro-Ro and container ships as well as of oil and gas carriers is illustrated below:



4.2.1.2 Existing Reception Facilities for oily wastes

In accordance with the information provided from the representatives of the port during the mission at the country, the reception and subsequent management of oily wastes is not well organized. However, apart from the fact that Libya is not a signatory Party of MARPOL 73/78 and thus it is not required to provide reception facilities for oily wastes according to the respective Annex I Regulations, a private company has been designated by the Port Authority to collect, upon request, limited quantities of sludge and oily bilge water from the machinery spaces of ships.

A tank vehicle of 15 m^3 capacity is employed in collecting these wastes basically from the harbour tugs (about 15 operate in the area of the port), fishing vessels and other ships of domestic traffic. Collection of oily wastes from the abovementioned ships is free of charge, since, as it was reported, these wastes collected from the port area, are used for heating purposes probably without any treatment. It should be stressed that the existing collection service has been in place to cover the needs of the local fleet and definitely not of the ocean going ships, apparently with greater needs.

4.2.1.3 Existing Reception Facilities for garbage

The Authority of the port has licenced a private company to provide collection of ship-generated garbage. Garbage collection is normally carried out in business hours and at all locations ships berthed, following a prior notice of

the Masters or the representatives of ships which specifies the volume to be delivered, the identity of garbage as well as the way the crew of the ships are going to deliver it to the facilities. In accordance with the requirements of the Authority of the port, garbage intended for delivery should be separated as per its type to enable easy handling and carriage.

A number of five, simple, non compactor trucks with a total capacity of 25 m^3, used as reception and transportation means are engaged in collecting garbage from the incoming ships. These trucks have a hydraulic system to easily discharge the wastes at the local landfill situated 50 kilometers far from the port area. In addition, a number of thirty receptacles of 30 m^3 total capacity, have been places in the port area serving the needs basically of the domestic fleet (fishing vessels, tugs, supply ships, etc).

It was reported that almost 80% of the ships that normally call at the port request to deliver garbage, however, there were not any data available to show the exact number of ships and the quantities landed to the reception facilities in the last years period. It was understood that a compulsory, charging system exists, applying to all ships that call to the port, regardless of the actual use or not of the available reception facilities. Such a ship is charged 25 dinars per call covering garbage collection during her stay at the port.

The following tables show the existing facilities for collecting ship-generated garbage and the estimated volumes of oily wastes and garbage that are likely to be delivered in the port from both ocean-going and domestic ships.

During the application of the methodology for estimating the abovementioned waste streams, it was taken into account the existing trade features of the port of Tripoli which demonstrate a strong relation with a number of European countries from which manufactured goods and food products are imported amounting to approximately 70% of the total imports.

Port	**Garbage collection capacity** *(m^3)*				**Description of port- based treatment**	**Operational restrictions on the use of the facilities**
Tripoli	**Trucks** (used as reception and transportation means)	**Navigable means**	**Receptacles provided at the quayside**	**Other reception means**		
	5 5 m^3 each one)		30 (20 m^3 total capacity)			
Service provider	**Requirements for ships to deliver garbage**		**Method of final disposal**	**Charging system**	**Other remarks**	
A licenced private company	A prior notice, at least, 24 hour before scheduled arrival at the port, outlining the volume and nature of garbage.		Disposal at the local landfill some 50 kms far from the port area	A compulsory, charging system applies to all ships equal to 25 Lib. dinars per call.		

Port: **Tripoli**
Country: **Libya**

❑ Estimated volumes of ship-generated oily wastes					❑ Estimated volumes of ship-generated garbage				
Oily wastes	Dirty ballast	Tank washings	Oily bilge water	Oil residues (sludge) and other waste oils	**Garbage**	Domestic garbage	Maintenance waste	Cargo-associated waste	Total volume of garbage
Reduced daily volume (m^3/day)	-	-	6,95	8,69	Reduced weekly volume (m^3/week)	25,1	7,41	1,65	34,1
Average annual volume (m^3/year)	-	-	2.536,7	3.171,8	Average annual volume (m^3/year)	1.307,5	385,6	85,92	1.779,0
Maximum volume per ship/arrival (m^3)	-	-	20.0	15.0	Maximum volume to be received per ship/arrival (m^3) (only domestic and maintenance)				5.0

4.2.1.4 Conclusions & Recommendations

4.2.1.4.1 Reception and treatment of oily wastes

It was estimated that approximately 5.700 m^3 of oily wastes are likely to be delivered from the incoming ships to the port of Tripoli on annual basis. In the absence of adequate and organized reception and treatment facilities and of an institutional and operational framework identical to MARPOL 73/78, retention of oil onboard during their stay at the port of Tripoli has been a practice for these ships. It is recommended that a reception and treatment facility should be established in the port to enable collection of oily wastes through appropriate road tankers as well as directly from ships through a fixed, reception point equipped with a system of flexible hoses, manifold and twin piping.

