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

ASSESSMENT OF THE EXISTING SITUATION AND NEEDS OF THE PORT OF AQABA, JORDAN REGARDING PORT RECEPTION FACILITIES FOR COLLECTING SHIP-GENERATED GARBAGE, BILGE WATER AND OILY WASTES

ACTIVITIES 1 & 2

COLLECTION AND TREATMENT OF SOLID AND LIQUID WASTES FROM SHIPS AND OILY BALLAST WATERS FROM TANKERS

FINAL REPORT

February 2004

ENVIRONMENTAL PROTECTION ENGINEERING S.A.

The present document and related study have been produced with the financial assistance of the Technical Co-operation Fund of the International Maritime Organisation (IMO) under Programme PG 616.

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1. General

1.1 Subject and scope of the Activities 1 & 2 of the project

The Activities 1 and 2 of the project "Assessment of the existing situation and needs of the port of Aqaba, Jordan, regarding 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, taking into consideration the type and capacity of existing installations and specific nature of traffic in the port of Aqaba as well as specific requirements resulting from such differences *(Activity 1),* and the identification of required capacities for collection and treatment of oily ballast waters from tankers *(Acitivity 2),* respectively.

It should be mentioned that the type of ship-generated wastes studied are these of oily ballast water from oil tankers, oily wastes from the machinery spaces and garbage from all ships. It was not possible due to the limited time of the above mentioned activities, that ballast water and washings from the carriage and handling of noxious liquid substances in bulk at the port, to be also included. The two days, facts finding mission to the port of Aqaba was carried out on the 17th and 18th November 2003, by the Consultant joined by Mr. Jonathan Pace, Programme Officer (Prevention) of REMPEC, the contribution of the latter was indispensable for the successful outcome of the mission and its follow up.

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 - unified interpretations and 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 means 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.

Oil tanker means a ship constructed or adapted primarily to carry oil in bulk in its cargo spaces and includes combination carriers and any chemical tanker when they carry a cargo or part of cargo of oil in bulk.

Clean Ballast means the ballast in a tank, which since oil was last carried therein, has been so cleaned that effluent therefrom, if it were discharged from a ship which is stationary into clean calm water on a clear day would not produce visible traces of oil on the surface of the water or on adjoining shorelines or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines. If the ballast is discharged through a type approved Oil Discharge Monitoring and Control System, evidence based on such a system to the effect that the oil content of the effluent did not exceed 15 parts per million shall be determinative that the ballast was clean, notwithstanding the presence of visible traces.

Segregated ballast means the ballast water introduced into a tank which is completely separated from the cargo oil and oil fuel system and which is permanently allocated to the carriage of ballast or cargoes other than oil or noxious substances.

Instantaneous rate of discharge of oil content means the rate of discharge of oil in litres per hour at any instant divided by the speed of the ship in knots at the same instant.

Slop tank means a tank specifically designated for the collection of tank drainings, tank washings and other oily mixtures.

New oil tanker means an oil tanker delivered, in practice, after 1/6/1982 or an oil tanker that has undergone a major conversion completed after the above mentioned date.

Crude oil tanker means an oil tanker engaged in the trade of carrying crude oil.

Product Carrier means an oil tanker engaged in the trade of carrying oil other than crude oil.

Red Sea area means the Red Sea proper including also the gulfs of Suez and Aqaba bounded at the south by the rhump line and seas between Ras si Ane and Husn Murad.

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

Cargo-associated wastes means 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 means 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 means 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 and Rules

2.1 Oily mixtures from the machinery spaces of ships

2.1.1. Criteria for discharging oily mixtures from the machinery spaces 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 Red 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.

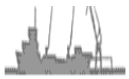
The oil residues which cannot be discharged into the sea in compliance with the abovementioned conditions shall be retained on board to be finally disposed of to available port reception facilities. The requirements that oil tankers and other ships should comply with, are presented schematically in the 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 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 port of Aqaba, 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 current 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 aluminium which is about half the weight of steel for equal strength in highspeed 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:

- 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 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.

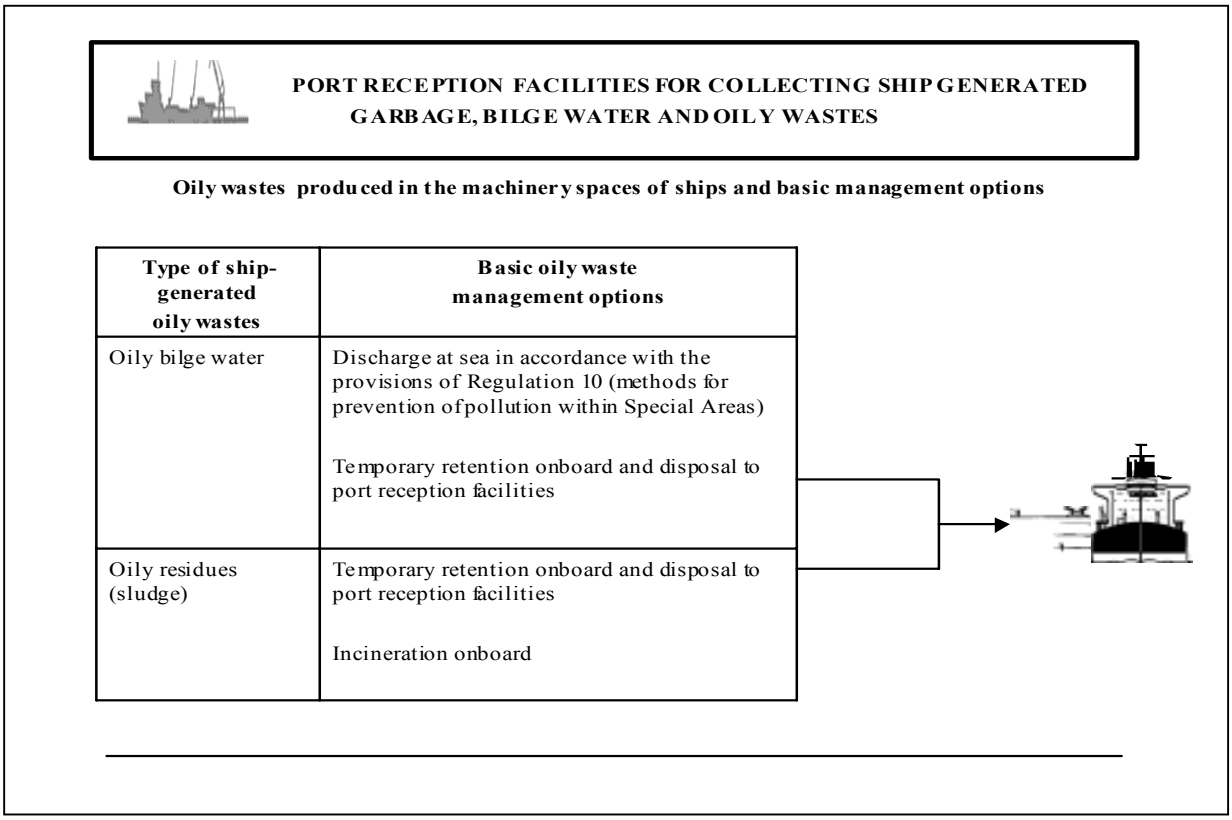
A bilge-water holding tank enable ships to operate safely during ports visits, during operation in special areas and coastal waters and during periods of maintenance of the oily water filtering equipment. It has also proved that a bilge-water holding tank also provides additional safeguards in the purification 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 port of Aqaba 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

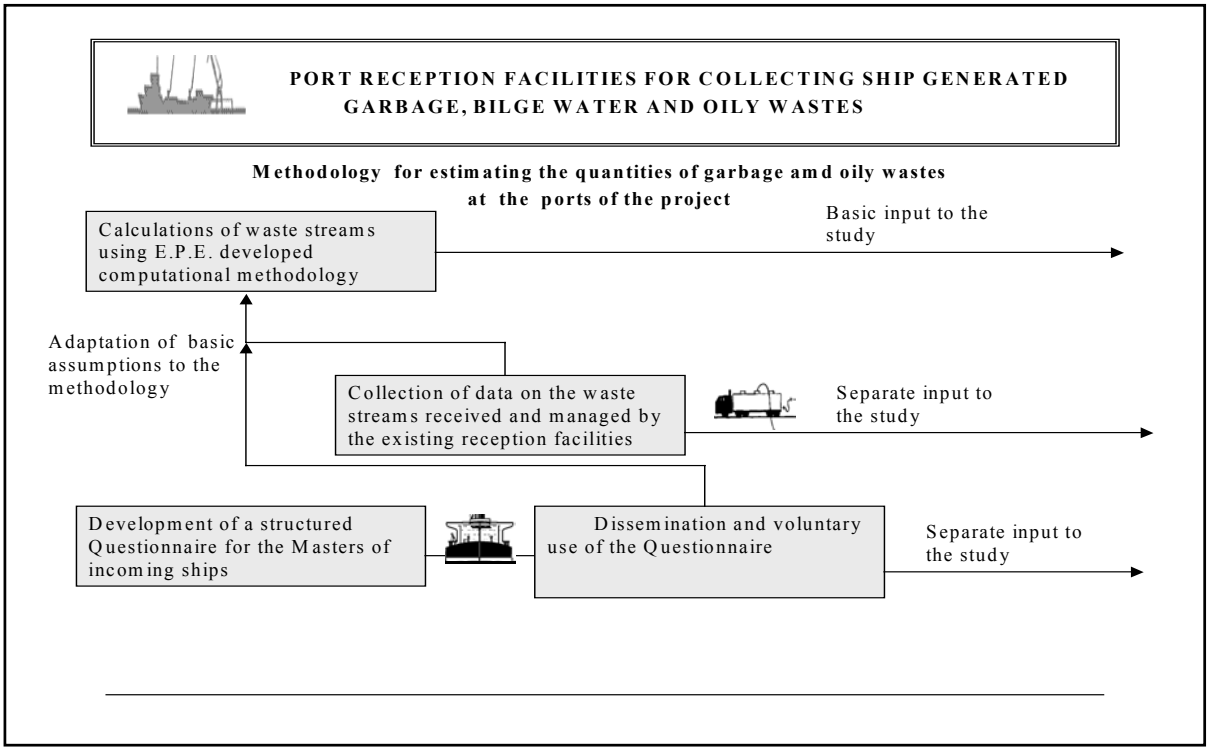
In estimating the quantities that are likely to be collected at the port of Aqaba, the following basic assumptions and criteria were used:

- The ships 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 port during the project. Apart from any necessary adaptations, data received either from the port authority, 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)

$\mathbf{N_1}$ = Number of ships calling at the port annually

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

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

$\mathbf{P_m}$ = 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 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 Ports Corporation 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 Oily water ballast from oil tankers

2.2.1 Criteria for discharging oily mixtures from cargo spaces of oil tankers at sea

Regulation 9 of Annex I of MARPOL 73/78 provides requirements with respect to the control of discharges of oily mixtures produced in the cargo and ballast areas of oil tankers. In principle, this kind of discharge is prohibited within the Red Sea area as a designated Special Area, except of clean or segregated ballast. In addition, outside Special Areas and at a specific distance from the coastline, oily mixtures from tankers proceeding en route, can be discharged at sea provided that:

(i) the instantaneous rate of discharge of oil content does not exceed 30 litres per nautical mile;

(ii) the total quantity of oil discharged into the sea does not exceed for existing tankers the 1/15,000 of the total quantity of the last cargo from which the residue formed a part, and for new tankers the 1/30,000 of the total quantity of the cargo respectively,

(iii) the tanker has in operation an oil discharge monitoring and control system as well as slop tank/s arrangements as required by the respective Annex I Regulations.

No discharge at sea shall contain chemicals or other substances in quantities or concentrations which are hazardous to the marine environment or similar substances introduced for the purpose of circumventing the conditions of discharge outlined above. The oily mixtures discharge criteria related with oil tankers engaged in voyages within and outside Special Areas are presented schematically into the next table:

Sea Areas		*Discharge Criteria*
Within a Special Area		No discharge except Clean or Segregated ballast
Outside a Special Area	Within 50 n.miles from the nearest coast	No discharge except Clean or Segregated ballast

	More than 50 n. miles from the nearest coast	No discharge except either: (a) of clean or segregated ballast (b) When: (1) the tanker is en route; and (2) the instantaneous rate of discharge of oil does not exceed 30 litres per nautical mile; and (3) the total quantity of oil discharged does not exceed 1/15.000 (for existing tankers) or 1/30.000 (for new tankers) of the total quantity of cargo which was carried on the previous voyage (4) the tanker has in operation an oil discharge monitoring and control system and slop tank arrangements

2.2.2 Applicable regulations dealing with Segregated Ballast Tanks and Double Hull arrangements for oil tankers

A summary of the requirements of Annex I, Regulations dealing with the segregated ballast tanks arrangements, as adopted by Resolution MEPC.52(32), before the adoption of the Resolution MEPC.95(46), on 27 April 2001 is illustrated in the next table:

Type of oil tanker	**Deadweight (t.dw.)**	**Time of delivery**	
		Before 1/ 6/1982	**After 1/6/1982**
Crude oil tanker	< 20.000	No any relevant requirements	No any relevant requirements but 13 F provides that all oil tankers of 600 t.dw and above delivered after 6/7/1996 should have hull spaces and tanks that can potentially take ballast water
Crude oil tanker	20.000 – 40.000	No any relevant requirements but in practice, due to the effect of Regulation 13G (4), this class of tankers, becomes PL/SBT tankers 25 years after delivery	Every tanker should be provided with segregated ballast tanks

	> 40.000	They should be provided with SBT, or they can operate with COW in accordance with Regulation 13B (similarly the abovementioned 13 G (4) Regulation applies)	Every tanker should be provided with segregated ballast tanks
Product Carrier	< 30.000	No any relevant requirements but in practice, due to the effect of Regulation 13G (4), this class of tankers, become PL/SBT tankers 25 years after delivery	No any relevant requirements but 13 F provides that all oil tankers of 600 t.dw and above delivered after 6/7/1996 should have hull spaces and tanks that can potentially take ballast water
	30.000 – 40.000	In practice, due to the effect of Regulation 13G (4), this class of tankers, become SBT tankers 25 years after delivery	Every tanker should be provided with segregated ballast tanks
	> 40.000	Alternatively of the provision of segregated ballast tanks, they can operate with dedicated clean ballast tanks in accordance with the requirements of 13 A Regulation (same effect of Regulation 13 G (4))	Every tanker should be provided with segregated ballast tanks

On crude oil tankers of 20.000 tons deadweight and above and product carriers of 30.000 tons deadweight and above, the aggregate capacity of wing tanks, double bottom tanks, forepeak tanks, and afterpeak tanks is required to be not less than the capacity of the segregated ballast tanks necessary to meet the requirements of the relevant Regulation 13 of the Annex I of MARPOL 73/78.

In addition wing tanks, or spaces and double bottoms tanks used to meet the requirements of the abovementioned Regulation shall be located as uniformly as practicable along the cargo tank length. Additional segregated ballast capacity provided for reducing longitudinal hull girder bending stress, trim, etc. may be located anywhere within the ship.

In April 2001, during the 46th session of the IMO Marine Environment Protection Committee, amendments to the 13 G Regulation of Annex I, were adopted which entered into force on the 1st September 2002. The impetus for the revision of the abovementioned Regulation was caused by the effects of the serious pollution that the total loss of the 23 year old product tanker

Erika in December 1999 caused, along with other subsequent casualties particularly in European waters. The new requirements are expected to have a dramatic impact on the world' tanker fleet since the adopted phase out criteria guide a significant number of oil tankers not only those built before 1982 (pre MARPOL tankers) but also new ships out of service.

For the purpose of the revised 13 G Regulation, oil tankers are classed into three categories, as follows:

- Category 1 oil tanker means an oil tanker of 20.000 tons deadweight and above carrying crude oil, fuel oil, heavy diesel oil or lubricating oil as cargo, and of 30.000 tons deadweight and above carrying oil other than the above, which does not comply with the requirements for new oil tankers as defined in Regulation 1(26) of Annex I.

- Category 2 oil tanker means an oil tanker of 20.000 tons deadweight and above carrying crude oil, fuel oil, heavy diesel oil or lubricating oil as cargo, and of 30.000 tons deadweight and above carrying oil other than the above, which complies with the requirements for new oil tankers as defined in the Regulation 1(26) of Annex I.

- Category 3 oil tanker means an oil tanker of 5.000 tons deadweight and above but less than the sizes previously mentioned.

Category 1 oil tankers

This category of oil tankers represent those, pre Protectively Located - SBT and non double hull oil tankers, which in practice, should be withdrawn by their anniversary date occurring between 2003 and 2007. Every oil tanker falling under this category, shall comply with the requirements of the Regulation 13 F of the Annex I, not later than the anniversary of the date of delivery of the ship in the year according to the following table:

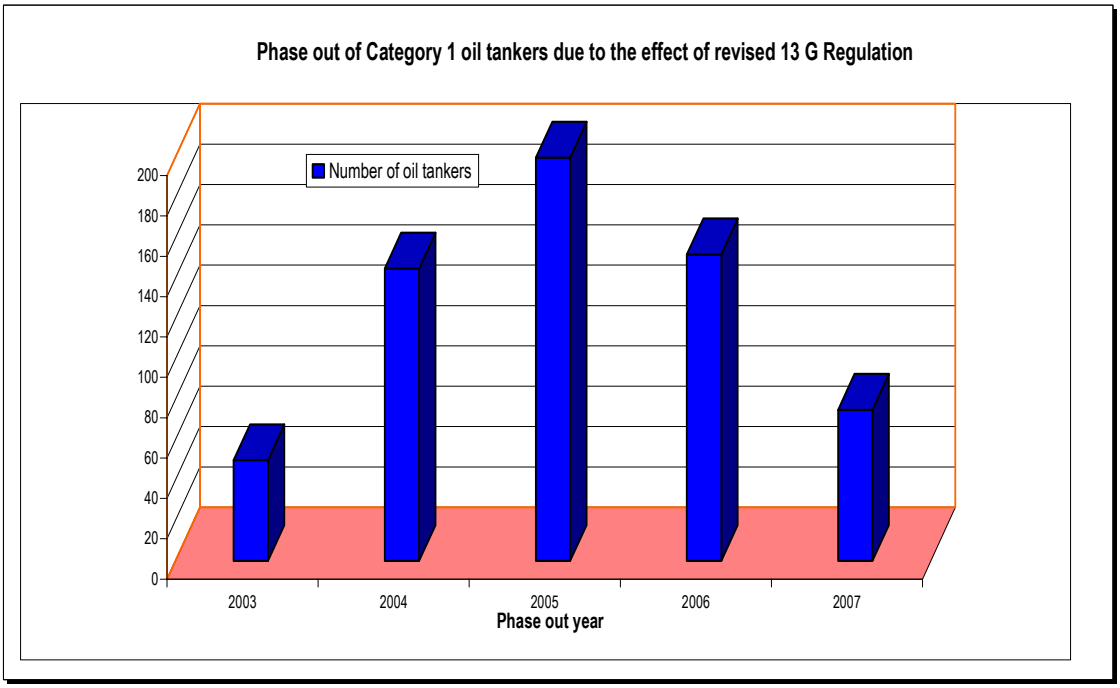
Category of oil tankers	Phase out Year
Category 1	2003 for ships delivered in 1973 or earlier 2004 for ships delivered in 1974 and 1975 2005* for ships delivered in 1976 and 1977 2006* for ships delivered in 1978, 1979 and 1980 2007* for ships delivered in 1981 or later
	* Subject to compliance with the Condition Assessment Scheme, in accordance with MEPC Resolution 94(46)

According to an INTERTANKO study, incorporated in an another study titled *"Oil Tanker Outlook, Assessing the impact of the revised IMO MARPOL 13G Phase out"* produced by ABS, it is estimated that about 600 oil tankers falling under the Category 1 representing in total 73 million tons deadweight, will be phased out between 2003 and 2007, reflecting the combined impact of

the remnants of the 1970s VLCC fleet and a large number of pre-MARPOL product tankers.

The obvious impact of the revised 13 G to the non SBT oil tankers is the accelerated schedule of their compliance with the requirements of 13 F, since the option to extent the time period for complying with 13 F up to 30 years after the date of delivery (provided that wing tanks or double bottoms not used for the carriage of oil, covering 30% of the side or the bottom) is lost and thus the 2007 year is determined as a key date where the presence of this size non-SBT tankers is fully eliminated.

The following graph shows the number of Category 1 oil tankers phased out in the period between 2003 and 2007.



Category 3 oil tankers (oil tankers of 5.000 t.dw and above but less than 20.000 t.dw)

Taking into account the 13F (2) Regulation, every new oil tanker of 5.000 tons deadweight and above has been provided with the following alternative structural and operational choices to comply with the requirements aimed at the prevention of oil pollution in the event of collision or stranding:

- Segregated ballast tanks and spaces other than oil tanks within the cargo tank length to be arranged as to comply with specific requirements,

- The entire cargo tank length to be protected by ballast tanks or spaces other than cargo and fuel oil tanks (double hull requirements),

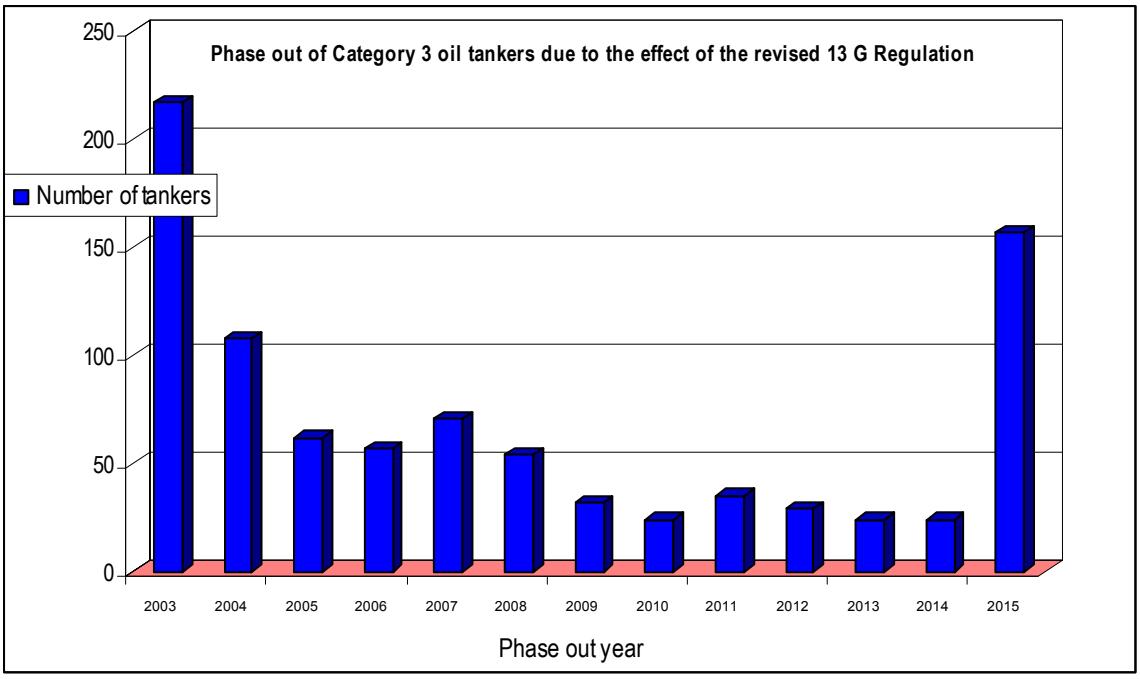
- Other methods of design and construction accepted as alternatives including hydrostatic ballast loading that ensure at least the same level of protection against oil pollution in the event of collision or stranding.

Since through the Resolution MEPC.52(32) adopted on 6 March 1992, the new Regulations 13 F and G entered into force on 6 July 1993, it is concluded that while the new oil tankers more than 5.000 tdw but less than 20.000 tdw, are built and operated with arrangements for segregated ballast tanks, the existing oil tankers of this size should comply due to the effect of the revised 13 G with the abovementioned requirements not later than their 26th anniversary date, effective from 2003 forward.

Phase out by Anniversary of delivery date in	**Year of delivery**	**Tanker age**
2003	earlier than and including 1973	30
2004	1974 – 1975	30 – 29
2005	1976 – 1977	29 – 28
2006	1978 – 1979	28 – 27 – 26
2007	1980 – 1981	27 – 26
2008	1982	26
2009	1983	26
2010	1984	26
2011	1985	26
2012	1986	26
2013	1987	26

2014	1988	26
2015	later than and including 1989	26 – 19

The most important peaks in the abovementioned phase out coincide with the beginning and end of the whole period when a large number of oil tankers that do not meet the double hull standards will be forced out of service. In 2003 and 2015 respectively, 217 and 157 of these tankers will have to be withdrawn. The impact of phase out to the small tankers which most of them are product carriers of between 5.000 and 20.000 tons deadweight is considered as significant due to the large number of these tankers. It can be projected that by 2007 (which was the beginning of the phase out process of the previous 13 G Regulation) 515 oil tankers of this size should be withdrawn.