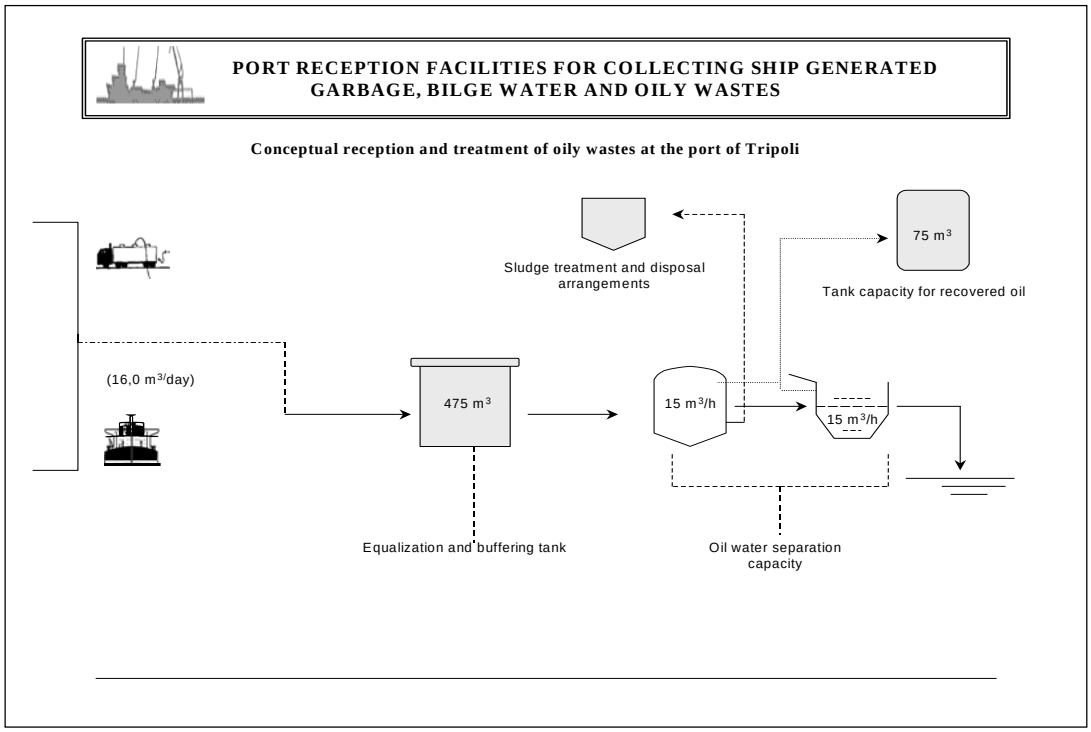
It is proposed that at least two road tankers of 15 m^3 capacity, properly designed and of adequate strength and of good construction suitable for the carriage of oily wastes, able to meet the existing national requirements that refer to the carriage of dangerous substances in road tankers, should be provided to deal with collection of oily wastes from all road - accessible berths.

Taking into account the nature and properties of oily wastes from the machinery spaces of ships, a number of basic principles should be considered, as follows: The shell of the tank, its attachments, service and structural equipment shall be designed to withstand without loss of contents (other than quantities of gas escaping through any degassing vents) static and dynamic stresses in normal conditions of carriage, shall be also designed in accordance with a technical code recognized by the country's competent Authority, the shell or each of its compartments shall be provided with an opening large enough to permit inspection, the respective equipment and fittings shall be so arranged as to be protected against the risk of being wrenched off or damaged during carriage or handling being compatible with the oily wastes carried, each bottom filling or bottom discharging opening shall be equipped with a proper number of independent closures, etc.

The location of the treatment facility is proposed to be at the western edge of the port area, however the exact position can be decided by the Authority of the port taking into account any future land exploitation, works, etc.

The length of the berth that will be devoted, the maximum displacement of ships it could host, the necessary machinery for handling the hoses of the facility and its entire necessary superstructure and its electrical-mechanical equipment, etc. need to be studied in detail. The twin, independent piping from the berth to the bilge oil and sludge storage tanks should be insulated and heated, made of steel complying with the respective, internationally accepted standards and should be provided with all necessary flange joints, hose strings, etc.

The storage capacity of the tanks where oily wastes are to be retained before treatment acting for flow equalization and buffering is proposed to meet one normal month needs, approximately 475 m^3 while treatment capacity can be between 15 – 20 m^3/hour. A conceptual scheme of the proposed reception and treatment facility is shown in the following diagram:



Separated water can be discharged into the sea in compliance with the regulations issued by the local and central environmental authorities. Its should be pointed out that an average, permissible oil content in the effluent in the Mediterranean countries has been set at 5 ppm (where port reception and treatment facilities for oily wastes operate) provided that the discharged effluent is regularly tested and the test results are controlled by the responsible Authorities.