2.2.3 Dirty ballast and other oily mixtures produced from oil tankers

The Activity 2 of the project is concerned with the dirty ballast from tankers, however it was considered as advisable to incorporate in this Report, tank washings and other oily mixtures and residues produced in areas other than the machinery spaces of tankers for the following two reasons:

1. Due to the already significant decrease of non SBT tankers and the anticipated dramatic decline in the future, the potential quantity of dirty ballast to be received at the oil loading terminals in the Red Sea area is expected to be minimized, therefore the next most important - in terms of quantity - oily mixtures are tank washings collected in the nominated slop tanks or other shipboard areas (1.5 - 8 % of tankers deadweight).
2. MARPOL 73/78 Regulations related with the reception facilities in oil terminals and ports, provide in practice, that these facilities should be capable to receive all oily wastes including - apart dirty ballast and tank washings - oily wastes from the machinery spaces of ships. Calculations of dirty ballast and tank washings waste streams for each port and oil terminal, have been made also in this Report for the other two oily wastes streams (oil residues and oily bilge water).

IMO has provided guidelines for estimating the quantities of oily wastes in general, which would be required to be retained on board and discharged to reception facilities within the constraints of the:

- origin of oily wastes or residues;
- ship type and design;
- ship operating route; and
- the various types of ports and terminals required to provide reception facilities to ships.

Dirty ballast water can not be discharged to the sea at oil terminals, while discharge of clean ballast might be carried out provided that local or national regulations allow this operation, usually under control and supervision.

The discharge of the bulk of the settled dirty ballast is characterized by a high flow rate, large in quantity but of low oil content. Oil content is typically (during for instance discharge in good weather outside a Special Area) around 30 ppm but higher oil content may be expected if there is substantial ship movement and disturbance of the water - oil interface.

The amount of dirty ballast aboard a tanker on arrival in the appropriate categories will vary from ship to ship and also with weather conditions. Generally, the total ballast weight on average might exceed 30 per cent of deadweight. Invariably, oil tankers arriving with dirty ballast may also have on board tank washings from tank cleaning performed en route which needs to be received ashore in any available reception facilities.

According to CONCAWE (the Oil Companies European Organization for Environment, Health and Safety, October 2000 Review), during studies focused on the emissions control at marine terminals, data from seven terminals indicated that in 1999, the share of involvement of non-SBT tankers in the loading operations of oil, in particular volatile products was less than 20%. Other studies mentioned therein, showed a gradual downward trend in the use of non-SBT tankers from 45 per cent in 1993 to 13 per cent in 1999.

Oily mixtures accumulated in slop tanks (the content of which is not allowed to be discharged within the Red Sea area), are produced basically during the following operations:

- Washing of cargo tanks in crude oil tankers before loading ballast or in product carriers before changing the type of cargo. Crude oil washing has significantly reduced the amount of water needed for washing of cargo tanks required for clean ballast or not. If crude oil washing is undertaken in all tanks during the cargo discharge immediately prior to entering a ship repairing yard for repairs, the total quantity of slops and sludge for disposal at the tank cleaning berth will be substantially reduced.

- Drainage and stripping of the cargo pumping system, flushing of cargo lines and pumps, stripping of oil residues of dirty ballast to slop tanks. The discharge of the bulk of settled water from a slop tank is characterized by a moderate discharge rate and oil content which could be typically around 150 ppm while the slow discharge (outside Special Areas) of slop tank water as the oil-water interface approaches the tank suction is characterized by very slow discharge rate but usually of a higher oil content, on average 500 ppm which can rise more during the discharge.

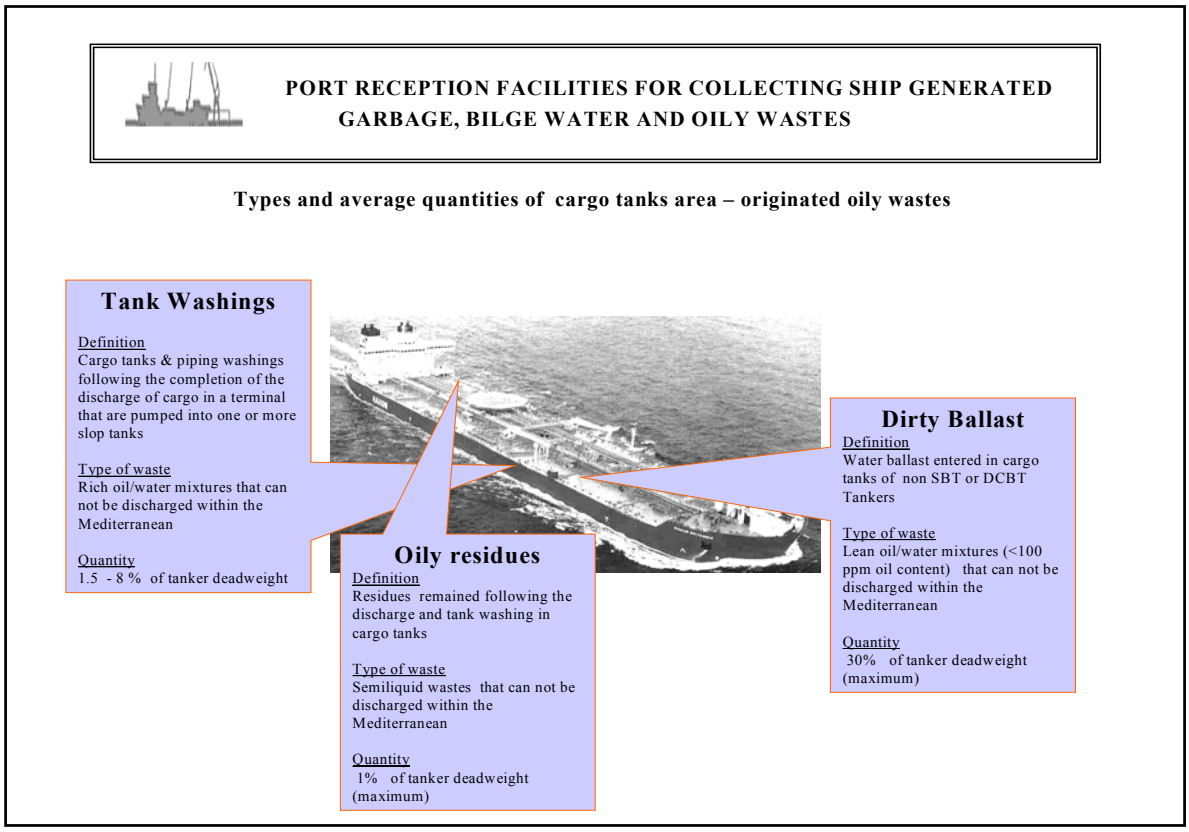
The wash water quantity, however, will be small in comparison with the quantity of dirty ballast (probably less than 5 per cent).

Retention of oil onboard requirements, 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 slop tank or a combination of slop tanks.

The arrangement of the slop tank or tanks (new oil tankers of 70.000 t.dw and above are provided with at least two tanks) shall have a capacity necessary to retain slops generated by tank washings, oil residues, and dirty ballast residues.

The total capacity of the slop tank/s shall not be less than 3% of the oil carrying capacity of the oil tankers. However, the abovementioned capacity can be reduced up to 1.5 % for oil tankers and 1% for combination carries provided that specific conditions apply accepted by the Flag State Administration of ships.

The different oily wastes from the cargo areas of oil tankers are shown schematically below:



While, in general, a tank, the content of which has been discharged to a terminal, should be washed and all contaminated washings should be discharged to a reception facility before the ship leaves the port of discharge for another port, however there are some exceptions from this rule such as:

1. The tanks that are discharged are to be reloaded with the same substance or another substance compatible with the previous one and that the tanker will not be washed or ballasted prior to loading,

2. The tanks that are discharged are neither washed or ballasted at sea if the tanker is about to proceed to another port unless it has been confirmed in writing that a reception facility at that port is available and adequate for the purpose of receiving the residues and solvents necessary for the cleaning operations.

For many of 25 year old and older pre-MARPOL tankers, the most attractive option for meeting the requirements of Regulation 13G is to utilise Hydrostatically Balanced Loading. It's estimated that this kind of option to comply with the requirements of the abovementioned Regulation, was of preference for most of the tankers over 50.000 t.dw. currently operating worldwide.

It should be noted that according to OCIMF (Oil Companies International Forum), the application of the Hydrostatically Balanced Loading process to a tanker engaged in performing multi port operations, requires that tanks

covering at least 30% of the side of the length of the cargo section should remain empty until the last loading location or they should be unloaded at the first discharge port. The result of the condition of a tanker in ballast upon its arrival at a loading oil terminal is the need for a distribution of ballast in such a way to enable the centre tanks and some of the wing tanks to be loaded first.

Consequently, clean ballast should be loaded to wing tanks, which have a higher percentage of shadow sectors which make them more difficult to clean to enable clean ballast to be hosted into them and due to the greater surface area to tank volume ratio, generation of bigger quantities of oil slops would be produced at the end of tank washing, that should be retained onboard and discharged to a suitable reception facility. Oil tankers which are not provided with segregated or dedicated ballast tanks, carry dirty ballast water during voyage without cargo, which corresponds to about 25% of the deadweight, however during adverse weather conditions, additional ballast up to 10 - 15% of the deadweight may be required (a 30% of the deadweight factor was considered as a safe margin for the abovementioned cases). Although uptake of water ballast in cargo tanks of SBT tankers can not be excluded in similar weather and sea state conditions, the respective column in the following table it was intentionally left without any entry.

In the following table, a synopsis of the quantities of dirty ballast, tank washings and other oily residues produced from cargo and ballast operations in oil tankers is illustrated.

Types and quantities of oily mixtures generated from cargo and ballast operations on oil tankers at oil terminals

Type of oil mixtures and residues	Oil contaminated ballast (dirty ballast)	Tank Washings	Oil Residues
	Loading Terminals, Ship-repairing Ports & Tank Cleaning Facilities	Loading Terminals, Ship-repairing Ports & Tank Cleaning Facilities	Loading Terminals, Ship-repairing Ports & Tank Cleaning Facilities
Crude oil tankers	30% of Dwt for non-SBT oil tankers	1.5 - 8 % of Dwt The minimum quantity is related to tankers performing tank cleaning en route to the terminal and arriving with washings wholly accumulated in the slop tanks	1 % of Dwt
Product Carriers	30% of Dwt for non-SBT oil tankers	1.5 - 8 % of Dwt The minimum quantity is related to tankers performing tank cleaning en route to the terminal and arriving with washings wholly accumulated in the slop tanks	0.5 % of Dwt for black oil products 0.1 % of Dwt for white oil products

The basic formulas used, before any adaptations as explained earlier, in estimating the different oily wastestreams are provided below:

$$\mathbf{D_b = \frac{0.3 \times N_t}{365} \times D_m} \text{ (tons)}$$

D_b = Reduced daily quantity of dirty ballast (tons)

N_t = Average annual number of oil tankers calling at the terminal

D_m = Maximum permissible deadweight of non-SBT oil tankers at the terminal (tons)

$$\mathbf{T_w = \frac{C_t \times N_t}{365} \times D_m \text{ (tons)}}$$

where

T_w = Reduced daily quantity of tank washings (tons)

N_t = Average annual number of oil tankers calling at the terminal

D_m = Maximum permissible deadweight of oil tankers at the terminal (tons)

C_t = Tank washings Coefficient factor varying from 0.015 – 0.08

$$\mathbf{O_w = \frac{C_r \times N_t}{365} \times D_m \text{ (tons)}}$$

where

O_w = Reduced daily quantity of oily liquid residues (tons)

N_t = Average annual number of oil tankers calling at the terminal

D_m = Maximum permissible deadweight of oil tankers at the tank cleaning facility or ship - repairing port (tons)

C_r = Oily residues Coefficient factor varying from 0.001 – 0.01

2.3 Ship – generated garbage

2.3.1 Criteria for discharging garbage from ships into the Red 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.

2.3.2 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.