Advise on the acceptable effluent quality might be requested by the General Water Authority, involved in formulating the national and local water policy, in conducting research to ensure optimum utilization of the available resources and deciding on the size, location and use of water processing applications as well as by the Environment General Authority.

4.2.1.4.2 Improvements to the existing garbage collection

Taking into account the available, nominal reception capacity and the routine emptying of the available receptacles in the port area, garbage collection can be considered as sufficient to meet the normal needs of ships, provided that the following improvements are made:

Separate receptacles should be allocated to receive potentially hazardous wastes with the aim to achieve their segregation during collection and subsequent handling and finally to the different waste transfer route from domestic like garbage, dependant upon their ultimate destination. The feasibility of this recommendation should be assessed from the Environment General Authority in relation to the availability and capacity of the local or national infrastructure to deal with such a waste stream.

Procedures regarding the receipt and handling of ships notification, record - keeping of volumes and garbage types collected, etc should be standardized to simplify and optimise garbage and oily wastes collection services.

Using in addition as reference, the Strategic Action Program to Address Pollution from Land-Based Activities adopted in the framework of the Mediterranean Action Plan, some pertinent recommendations can be extracted, as follows:

- Where facilities for the environmentally sound treatment and disposal of hazardous wastes are to be established or currently operate, considerations should be made for the hazardous waste streams that may originate from shipyards and ship repairing zones and the feasibility of properly disposing them to these facilities.

- When national plans are developed for the management of hazardous wastes, an evaluation of the quality and quantity of hazardous wastes from ships delivered in the ports and other facilities of the country should be included.

- The cost recovery and polluter pays principles should be integrated into future hazardous waste management plans to ensure their economic viability and to encourage the involvement of private sector.

- Ship – port notification systems and procedures, established to facilitate the collection of wastes from the available facilities, should enable the formal exchange of information on the existence of hazardous wastes or substances and the subsequent need for disposal at the port.

4.2.2 Port of Misurata

4.2.2.1 Type and operation

The port of Misurata is located in the north - western area of the country, east of Tripoli, at $32^0$22′ N and $15^0$13′ E, some 210 kms far from Tripoli, and it's operated by the General Ports and Lights Authority. It is accessed through an entrance channel 150 meters wide and 13 meters deep with its north breakwater extending 1400 meters east from the Ras Zarrugh lighthouse and its east breakwater 1800 meters north from the shore. The port constitutes an import centre basically for packaged edible products such as sugar, coffee, tea and an export one for textiles, etc and can be distinguished to the main port and the Steel Harbour.

The Steel Harbour is situated 1 n.m. south of the main port surrounded by a 2.500 meters long North Breakwater and a 650 meters long secondary one, providing a 384 meters long bulk berth on steel piles and pre-cast reinforced concrete deck members, dedicated to iron ore carriers from 40.000 to 110.000 tdw. The Steel Harbour supports the iron handling activities of the biggest, industrial, land-based complex of the country with an annual throughput around 1.330.000 tons of DRI (Direct Reduced Iron) with main, end products, bars and wires, hot and cold rolled rolls and sheets.

The whole port provides 21 berths in total, 4.260 meters long with a maximum depth of 11 meters, 290 ha open storage area, an area of 67.500 m^2 of covered warehouses, grain silos with a 40.000 tons capacity. An annual throughput of about 6 million tons has been achieved. At berth 28 of the port, oil products are discharged to the near by tank farm for domestic use purposes. On average 1.5 million tons of oil products are discharged annually by around 100 - 150 oil tankers.

It should be noted that a Free Zone has been established in Misurata close to the Steel Harbour (the first in the country) occupying an area of about 1200 ha following the efforts of the government of the country to enhance the international trade and to facilitate the commercial, industrial activities of the wider area. Activities such as storage of transit and domestic goods, repacking operations, import or export of products to or from the Free Zone are privileged due to the favourable conditions and regime granted to the investors in the zone. On average, 1.000 ocean – going ships call annually to the port, a figure that remains almost constant for the last three years period.

The port has a syncrolift ship-lift managed by a private company which undertakes repairs to around 35 ships annually of a maximum allowable size of 5.400 tdw. In the absence of facilities to collect oily wastes from ships accommodated in the repair yard, oil tankers that happen to be accommodated for major or minor repairs are required to arrive with only clean ballast and minor quantities of other oily wastes.

4.2.2.2 Existing Reception Facilities

There are not any facilities available for receiving and managing oily wastes from ships that call to the port of Misurata.

As far as garbage is concerned, a non - systematic collection service is available through the involvement of a local, private company working under the supervision of the Authority of the port.

Three open trucks of 15 cum. meters total capacity are employed to receive garbage upon request from ships. Garbage collected is destined either for final disposal at the local landfill which is located a few kilometers far from the port, or for combustion depending on the nature of collected, dry garbage.

Data with respect to the number of ships that wish to deliver garbage, to the actual volume collected are not maintained while information on the applying charging system was not provided.

4.2.2.3 Needs' Assessment and Recommendations

Collection of oily wastes from ships is proposed to be carried out by means of a fleet of two properly designed road tankers of 15 m^3 capacity, of adequate strength and of good construction, suitable for the carriage of oily wastes, able to meet the existing national requirements that refer to the carriage of dangerous substances in road tankers.

Collected oily wastes will be subsequently discharged to a 350 m^3 tank farm serving for initial storage, buffering and equalization purposes. The average daily volume is expected to be not more than 12 cub. meters grossly suggesting a limited oil – water separation capacity between 5 – 10 m^3/hour.

The performance of the separation process and the subsequent treatment might be sought towards the effluent water quality standards and the quality of the recovered oil that can be used as substitute fuel oil or for other acceptable uses in compliance with the national legislation.

Garbage collection at the port of Misurata should be improved as follows:

- All wharf areas where fishing vessels, port support craft and in general small ships are normally berthed, should be provided with receptacles of more than 200 lt to receive non bulky, domestic like garbage. Two vehicles of 10 m^3 capacity, compatible to these receptacles, with a proper hydraulic lifting arm and garbage compression arrangements should be also employed for the daily emptying service.

- Separate, special receptacles and a dedicated, hazardous waste collecting vehicle should be provided to the area of the repairing zone and also in a central place of the port including its free zone area, where

separation and transfer of potentially hazardous waste can be carried out.

- Separate, special receptacles and a dedicated collecting vehicle are also proposed to be provided to receive recyclable garbage from ships, in the area of the commercial port, on the basis that these facilities can be linked in the near future with existing recycling schemes for land – based wastes.

The standardised table showing the anticipated volumes of ship-generated waste at the port, is presented in the following page:

Port: **Misurata**
Country: **Libya**

❑ Estimated volumes of ship-generated oily wastes					❑ Estimated volumes of ship-generated garbage				
Oily wastes	Dirty ballast	Tank washings	Oily bilge water	Oil residues (sludge) and other waste oils	**Garbage**	Domestic garbage	Maintenance waste	Cargo-associated waste	Total volume of garbage
Reduced daily volume (m^3/day)	-	-	4,9	6,8	Reduced weekly volume (m^3/week)	9,2	4,2	2,6	16,0
Average annual volume (m^3/year)	-	-	1.800,0	2.500,0	Average annual volume (m^3/year)	480,0	220,0	138,3	838,3
Maximum volume per ship/arrival (m^3)	-	-	20.0	15.0	Maximum volume to be received per ship/arrival (m^3) (only domestic and maintenance)				5.0

4.2.3 Port of Khoms

4.2.3.1 Type and operation

The port is located in the north - western part of the country, in the middle of the distance between Tripoli and Misurata, at $32^0$41′ N and $14^0$15′ E. It is accessed through a 13 meters deep (minimum depth) channel and it's protected from two breakwaters, forming a 150 meters wide entrance. Eight berths of a total length of around 1.800 meters are allocated for ships that are basically engaged in handling cement in bulk, containerized cargo, livestock, etc. The berthing capacity of the port is presented below:

Berths	**Depth** (m)	**Length (m)**	**Type of ships normally accommodated**
13	8	200	Small draft ships and harbour support craft including tugs
14 - 15	12	530	Container ships
16 –17	12	500	Container ships
18	12.6	340	General cargo ships, cement carriers and cargo ships carrying livestock
19	12.6	150	Cement carriers
20	13	75	Fishing trawlers

About 34.000 tons of containerized cargo carried in around 290 container ships, about 350.000 tons of cement carried in around 50 cement carriers, about 45.000 tons of livestock as well as 22.500 tons of general cargo constitute the annual cargo throughput of the port.

4.2.3.2 Existing Reception Facilities

There are not any facilities available for collecting and managing oily wastes from ships that call to the port of Khoms. This information is available to the agents of ships through the standard, port notices.

A local private company has been designated by the Authority of the port to collect garbage upon request from the incoming ships. Open trucks and towed receptacles are provided for the reception of garbage and its final disposal to the local landfill which is situated approximately 7 kilometers far from the area of the port.

The company has been cautious to collect domestic like garbage and not other solid wastes that might be hazardous such as oil contaminated wastes and in general waste that exhibit harmful properties.

A systematic monitoring of ships' needs and maintenance of data on the volumes collected, number of ships served, etc., does not exist. From the discussions held during the few hours visit to the port, it was concluded, that in practice, ships used to spending more than a day berthed in the port request garbage collection services. All berths of the port are accessible so that any garbage collecting vehicles can approach alongside the ships to receive garbage normally directly delivered from the ships' crew.

4.2.3.3 Needs' Assessment and Recommendations

The estimated volume of oily wastes to be delivered from ships that normally call at the port are not more than 1.300 m^3 per year while the daily batch is less than 3.5 m^3. The small amount of estimated oily wastes does not justify the establishment of an economically feasible fixed reception and treatment facility in the port.