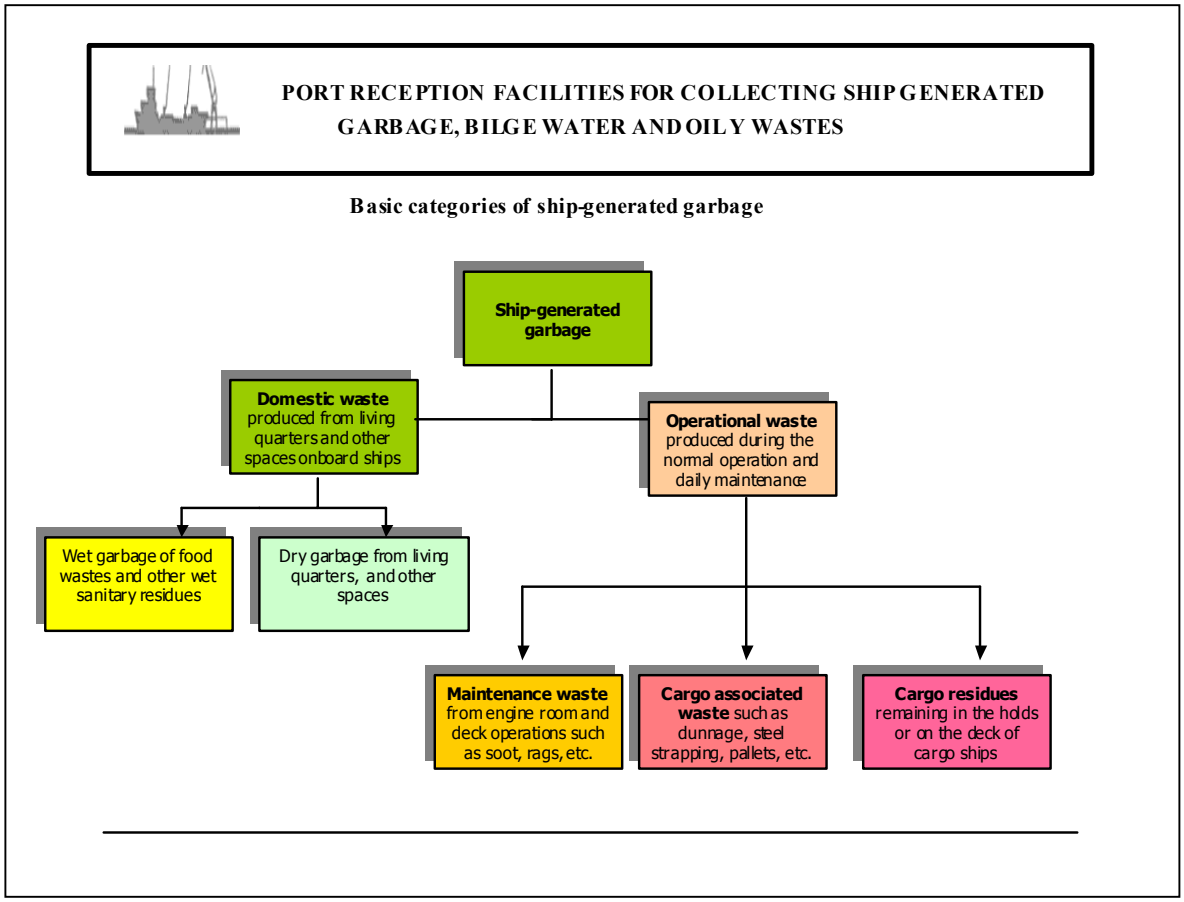
2.3.3 Ship – generated garbage and current management practices onboard ships

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 containerisation 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.

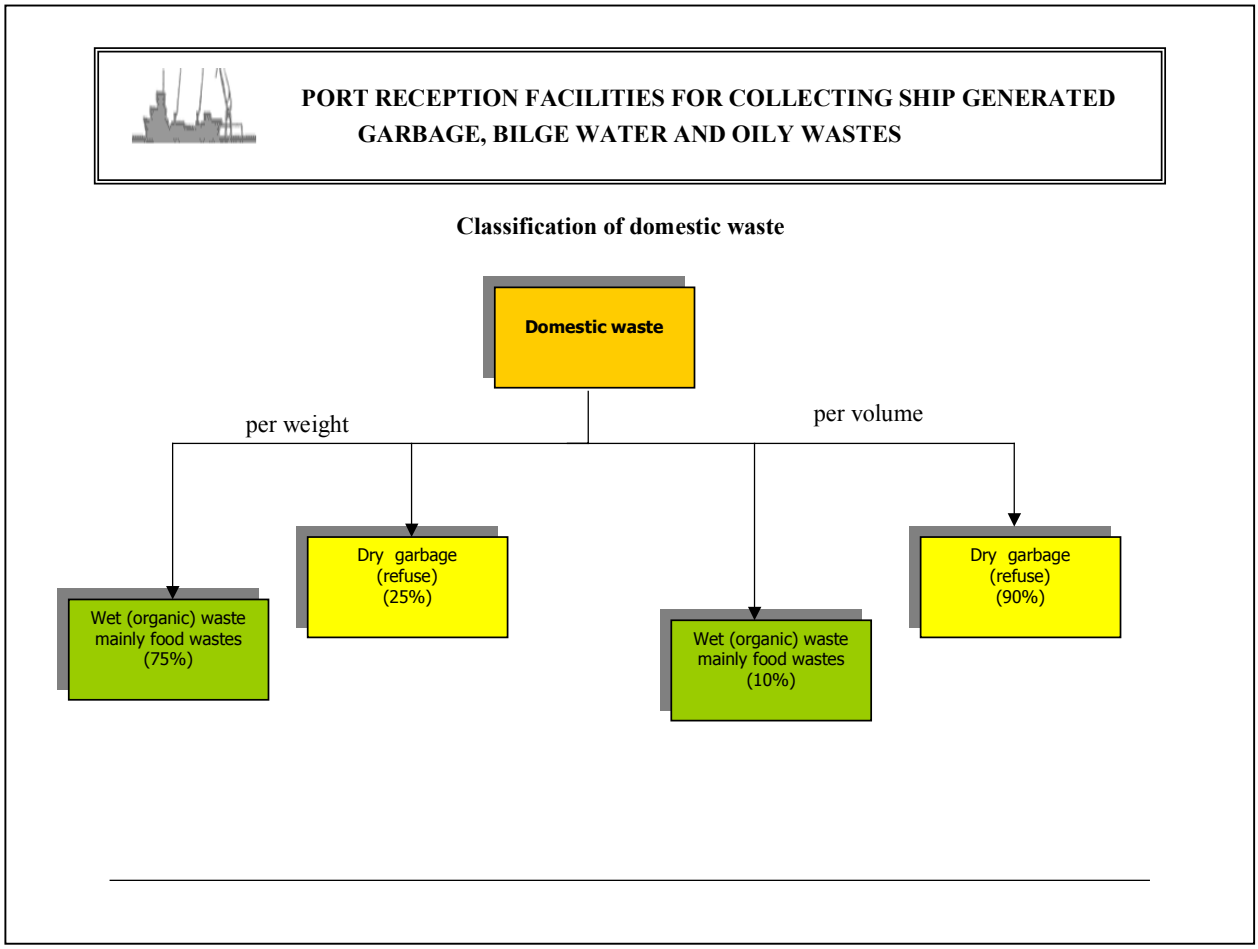
A variety of works carried out onboard ships normally, such as cleaning of boilers, tanks, decks and platforms result in the production of maintenance wastes, the quantity of which that can be accumulated on a large sea-going ship could exceed 20 kgs daily.

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.



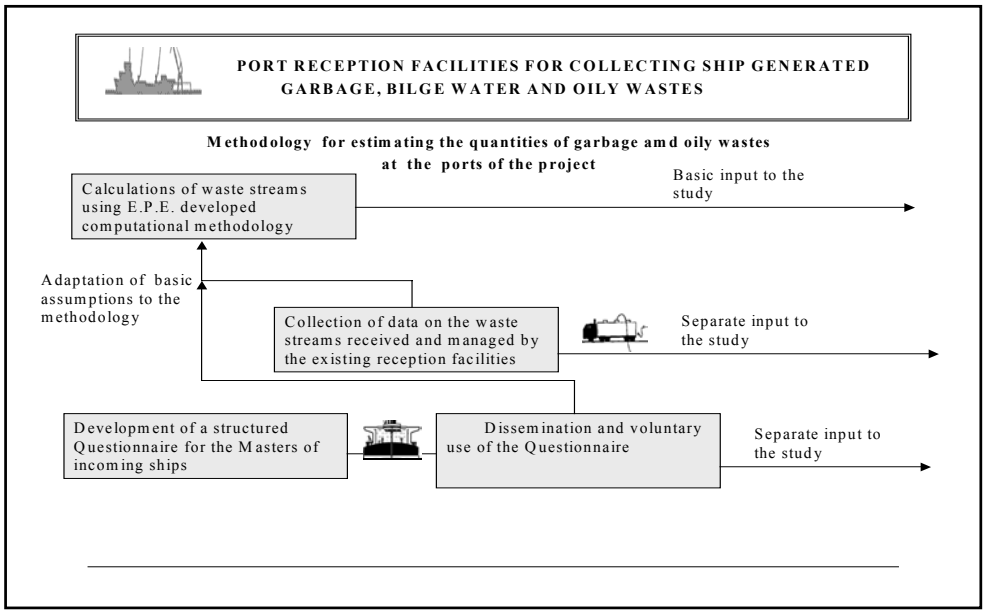
The following table provides an arbitrary estimate of cargo associated waste per kind of cargo handled in a port.

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

2.3.4 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 port of Aqaba take the necessary 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 a Special Area.
- 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 the Masters of ships that happened to call to the port of Aqaba. Apart from any necessary adaptation, data received either from the Ports Corporation 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

$$G_C = C_B + C_D + C_C$$

where:

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

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

1 / 123 = break bulk cargo waste generation factor;

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

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;

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

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

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

2.3.5 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 the port (as estimated from the last three years period data).

The projection of volumes of wastes that could be collected 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* (Ti means 2004, 2005 and 2006 years).

(W_{bs}) is the baseline estimate of both oily wastes and garbage streams which is also considered as identical for 2003.

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.

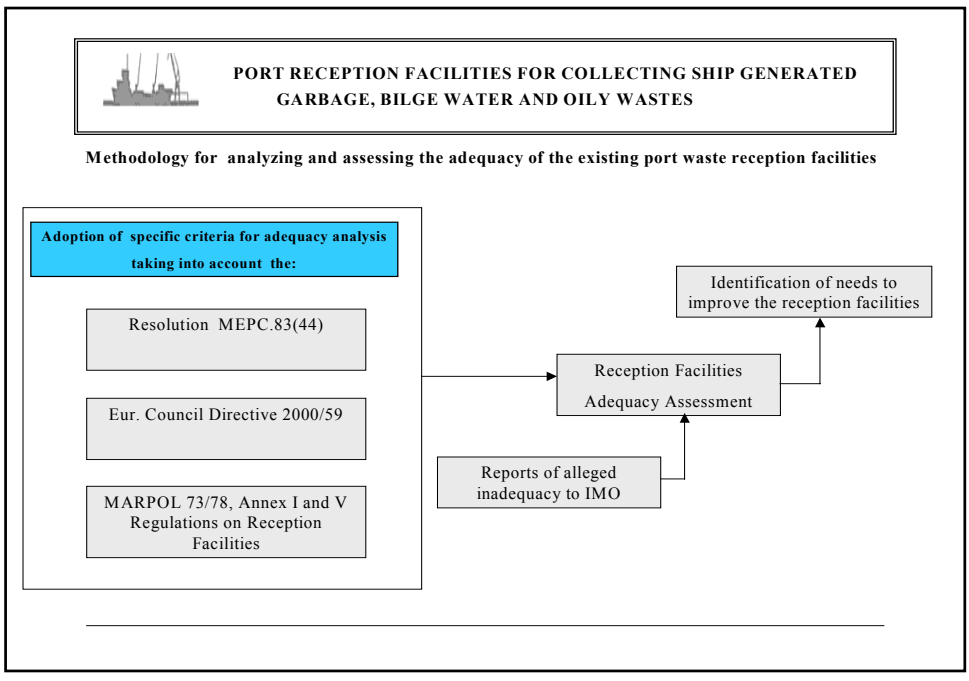
3. Methodology

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 the 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, as well as from other sources.

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

It should be explained that although facilities for collecting garbage from ships are available in the port of Aqaba, the methodology described here, (initially developed by the Consultant, for the scope of a similar project, - MED. B7.4100.97.0415.8 - implemented in 10 Mediterranean Countries within the framework of the Euro-Mediterranean Partnership) has been extracted here to provide a tool for the responsible bodies of Jordan to systematically assess and verify the adequacy of the facilities for almost any type of pollutant as per the requirements of MARPOL 73/78. 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 survey and data collection phase, taking also into account the preceding preparatory work. 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.

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.

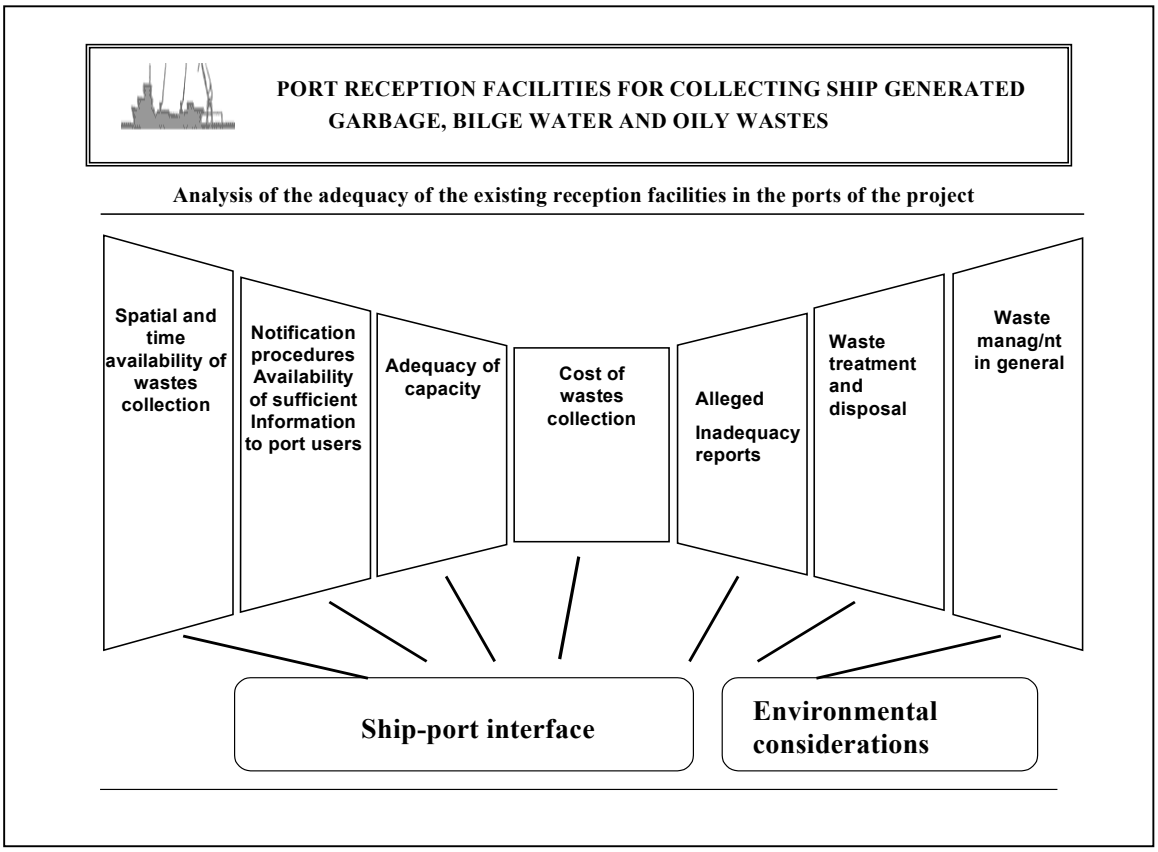
The first set provides a series of criteria emphasizing on the operational needs of ships normally calling at the port of the project. There is no doubt that a port to become successful and adequate in providing reception facilities for ship-generated waste, should have regard to the operational

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 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.

- **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. Under 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, 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 port, 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 the Port Authority 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. Oily wastes reception in several ports and oil terminals is 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.

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, is 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.

- **Waste final disposal and valorisation**

Since, disposal of wastes collected from ships is an integral component of the entire waste management system, 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. 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 is 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 majority of the ports 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 are 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,

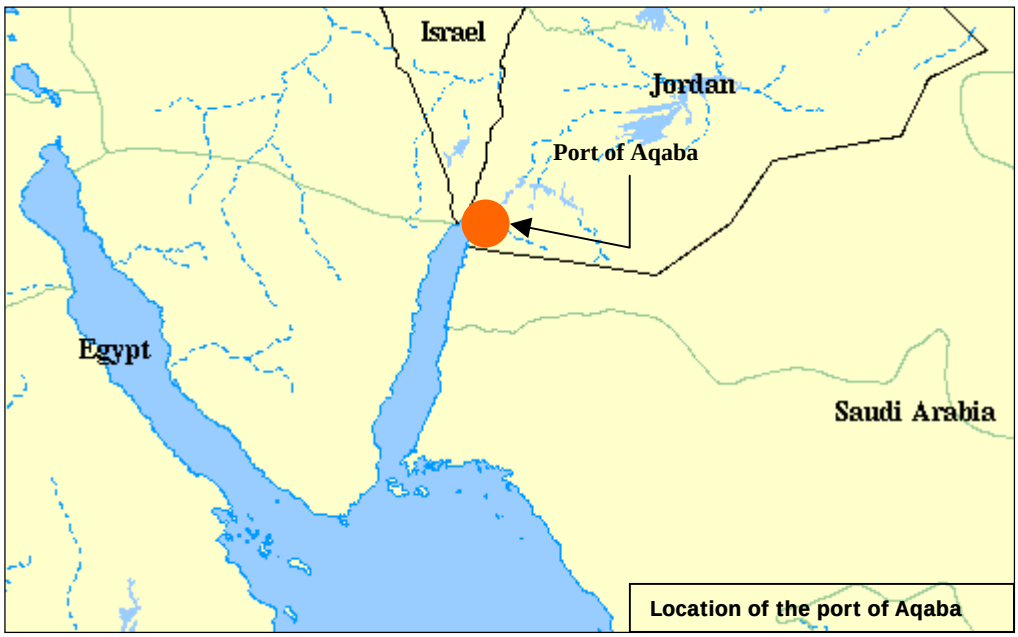
Procedures for enabling the traceability of wastes collected from the area of their reception to their final disposal site.

The European 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 of Results & Recommendations

4.1 Introduction

Jordan's gulf of Aqaba has a coastline about 27 kilometers long, within which, the country's sole port and other industrial facilities including power plants, a well developing tourism industry and the residential and commercial areas on the north eastern area, exist sharing a particularly, sensitive marine ecosystem. The operation of the port, stretching almost on the 30% of the above mentioned coastline represents an integral component of the national economic life and development enabling the exporting activities of the industry, in particular of the fertilizers and minerals processing industry. Growing into a significant, regional maritime centre under the management of the dynamic Ports Corporation and the strategic planning of ASEZA, the port area fosters the efforts of the local industry to increase the production levels, while at the same time it is given particular attention for the preservation of the quality of its land-based and marine environment.



Two major stakeholders for the land planning and management of the wider port area and the development of the maritime sector in the country, ASEZA and the Jordan Maritime Authority respectively, have emerged quite recently.

On January 2001, the government of Jordan established the Aqaba Special Economic Zone (ASEZA) as a low tax, duty free and multi sectoral development area with the objective to transform the region of Aqaba into an engine of economic growth through the introduction of a modern, drastic and simplified business environment able to attract the private sector initiatives and investments. The whole area stretches to a 375 kms surface, with the port facilities having a vital role in enabling transport of raw materials, ready products and energy in the form of either liquified natural gas and fuel oil, in providing berthing and storage infrastructure and hosting dedicated terminals.

The Jordan Maritime Authority, founded recently, as the responsible body of the Ministry of Transport with the task to regulate, control and develop the maritime sector of the country. In particular, the Authority has been given the mandate to deal with the registration of ships under the Jordanian Flag, their survey and certification according to the international, statutory requirements, the control of navigation in the country's marine territory, the development of SAR operations, etc.

The Authority constantly takes part in the IMO activities and meetings, being already a Party to a number of International Conventions and other Regional Treaties. The Ports Corporation is responsible for the construction, operation and maintenance of port related facilities in Aqaba, the safety of ships' operation in the port area but also the control of incoming ships in complying with the international, maritime safety rules and regulations.

4.2 Environmental impact from the establishment and operation of port reception facilities

Jordan has not ratified yet the International Convention of MARPOL 73/78 dealing with the prevention of ship-generated marine pollution. The Annexes of the Convention in relation with the requirements on the provision of port reception facilities are indicated in the following table:

MARPOL 73/78 Annex	Kind of pollutant	Entry into force internationally	Requirement for provision of Reception Facilities according to MARPOL 73/78
I	***Oil***	✔	✔
II	Noxious Liquid Substances in bulk	✔	✔
III	Harmful Substances in packaged form	✔	***X***
IV	Sewage	✔	✔
V	***Garbage***	✔	✔
VI	Air emissions	***X***	✔

From the discussions held with the representatives of the Jordan Maritime Authority, ASEZA and the Ports Corporation during the mission in the port, it was made clear that the reluctance shown towards the ratification of MARPOL 73/78 is strongly related to the Convention's requirements on port reception facilities and to the wrong perception which existed in the past that the operation of reception facilities might have a negative impact to the local, marine environment.

From clearly an environmental point of view, the establishment and operation of facilities for collecting and treating oily wastes, garbage and other pollutants from

ships which call at the port of Aqaba, provides a fundamental means for discouraging ships to cause illicit discharges at sea in the absence of proper port infrastructure to receive wastes and cargo residues retained onboard. An operationally reliable, economically fair to its users and well organized waste collection system has proved to be essential for the improvement of the environmental conditions in busy commercial ports similar to Aqaba in terms of physical scale, diversity of terminals and traffic. It should be stated that ASEZA's environmental impact assessment regulations can quarantee the use of the best available techniques, strict monitoring of the performance of collection and treatment activities and an effective integrated waste management system commensurate to the targets set for the protection of the land-based and the marine environment.

Counting in the benefits shared from the synergy of the implementation of MARPOL 73/78 (in particular at a time when the immediate phase out of pre-MARPOL tankers, the recent entry of the Annex IV into force, etc. take place) and the establishment of reception facilities in the port of Aqaba, it could be stated that the timing for the government of the country is ideal to take all necessary steps to ratify the Convention by studying in detail and planning what the port of Aqaba should provide to meet the needs of ships it normally accommodates.

4.3 Type and operation of the port

The port is located on the north coast of the Gulf of Aqaba at 29^0 31'N, 35^0 01'E consisting of three separate zones, the Main Port Zone, the Container and the Industrial Port Zone including also an extensive, designated anchorage area suitable for ships engaged in cargo lightering and transfer operations as well as for those waiting orders. The type of operation of the port is indicated in the following table:

Port		**Oil Terminal**					
		Crude oil		Oil Products		Fuel oil fired power plant	Other facility
Commercial Port	Port with major ship - repairing and/or tank cleaning facilities	Loading terminal	Unloading terminal	Loading terminal	Unloading terminal		
✔		*1	✔	*1	✔	*2	

*1 *The oil terminal at the industrial port zone, is not presently used as a crude oil exporting facility, but it is likely to resume operations as such for truck transported Iraqi crude oil. In parallel, only minor quantities of marine fuel oil are currently loaded to ships in the Main port.*

*2 *A new LNG fired power plant has recently replaced the fuel oil one.*

The Main Port Zone which is situated near to the town of Aqaba provides 10 nominal berths stretching at 2.050 meters long quays, used for accommodating general cargo ships and bulk carriers engaged in handling grain, phosphate, general cargoes, etc. Among them, there are six, deep water berths, 1060 meters long allocated to accommodate ships up to 70.000 tdw, three other with an average

length of 150 meters to accommodate basically general cargo ships up to 3.000 tdw, a quay used by lighter cargo ships and other small craft including a repairing and maintenance zone with a 300 tons slipway and its associated facilities. In addition, within the Main Port, two dedicated terminals, the phosphate berths A and B, 220 and 180 meters long respectively also operate, where mainly phosphate, vegetable oils and marine fuel oils are handled at the first and phosphates in bulk and other cargoes in packaged form at the second.

Photo.1 View of the terminals in the Main Port

Photo.2 View of the oil jetty at the Industrial Port

It should be noted that vegetable oils are discharged through the berth and its piping to a nearby, 5.000 tons storage capacity tank farm while bunkering can also take place upon request.

The berthing capacity of the main port zone is summarized below:

Berths	Berth length (m)	Ships' permissible displacement (tons)	Ships' permissible draft (meters)
1	160	70.000	11.0
2	180	45.000	10.0
3 – 6	180	53.000	11.5 – 13.0
7	150	14.000	8.0
8 – 9	150	5.000	5.4 - 5.8
10	210	3.000	4.0
Phosphate A	220	25.000	11.0
Phosphate B	180	125.000	14.4

It should be mentioned that the recent Master Plan of the port, provides for the relocation of the facilities established in the Main Port to the southern Container or the Industrial Port, aimed at allowing the development of cargo free, significantly less polluting, urban and tourism activities, which will be enabled also with the operation of cruise and passenger ships facilities.