The majority of the cargo ships that call to the port come or sail to ports and terminals of Europe where invariably reception facilities exist guaranteeing to a certain extent that those ships destined to Khoms or other ports of the country would have preferred to deliver their wastes before departing, ensuring also that the waste retention onboard capacity is sufficient for such a passage. It should be noted that it was not possible to have completed questionnaires from the Masters of ships that happened to call at the ports studied during the project, effecting this way to the safe margins of the calculations.

Collection of oily wastes is strongly recommended to begin with analogous means such as those suggested in the ports of Tripoli and Misurata. At least two road tankers (one to replace the other during maintenance and repairs) of not more than 15 m^3, specially designed and built to carry oily wastes are suggested to be employed in the daily, collection activity.

Taking into account the today's character of the operation of the port with its industrial features to dominate due to its proximity to the power station and cement plant in El Khoms area, it's proposed that either collected oily wastes to be discharged in the recommended treatment facility for the ports of Tripoli and Misurata or directly (or following a primary treatment) to be discharged in the nearby cement factory.

The available garbage collection service is, in general, sufficient to meet the needs of ships, as far as domestic like garbage is concerned. However, the following improvements are recommended to be made in due time:

Quarantine wastes produced from the normal operation of ocean-going ships or from the carriage of livestock in the port should be properly collected and

managed. Apart from the enforcement of procedures set to enable inspection and awareness purposes, appropriate reception means at least, should be provided to achieve isolation and separation of these wastes. However a no reception policy can be also considered for high risk wastes from ships such as hazardous, infectious or quarantine wastes.

At least 2 skip containers of more than 3.5 cub. meters capacity each one, served by one appropriate collection vehicle should be provided for the needs of reception of cargo associated waste at the commercial and the Steel port.

The standardised table showing the anticipated volumes of ship-generated waste at the port, is presented in the following page:

Port: **Khoms**
Country: **Libya**

❑ Estimated volumes of ship-generated oily wastes					❑ Estimated volumes of ship-generated garbage				
Oily wastes	Dirty ballast	Tank washings	Oily bilge water	Oil residues (sludge) and other waste oils	**Garbage**	Domestic garbage	Maintenance waste	Cargo-associated waste	Total volume of garbage
Reduced daily volume (m^3/day)	-	-	2,0	1,4	Reduced weekly volume (m^3/week)	5,9	1,5	3,3	10,7
Average annual volume (m^3/year)	-	-	756,0	540,0	Average annual volume (m^3/year)	311,0	79,4	173,6	564,0
Maximum volume per ship/arrival (m^3)	-	-	20,0	15,0	Maximum volume to be received per ship/arrival (m^3) (only domestic and maintenance)				5,0

4.2.4 Zawia oil terminal

4.2.4.1 Type and operation

The Zawia oil terminal is operated by the Azzawiya Oil Refining Co. a subsidiary of the state - owned National Oil Corporation, which was established in 1970 by the Libyan government with the mandate to deal with the crude oil research and development activities at every level, from exploration, drilling, refining, exporting and marketing aimed at supporting the national economy. The terminal is located in the north - western Libya at $32^0$49′ N, $12^0$43′ E constituting the harbour facility of the refinery (the second larger refinery of the country after that of Ras Lanuf) which has been operating since 1974. The refinery has two atmospheric distillation plants with a total, nominal capacity of 120.000 bpd, a catalytic hydrotreater (16.500 bpd), a vacuum unit (7.500 bpd) and other facilities. Naphtha, gasoline, kerosene light, vacuum gas oil, fuel oil, base lubricating oils, asphalt and other oil products constitute the range of the production line of the Zawia oil refinery.

View of the oil refinery in Zawia

The terminal comprises three offshore berths, located north-east of the refinery, as follows:

Berths	Depth (m)	Remarks
1	27	The berth is provided for fuel oil, naphtha and gas oil exporting activities, accommodating ships of 10.000 – 100.000 tdw
2	23	For loading and unloading of oil products such as gasoline, jet kerosene, etc. able to accommodate tankers of 5.000 – 20.000 tdw

3	30	For oil tankers up to 140.000 dwt engaged in crude oil discharging activities

On average, more than 200 oil tankers call at the terminal annually. In 2000, 195 tankers called at the terminal, 213 in 2001 and 215 in 2002 respectively. The volume of crude oil and oil products handled at the terminal in 2003, destined for local consumption purposes or exports abroad is illustrated below:

Type of oil discharged/loaded to/from the refinery	**Volume (x 10^3 m^3)**
Crude oil	6.000
Fuel oil	685
Gas oil	692
Kerosene	755
Gasoline	452
MTBE	81,5
Other	676

Cargo throughput at Zawia terminal (2003)