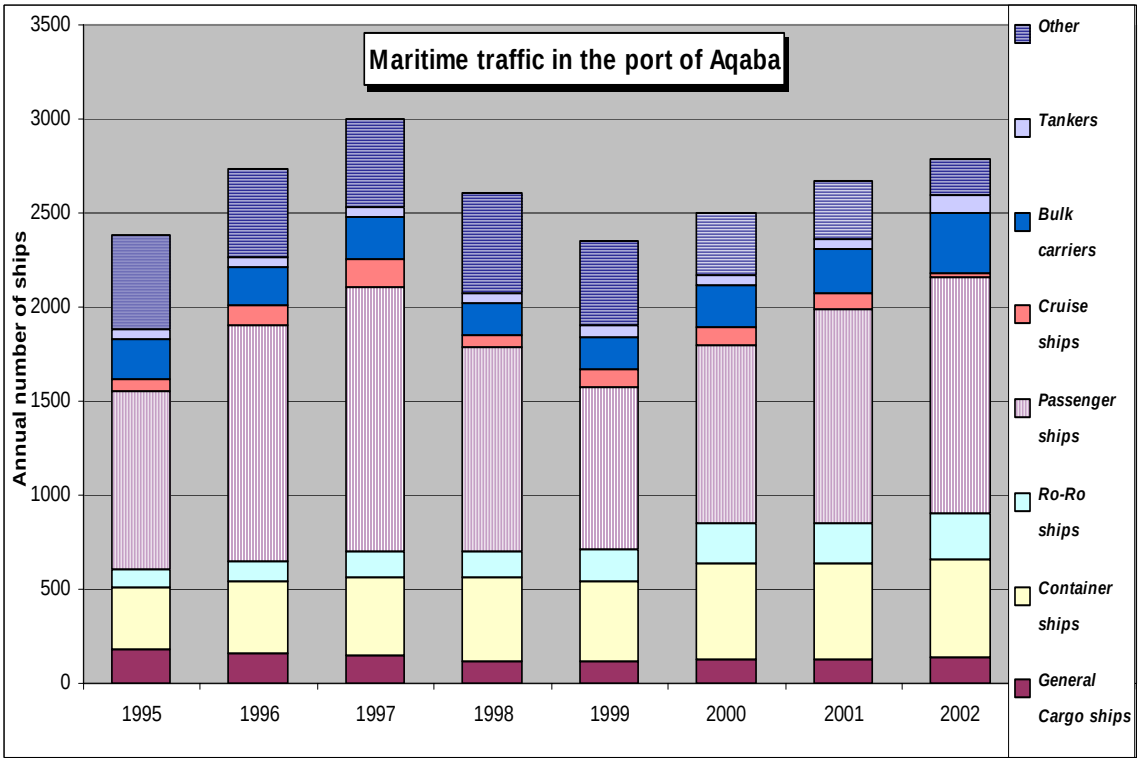
The materialization of the abovementioned component of the Master Plan would definitely have an impact to the ship-generated wastestreams flows, in case that ASEZA and the Authority of the port proceed to establish and operate reception and treatment facilities.

The Container Port Zone, situated about 5 kms from the area of the Main port, provides three berths with a total length of 540 meters at which ships up to 55.000 t.dw can be accommodated. Containers' handling is carried out by means of three 40 – 45 tons gantry cranes and other related equipment. Another berth is allocated for handling Ro-Ro ships up to 35.000 d.wt, two more dedicated to facilitate the operation of the adjacent rice processing plant and cement factory while Yarmouk berth is engaged in passenger traffic.

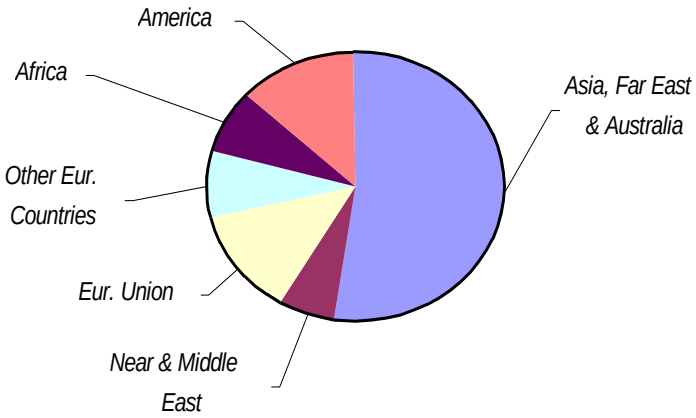
The Industrial Port Zone is located 18 kms south of the Main Port consisting of a 24 meters deep oil jetty where oil tankers of up to 406.000 dwt can be accommodated, a 80 meters long and 7 meters deep timber berth used mainly for handling timber, a twin berth serving the needs of the nearby operated Jordan Fertilizer Industry Plant at the western part of which, potash, sulphur and other dry bulk cargoes are handled while at the eastern one, ammonia, chemicals in bulk and packaged form and fertilizers are mainly handled.

Dry bulk is the predominant type of cargo handled in the port (60% of the total), featuring an average, annual throughput of about 6 million tons.

The maritime traffic and its break down to principal types of ships in the 1995 – 2002 period is illustrated below, while a diagram demonstrating that the location of the port privileges the cargo exchange with ports in Asia, Far East and Australia (while cargo carried by sea from and to the European Union and Americas areas accounts for 12.9% and 12.7% respectively), is shown next:



Cargo flow pattern from / to the port of Aqaba



4.4 Needs for the provision of reception facilities

4.4.1 Oily water ballast from tankers

Jordan, in the absence of significant oil resources at its territory, relies on the crude oil supplies from Iraq to operate its refinery at Zarqa and the production of oil products for domestic distribution and exports, the standing agreement of which with its neighbouring country was renewed on December 2002. It should be noted, that although at present, there is no crude oil exporting activity from the port of Aqaba, the strategic location of the port could offer alternative sea routes, the examination of which in terms of the future needs for the provision of reception facilities for dirty ballast and tank washings from tankers, at least in the framework of this short project, was not feasible.

Unloading operations of crude oil via the oil jetty located in the Industrial Port Zone to the nearby tank farm that is operated by the Jordan Petroleum Refinery Company with final destination its refinery in Zarqa, restarted at the end of the first half of November 2003.

Crude oil handling in the port is exclusively carried out at the Oil Jetty in the Industrial Port Zone, which constitutes a four dolphin berth connected to the shore by a 150 meters long approach arm, able to accommodate up to 406.000 tdw oil tankers, 370 meters long with 24 meters draft. To increase the storage capacity of the 73.000 tons crude oil tank farm, the Government has hired a 290.000 tdw crude oil tanker to operate as a Floating Storage Unit which is currently berthed alongside the jetty, through which crude oil is temporary stored and transferred to the tank farm for further transportation to the refinery in Zarqa. A large number of road tankers are daily engaged in transporting crude oil to the refinery. A summary of the particulars of the crude oil tanker *Jerash,* is provided below:

Port of Registry	Aqaba
Gross Tonnage	137.227 grt
Deadweight	289.980 tdw
Length B.P.	331.31 meters
Number of slop tanks	2
Capacity of slop tanks	20.159 cub. meters
Number of sludge and waste oil holding tanks	2
Capacity of sludge and waste oils tanks	22 cubic meters

The tanker is a pre PL-SBT MARPOL tanker which is required to comply with Regulation 13F of Annex I of the Convention not later than the 28th-2-2005, supplied with crude oil washing system and a 2.5 cub. meters/hour oily water separating equipment approved with the IMO Resolution A.393(X).

Taking into account, that the maximum deadweight of tankers that can be accommodated is far beyond the 20.000 tdw margin and considering a scenario of the re-operation of the terminal as a crude oil loading one, it is concluded that the revised 13 G Regulation of the Annex I of MARPOL 73/78 will totally eliminate, non SBT oil tankers' (Category I tankers) involvement in cargo handling operations in Aqaba, and therefore no future need will appear for the collection of dirty ballast from oil tankers.

The next most important cargo – associated wastes that should be taken into account, are slops consolidated and retained in the designated slop tanks of tankers and tank washings produced either during short or long haul voyages. In case of slops, it should be mentioned that decanting using the oil discharge control and monitoring system, complying with the 30 lts per mile and 1/15.000 or 1/30000 criteria is not allowed within the Red Sea Special Area.

However, regardless of the quality of imported crude oil, load on top procedures can be performed from the incoming crude oil carriers, eliminating any need for delivery of this kind of residues ashore in Aqaba. Certainly, with cargoes other than crude oil, the need for product quality may inhibit the mixing of residues with the new cargo, but this consideration is only valuable on the condition that the operation of the oil terminal turns to an oil products' discharging facility.

Coming to tank washings stripped to the designated slop tanks following the cleaning of cargo tanks and their associated piping, the usual practice onboard oil tankers leads to the eventual minimization of oil discharged at sea (when permitted outside Special Areas) by eliminating unnecessary washing and recirculating the wash water.

However, for oil tankers proceeding to the port of Aqaba after performing a short haul voyage within the Red Sea or other neighboring Special Area, the procedures for retaining of oil residues on board can not be fulfilled to enable permissible discharge of tank washings at sea, making necessary their delivery to the port reception facilities at the loading port, unless such delivery is carried out at the previous discharge terminal.

However, it should be noted that since a reception and treatment facility is proposed to establish in the Industrial port zone, provided with a dedicated slop tank for thermal treatment, it would be advisable that, in principle, the Jordan Petroleum Refinery Company and then the Ports Corporation, co-estimate the need for increasing the capacity of the recommended tank on the basis of land use requirements and interconnection feasibility with the whole treatment facility aimed at serving potential needs for delivery of either consolidated slops or tank washings, in case that the operation of the oil terminal changes.

It should be clearly stated here that, under the current operation of the port and in particular of its oil jetty, there is not any need for its Authority to provide facilities for collecting oily ballast water from oil tankers.

4.4.2 Oily bilge water and sludge from all ships

It was attempted to estimate the oil - related waste streams from each zone of the port taking advantage of the well – maintained traffic data by the Authority of the port and, the almost particular operation of the available terminals and berthing sites in relation with the size, the anticipated engine output of ships, and other factors that influence the production and need for delivery of oily wastes from the machinery spaces of ships.

Port: Aqaba
Port Zone: Container Port Zone

- Estimates of ship-generated oily wastes that could be delivered at the port

Oily wastes	Dirty ballast	Tank washings	Oily bilge water	Oil residues (sludge) and other waste oils
Average annual volume *(m^3/year)*	-	-	5,876.0	6,985.0
Reduced daily volume *(m^3/day)*	-	-	16.0	19.1
Maximum daily volume *(m^3/day)*	-	-	135.0	105.5

Port: Aqaba
Port Zone: Main Port

- Estimates of ship-generated oily wastes that could be delivered at the port

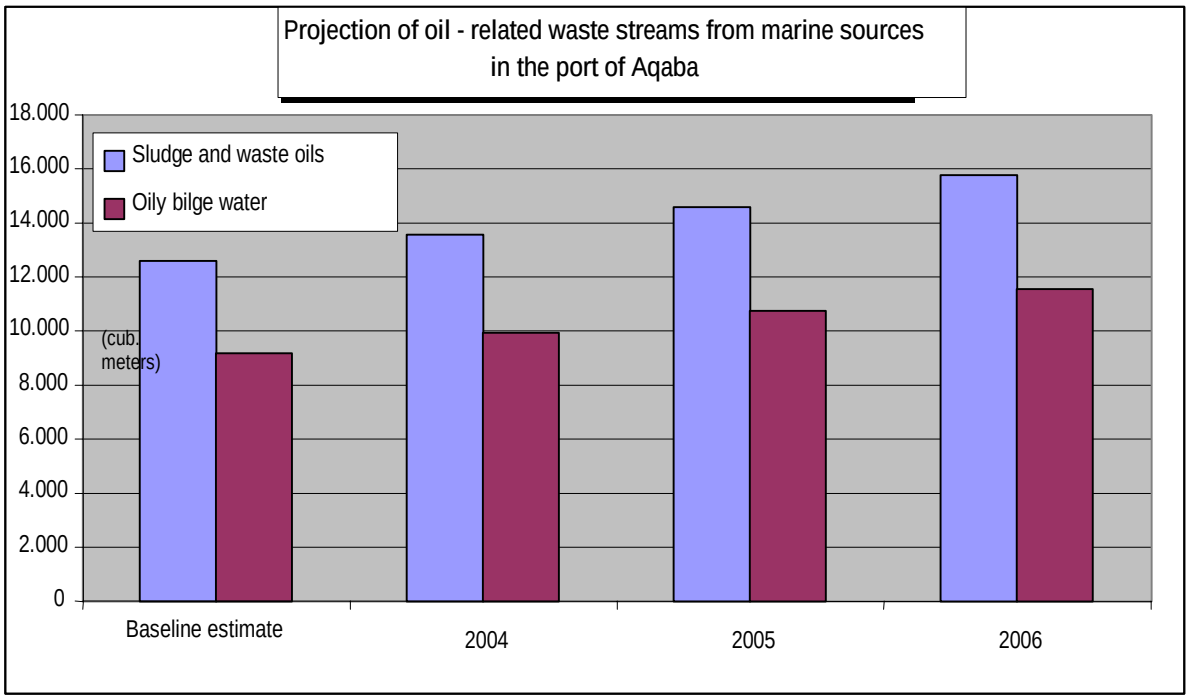
Oily wastes	Dirty ballast	Tank washings	Oily bilge water	Oil residues (sludge) and other waste oils
Average annual volume *(m^3/year)*	-	-	2,137.5	3,562.5
Reduced daily volume *(m^3/day)*	-	-	5.8	9.7
Maximum daily volume *(m^3/day)*	-	-	180.0	90.0

Port: Aqaba
Port Zone: Industrial Port Zone

- Estimates of ship-generated oily wastes that could be delivered at the port

Oily wastes	Dirty ballast	Tank washings	Oily bilge water	Oil residues (sludge) and other waste oils
Average annual volume *(m^3/year)*	-	-	1,206.0	2,010.0
Reduced daily volume *(m^3/day)*	-	-	3.3	5.5
Maximum daily volume *(m^3/day)*	-	-	48.0	36.0

The port of Aqaba has been presenting a constant growth in terms of its maritime traffic during the last four years period (1999 – 2002), accommodating on average 2.509 ships per year. Considering a linear function of ship - generated waste production and delivery with the traffic development of a port (number of ships that call annually), an average growth of the latter equal to 7.9% (which is the average annual increase of maritime traffic in the port in the 1999 – 2002 period), was used to project the waste streams flow in the near future.



Taking into account the estimated volume of oily wastes from ships, expressed as a reduced daily figure, the berthing capacity of the port, the average time spent by

ships pierside and at anchor, the distance and the required steaming time between the three zones of the port as well as the assumption that a port based treatment facility will be established to optimize the collection and facilitate the final disposal of oily wastes, the following, minimum system of facilities was identified to be suitable:

- A self propelled, 200 t.dw tanker that will be engaged in collecting oily bilge water and sludge from both the anchorage or pierside where and when, ship to ship transfer of oily wastes does not interfere with safety regulations and other applicable operational standards. It is recommended that this navigable means should be sufficiently manoeuvrable to berth alongside ships and that its cargo tanks to be provided with heating coils able to handle heavy oil residues and mixtures by maintaining their temperature at least at 40^{o}C. The tanker should not operate as a floating separator since there is no doubt that the gravity and heat induced separated water can not meet the almost, zero discharge regime in the waters of the port. In the framework of the perspective that Jordan will become a Party of MARPOL 73/78 Convention, it is obvious that the recommended collection tanker will fall into the application field of the Convention, forced to comply with its related requirements on survey, certification, structural integrity, operation, equipment, etc. The provision of another, similar, collection tanker should be also examined to replace the first in case of dry-dockings and surveys, but also in operating in parallel in peak periods.

  A new berth should be provided for the above mentioned, collection tanker equipped with the necessary piping to the proposed below, adjacent temporary storage and treatment facility. The question of the location of this berth has to be answered on condition that a decision of the area where the treatment facility will be constructed has been previously made. It is recommended that the Industrial port zone hosts the facility and the berth for the collection means. This is because of the similar land and marine use (handling and storage of flammable liquids, etc.) and also of the future perspective that the existing oil jetty could resume crude oil discharging operations which might require the reception of tank washings and in exceptional cases of dirty ballast, even from SBT tankers. The length of the berth, the maximum displacement of ships it could host, its ability to withstand impact and mooring forces, etc. needs to be studied in detail. It will be worth examining the perspective of the additional use of the berth by ships other than the collection tankers, which need to deliver oily wastes directly to the land based facility. The piping from the berth to the bilge oil and sludge storage tank should be preferably above ground, insulated and heated, made of steel complying with the respective, internationally accepted standards and should be provided with all necessary flange joints, hose strings on the berth, etc.

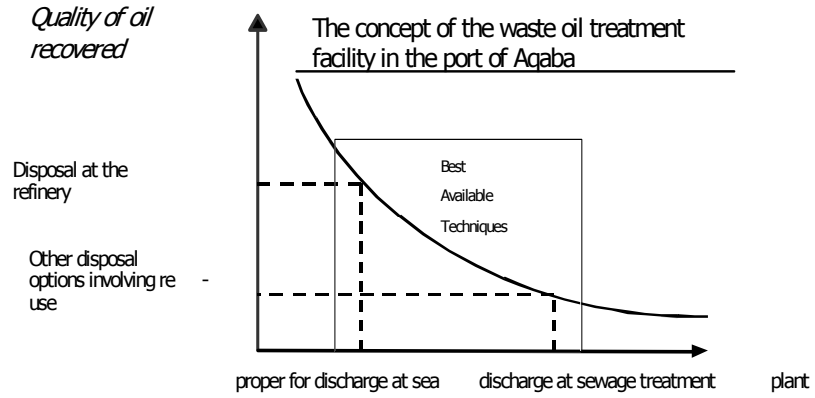
- A fleet of at least four, vacuum, road tankers of 15 – 20 m^3 holding capacity, to be provided for collecting oily wastes from every berthing place of the port. In principle, collection should not be carried out when loading/discharging operations of oils or other harmful liquid substances take place in the terminals of the port.

During the mission in the port and the information collection from ASEZA, the Authority of the port and the Jordan Maritime Authority, two basic aspects were

considered that they should be taken into account to determine the technological identity of the treatment facility in the port:

- the required level of protection of the sensitive marine environment or any potential receiving media that should be achieved, which is strongly related with the permissible concentrations of pollutants in the effluent water,

- the quality of the oil recovered from the treatment that will allow its final disposal to the oil refinery in Zarqa for recycling purposes or in any other potential installation that could make use of it. The concept of these driving forces is illustrated below, assuming a relation between oil recovery and wastewater treatment which both increase towards the beginning of the axes:



In respect of the first aspect, it is obvious that a Best Available Technique should be determined for local application in the area of the port, which, in practice, incorporates the following principles:

- A technique that includes both the technology used and the way in which the treatment facility is designed, built, maintained and operated following the collection and storage of bilge oily water, sludge and other waste oils from ships.

- An available technique that has been developed on a scale which allows implementation in the port of Aqaba, under economically and technically viable conditions, taking into account the costs and the benefits.

- The most effective technique in achieving a high level of protection of the environment, not only of the marine but also of the atmospheric and land-based environment, since emissions and solid waste by-products will be also produced.

It should be stated that both the achievement of the environmental objectives and the final quality of recovered oil are demanding tasks. ASEZA is in a position that through its Environmental Impact Assessment requirements to assess the environmental impact from the operation of a port based treatment facility and to take the necessary measures that ensure the prevention and recovery of waste, energy use efficiency, etc. and in general the compliance with the environmental and port or land use standards.

The Consultant considers that the Best Available Technique should be identified towards the tertiary treatment stage of waste water prior to its disposal at sea or to the nearest inlet of the sewage collection piping that runs across the port and the town of Aqaba. Taking this into account, some views are expressed with regard to the bilge oily water and sludge storage and treatment. The quality of the processed or not, collected waste oil that can be received by the oil refinery is as follows:

Substance / property	Maximum concentration
Lead	100 ppm
Arsenic	5 ppm
Cadmium	2 ppm
Chromium	10 ppm
Halogens	1000 ppm
Water	0.5 %
Minimum flash point	37.5° C

Apart from ASEZA coherent, legislative, environmental framework, the Water Authority of Jordan is responsible for regulating industrial, waste water discharges and also for establishing maximum permissible limits through the issuing and revision of Jordan Standard Specifications. It is understood that the specifications presented in the following table, are these applying for the discharge of effluent water from industrial facilities to the existing, urban sewage and industrial waste water treatment plant in Aqaba. However, it is suggested that it should be investigated the prospect of the future adoption of a standard setting the allowable limits for discharging effluent water at sea from similar sources including treatment facilities.

Chem. elements	Concentration (mg / lt)
Total Chrome*	5
Copper*	4.5
Tin	10
Beryllium	5
Nickel*	4
Cadmium*	1
Arsenic	5
Barium	10
Lead*	0.6
Manganese	10
Silver*	1
Boron	5
Mercury*	0.5

Iron	50
Zinc	15
Cobalt*	0.05
Selenium*	0.05
Lithium	5
Vanadium*	0.1
Aluminum	5

** The total sum of these elements altogether must not increase 10mg/l and these levels could change in the when a national standard is issued.*

The initial storage capacity for oily bilge water and sludge collected from ships is proposed to be 120 cub. meters, in the physical form of one or two, steel, insulated, fixed roof tanks (which will also serve as buffer tanks controlling the treatment flow), equipped with all necessary valves to enable filling and emptying, openings for cleaning and maintenance, and other arrangements for level measuring, etc.

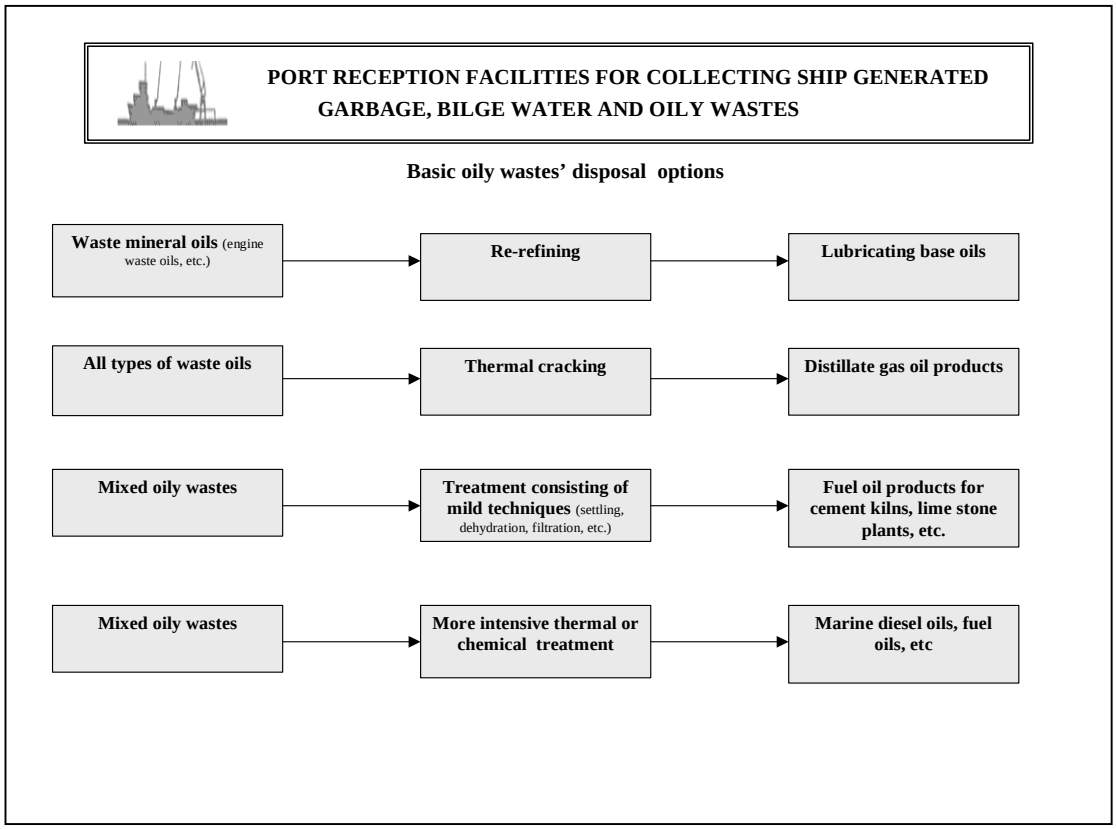
The first stage of waste water treatment (after a sufficient standstill time in the above storage tank) could be effected through the operation of a self contained, automatic, two phases decanter or an enhanced oil water separating system (equipped with coalescing media, etc.) able to separate free oil (oil present in oily wastes as droplets larger than 30μm that can raise to the surface) which must be sized or designed to allow an effluent prior to the next stage of treatment, with a concentration of hydrocarbons less than 15 – 20 mg/lt. It is widely known that oily bilge water might, apart from free oil, consist of physically emulsified oil (oil dispersed in water in a stable form like mechanical emulsions produced from mixing through pumping, other restrictions in flow, etc) chemically emulsified oil (formed as a result of the use of detergents and other chemicals in the machinery spaces of ships) as well as dissolved oil. The minimum separation capacity of the system should not be less than 15 cub. meters per hour.