4.2.4.2 Needs' Assessment & Recommendations

4.2.4.2.1 Reception and treatment of oily wastes

In the absence of any reception facilities for dirty ballast and other oily wastes, the terminal operator requires from the oil tankers calling at it, to arrive with only clean or segregated ballast in accordance with the Zawia Marine Rules. To this effect a well produced, Ballast Water Discharge Data Sheet should be completed in advance by the Master of each tanker that wishes to load oil as cargo, indicating among other details regarding the following items:

- The quantity of ballast water to be discharged at sea
- The concentration of oil in ballast water
- The kind of ballast water and the associated ballast water system (tanks and piping) in accordance with MARPOL 73/78, Annex I definitions
- The date and time that de-ballasting will commence and be completed

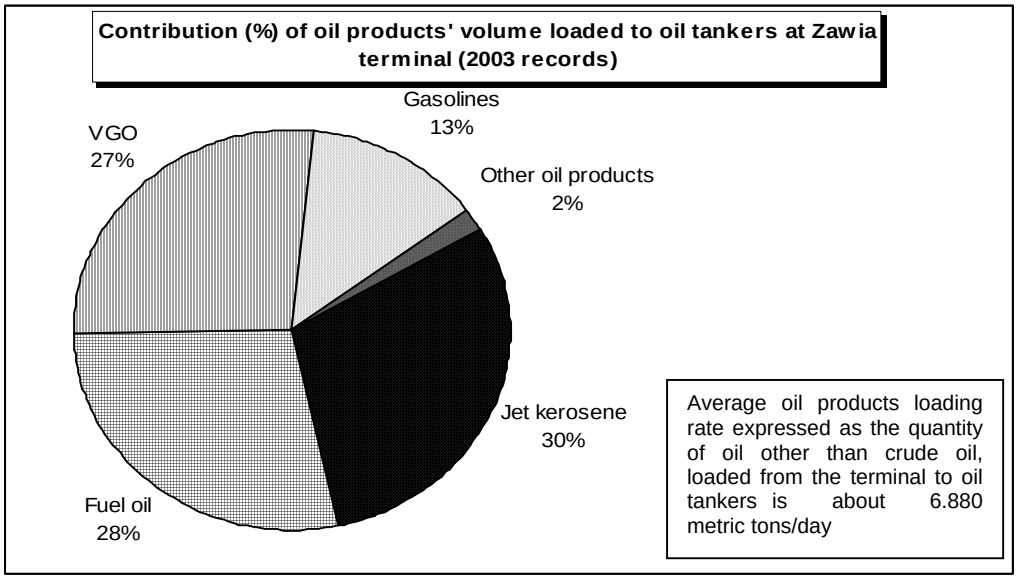
- The number and the storage capacity of the sludge tanks as well as the quantity of sludge retained onboard prior to arrival

- The number and the storage capacity of the oily bilge water tanks as well as the quantity of such mixtures retained onboard prior to arrival

It is obvious that the terminal operator has set in place an effective procedure to collect information from the incoming tankers with regard to the their need to discharge ballast water at sea and also information on the quantities of oily wastes from the machinery spaces retained onboard prior to their arrival at the offshore installations. Custom, safety related information is provided for the incoming oil tankers with regard to the approach, mooring and loading-discharge operations from the terminal operator. It is understood that following the examination of the Ballast Water Discharge Data Sheet from the responsible terminal representative and the agreement on the operational details submitted, de-ballasting at sea can be commenced.

It was also verified that crude oil tankers fitted with inert gas system and crude oil washing arrangements which call at the terminal to discharge crude oil, invariably perform tank washing using the crude oil carried either at the terminal or at sea prior to the arrival. The need for water washing the emptied tanks during the ballast voyage for the removal of residues is much reduced, if not entirely eliminated.

The Services Dept. of the Azzawiya Oil Refining Co., in special occasions and upon request, can manage to collect garbage directly to the service tugs that are employed in the mooring and assisting of oil tankers.



The terminal is engaged, so far, in importing crude oil to feed its distillation activities. Therefore there is no need to provide reception facilities for dirty ballast to the incoming fully loaded or semi-loaded crude oil carriers. From the discussions held during the mission with the representatives of the

terminal with regard to the development of national oil fields and the forecasts for the increase of Libya' oil production capacity, it was understood that the terminal in the near future will not change its crude oil receiving character.

The emphasis on the assessment of the needs of the terminal was shifted to those oil tankers that load oil products in excess of the average quantity of 1.000 metric tons set by the respective Regulation 12 of the Annex I of MARPOL 73/78, and particularly those engaged in handling fuel oil and other "black" oils at the 1st offshore berth. Regulation 12(2)b requires reception facilities at such product oil loading terminals to receive tank cleaning wash water, dirty ballast water from tankers on short ballast voyages and concentrated oily wastes.

Since the policy of the operator of the terminal is to accept only tankers fitted with either segregated ballast tanks or dedicated clean ballast tanks, and taking also into account that the average deadweight of tankers that call to the terminal exceed the 20.000 tdw margin, it is expected that the revised 13 G Regulation of the Annex I of MARPOL 73/78 will progressively eliminate pre MARPOL, non SBT oil tankers (Category I tankers) from the world scene and the operation as well, at the Zawia oil terminal.

It should be mentioned that where product oil is to be carried for which contamination with the oil previously carried is not allowed, cargo tanks should be cleaned. Requirements on retention of oil on board, provide that adequate means shall be provided for cleaning the cargo tanks and transferring the dirty ballast residues and tank washings from the cargo tanks into a slop tank or a combination of slop tanks. Oily residues generated during the cargo voyage can be mixed with the next cargo to the extent that it can be loaded on top of the contained residues in the designated slop tanks.

Lean mixtures with a low oil content such as those produced from tank washing activities performed in particular in open cycle and rich mixtures such as slops originated from the concentration of washing waters onboard the tanker constitute the identity of the anticipated oily wastes that should be taken into account, in the event a reception and treatment facility is to be established at the terminal of Zawia.

In the absence of information regarding the previous cargo carried by product tankers calling to the terminal to load either "black" or "white" oil products, the basis used in estimating the anticipated volume of tank washings and consolidated slops produced from the tankers that call at the 1st and 3rd berth was based on the following assumptions, taking into account the prevailing routine practices referring to the carriage of such cargoes in shipping:

- One third of the annual number of product tankers of the maximum permissible displacement calling at the 1st berth to be loaded with naphtha, vacuum gas oil and fuel oils need to deliver tank washings and

accumulated slops following tank cleaning and oil retention on-board prior to their arrival.

The range of products discharged from the terminal in this case covers straight run products (produced through atmospheric distillation at the refinery) as well as other from secondary processing of heavier fractions, which to a considerable extent reflect the previous cargoes of the tankers accommodated to this berth.

- one third of the annual number of product tankers of the maximum permissible displacement calling at the 2st berth to be loaded with "white" oil products need to deliver tank washings following tank cleaning and oil retention onboard prior to their arrival.

Terminal: Zawia oil terminal
Country: Libya

Estimates of ship-generated oily wastes and residues

Oily wastes	Dirty ballast	Tank washings	Oily bilge water	Oil residues *(sludge)* and other waste oils
Reduced daily volume *(m^3/day)*	-	31,5	5,1	4,2
Average annual volume *(m^3/year)*	-	11.550	1.863,0	1552,5
Maximum volume to be received per ship/arrival *(m^3)*	-	1.650	30.0	25,0

The calculations of the volume of the machinery spaces' oily wastes were carried out in accordance with the methodology outlined in the Report of the Activity 1 of this project.

On average, 11.550 m^3 of tank washings and slops, around 1865 m^3 of oily bilge water and 1.550 m^3 of sludge and other waste oils, are likely to be delivered to the terminal taking into account its existing traffic and berthing infrastructure.

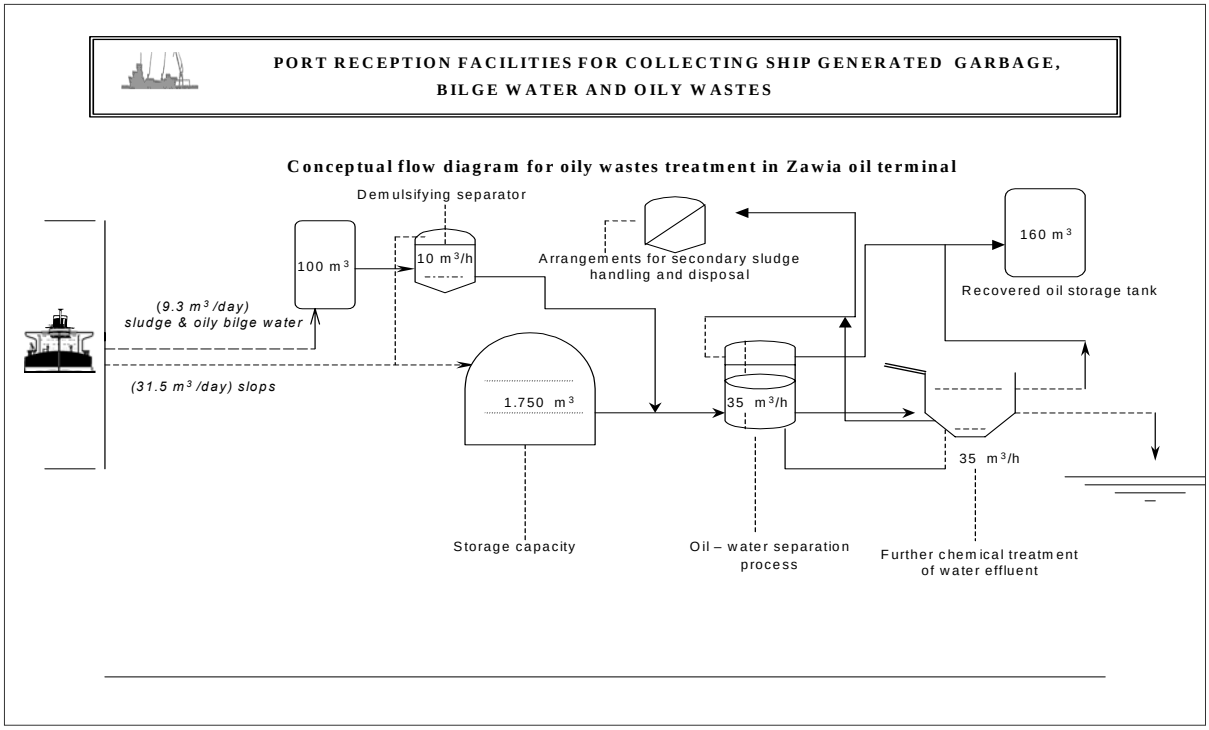
Due to the flexibility of the terminal to discharge and load oil products from different berths and a preliminary assessment of the considerable cost to install to the 1st and 2nd berth, separate piping and associated machinery for transferring oily wastes towards the proposed below, storage and treatment plant, it was estimated that two alternative, technical solutions are more suitable for the reception process:

a. the building of a special berth or of an offshore platform with the necessary loading gear, hoses, and piping to the storage and treatment plant, that will accommodate tankers of the maximum, nominal displacement that can be accommodated in the terminal,

where the incoming tankers will berth to discharge their tank washing, slops or any machinery spaces' oily wastes,

b. the building of a special berth with the necessary machinery, to accommodate only the abovementioned collecting tanker that will be engaged in receiving following ship to ship transfer operations, oily wastes from the incoming tankers.

In addition, as far as the subsequent treatment is concerned, a conceptual scheme is illustrated below, which demonstrates the estimated storage capacity for wastes equalization and buffering purposes, the treatment capacity, etc.



It is obvious from the estimation of the anticipated volumes of wastes, that there is no need for dirty ballast deliveries at the terminal, a fact which is strongly related with the elimination of non SBT oil tankers from the local scene driven from the requirements of the revised Regulation 13 G of MARPOL 73/78 in addition to the established policy of the terminal to accept tankers without oil contaminated ballast.

4.2.4.2.2 Improvements to the existing garbage collection

The discharge of ship-generated garbage into the marine area of the terminal is strictly prohibited. This information is clearly reflected in the Ballast Water Discharge Sheet that is provided to the Masters of the oil tankers that call to the terminal in advance of the commencement of the cargo handling operations.

A systematic provision of facilities for collecting garbage from ships does not exist at the terminal. The Services Dept. of the Azzawiya Oil Refining Co. in particular cases, can arrange collection directly from the tugs employed in assisting the mooring of oil tankers at the offshore berths. At the time of the implementation of the project, five tugs of various operational characteristics were engaged in the operation of the terminal.

The anticipated volume of garbage from the incoming oil tankers, estimated in accordance with the methodology described in detail in the paragraph 2.2.4 of this Report, is illustrated in the following table. The projection of the estimated volume in the future according to the methodology outlined in the paragraph 2.2.5 was not considered as necessary because of the almost constant, annual number of ships' calls.

Port: **Zawia oil terminal** **Country:** **Libya**				
▪ Estimated volume of ship-generated garbage				
Garbage	Domestic garbage	Maintenance waste	Cargo-associated waste	Total volume
Reduced weekly volume *(m^3/week)*	7.6	1.6	-	9.2
Average annual volume *(m^3/year)*	400.0	87.9	-	487.9
Maximum volume to be received per ship/arrival (m^3) *(only domestic and maintenance)*				< 6.0

Taking into account the above estimated volumes of garbage and the respective assessment of the existing availability of reception facilities carried out according to the methodology outlined in 3.2 paragraph of the Report, the following constitute a set of recommendations towards the improvement of the existing garbage collection practices and facilities at the terminal:

- The current Ballast Water Discharge Sheet should be modified, to offer the possibility to the Masters of the ships that call to the terminal to notify their needs to deliver garbage (kind and estimated volume).

- A responsible person from the terminal Services Dept. should be nominated to receive the abovementioned notification and respond accordingly, defining the time, place and other details of garbage collection. Record-keeping procedures should be also placed to systematically monitor and assess the needs of the ships and enable the traceability of garbage from the terminal to the final disposal site.

- A waste reception and storage barge should be provided in the area of the terminal to collect garbage upon request, from the tankers berthed to the available offshore moorings. Temporary storage can be made either to the clear weather deck of the barge or in standard, skip, open top containers of an approved type and design to prevent accidental leakage. The storage capacity should be not less than 6 cub. meters and it would be advisable that, separation of collected garbage in combustible, other hazardous and non-hazardous waste is effected onboard the barge.