Separated oil is proposed to be skimmed off to a 60 cub. meters, thermal treatment tank, for heating up to 60^0 C, while separated water is discharged to the next, physical - chemical treatment plant, where favorably, by mixing with poly-electrolytes and chemicals for pH adjustment and emulsion breaking, subsequent coagulation and flocculation assisted by compressed air cause an efficient separation of oil flocs from water. The oil content in the effluent from this type of treatment, as shown from the experience gained from several reception facilities in ports of Europe but also from similar applications in oil refineries and oil depots could be less than 15 mg/lt.

The tertiary treatment of effluent water is necessary before its final disposal at the nearest inlet and pumping station of the sewage piping towards the treatment plant or directly at sea, provided that the applicable quality standards are met. The selection of the appropriate technique should be studied and tested since, apart from the traditional solutions offered by small scale biological treatment plants, new technologies have developed at the scale and treatment rate of the proposed facility.

Oil recovered from the whole treatment should be stored in a separate, steel, fixed roof, insulated tank with a capacity of 60 cub. meters able to hold the separated oil for at least a week to be further disposed of for refining or re-use as fuel oil in accordance with the national regulations and restrictions. Sludge pumped from the first two phases of the wastewater treatment and produced also from maintenance and cleaning operations should be properly processed in a thickener, a centrifuge dewatering system to increase the content of solids while for the final disposal ASEZA should be consulted for the endorsement of landfilling following preferably lime stabilization or other techniques.

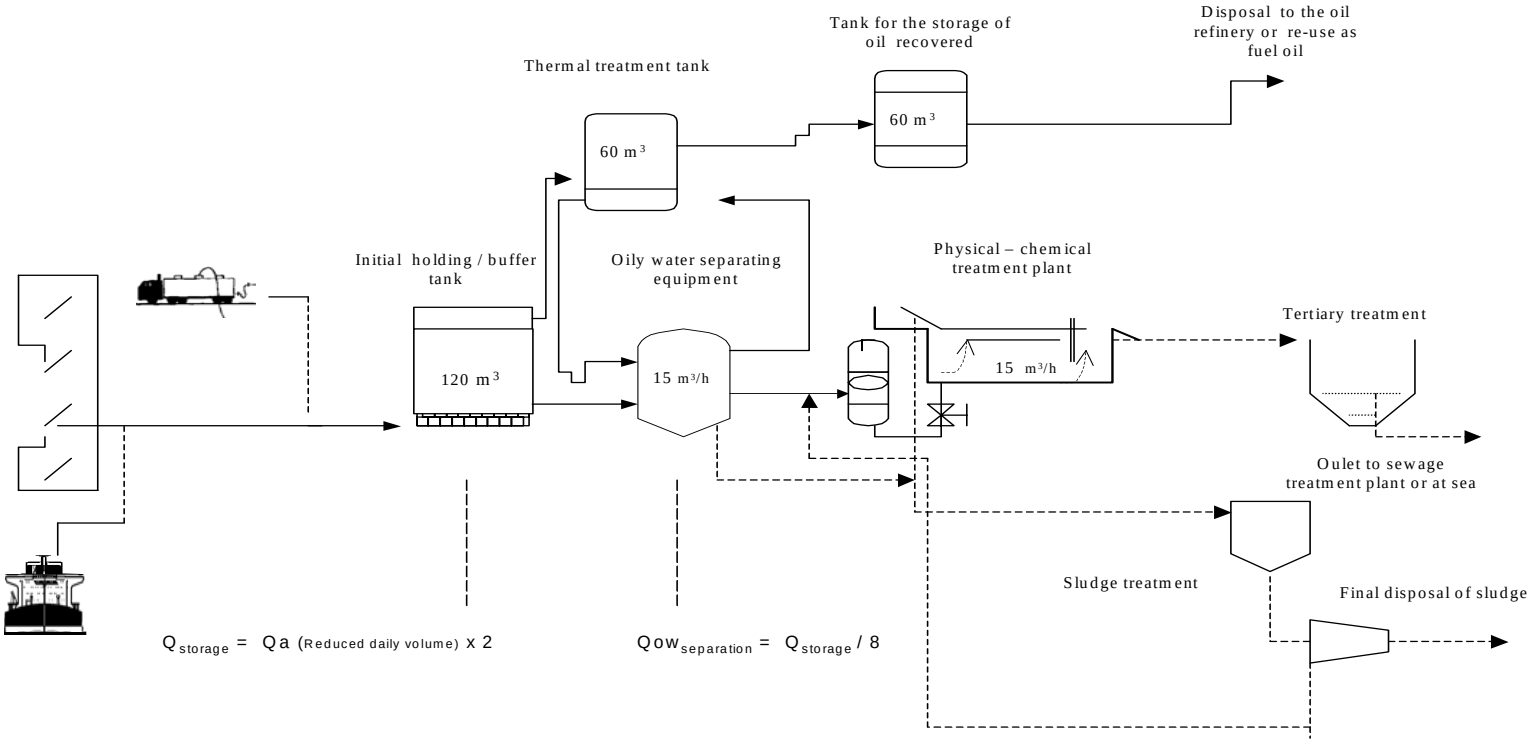
A comprehensive diagram of the different oily wastes routes in terms of the after - treatment and disposal processes used and the final products, is presented below:



Generally, oily wastes can be recovered and recycled, either directly in the case of high oil content wastes or after some form of separation and concentration from high aqueous content wastes such as dirty ballast. While certain types of oily wastes such as waste mineral oils in particular, can be subjected to regeneration processes which give products of comparable quality to the original base material, a large volume of oily wastes is used for its energy potential as a secondary or substitute fuel.

A rough, conceptual process diagram which illustrates the basic principles of the operation of the proposed reception and treatment facility is provided below:

Conceptual reception and treatment of oily wastes in the port of Aqaba



4.4.3 Ship - generated garbage

The Red Sea area which includes the Gulfs of Suez and Aqaba has been designated as a Special Area for the purposes of the Annex V of MARPOL 73/78, in the waters of which, discharge of garbage is prohibited apart from food wastes provided that such discharge is carried out at least 12 nautical miles from the nearest land.

In accordance with the Regulation for the Protection of the Environment in the Aqaba Special Economic Zone issued for the year 2001 and specifically with the provisions of the Article 56, discharge of garbage and litter from ships, other transportation means and coastal facilities is strictly prohibited. In addition, according with Article 57 of this Law, ships calling at the port of Aqaba shall not dispose of oil and oily mixtures, garbage, litter, sewage and ballast water unless upon the prior approval of the Authority of the Zone.

To meet the abovementioned objectives, the Authority of the port through its Safety and Cleaning Division has been organizing and providing, on a 24 hour basis, facilities for collecting domestic - like garbage from ships. A prior notice either directly from the incoming ship or its agent in Aqaba, is required to arrange the means that will be allocated, the time of transfer and other operational details.

Collection of garbage at the designated anchorage is carried out through a barge of 120 tons d.wt and 45 meters length overall, while collection pierside and transportation is performed through three, 6 cub. meters holding capacity, trucks. Collection of garbage is practically effected through the provision of small volume receptacles and barrels to ships or in the case of Ro-Ro or ferries, garbage is directly off-loaded to trucks. The Authority of the port recommends that food waste should be tightly packed to minimize leaks or odours during their collection and transport to the designated landfill.

It was reported from the Port Services Division that the operation of the collection means and the whole service is satisfactory making able the reception of 100 cub. meters of garbage daily on average apart from cargo associated waste delivered to the dedicated terminals of the port. A daily, fixed charge is applicable that varies depending on the area from which garbage is actually collected (10 $ US per day for ships alongside the berths and 15 $ US when at anchor). It should be mentioned that garbage collection rates, as a technical performance element, are really high, which is also the case for the municipal waste collection both in urban and rural areas of Jordan. In general, solid waste management in the country is carried out by the public sector. The zero discharge at sea policy, for ship-generated garbage that is applicable tor marine and land based activities is almost equivalent to the discharge regime provided by the Annex V of MARPOL 73/78, taking into account that the width of the gulf is between 5 – 26 kilometers. Jordan is a Party to the International Convention on the Prevention of Marine Pollution by Dumping of wastes and other matters, which regulates the disposal at sea of wastes from ships, offshore platforms and other structures.

The existing facilities for collecting garbage from ships, are summarized in the following table:

Assessment of the existing situation and needs of the port of Aqaba, Jordan

Port	**Garbage collection capacity provided in the port** *(m^3 or tons)*				**Description of port- based treatment of garbage collected from ships**	**Operational restrictions on the use of the facilities**
Aqaba	**Trucks** *(used as reception and transportation means)*	**Navigable means** *(such as barges used as reception and transportation means*	**Receptacles provided at the quayside**	**Other reception means**		
	3 (6 m^3)	1 (120 tons)	A number of barrels are placed quayside or at other locations			
Garbage collection provider	**Requirements for ships to deliver garbage**		**Method of final disposal**	**Charging system**	**Other remarks**	
The Ports Corporation tel: +962 3 2014031 fax: +962 3 2016204	Food waste should be delivered tightly packed to avoid leakage or emissions		Disposal at the local landfill a few kms far from the port area	10 $ US/ day (ships berthside) 15 $ US (at anchor)		

The estimated wastestreams flows from every zone of the port are presented below:

Port: Aqaba
Port Zone: Container Port Zone

- Estimates of ship-generated garbage that could be delivered at the port

Garbage	Domestic garbage	Maintenance waste	Cargo-associated waste	Total volume of garbage
Reduced weekly volume (m^3/week)	67.9	4.6	12.3	84.8
Average annual volume (m^3/year)	3,530.8	242.0	637.9	4,410.7
Maximum volume to be received per ship/arrival (m^3) (only domestic and maintenance)				5.0

Port: Aqaba
Port Zone: Industrial Port Zone

- Estimates of ship-generated garbage that could be delivered at the port

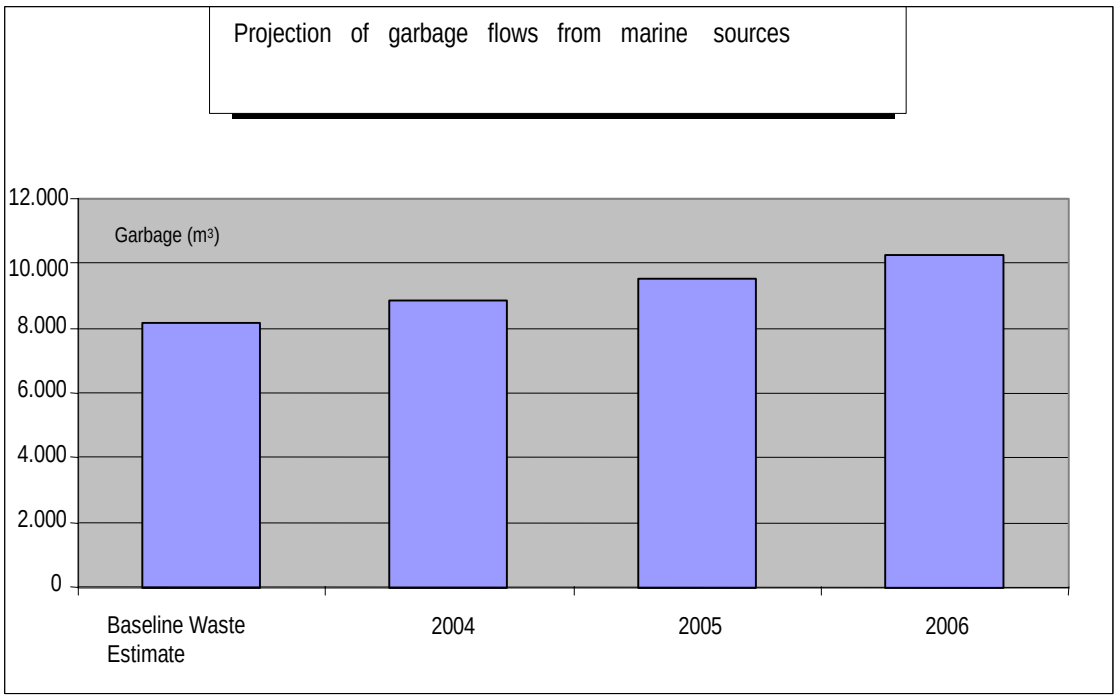
Garbage	Domestic garbage	Maintenance waste	Cargo-associated waste	Total volume of garbage
Reduced weekly volume (m^3/week)	10.3	2.2	18.4	30.9
Average annual volume (m^3/year)	536.0	117.9	957.3	1,611.2
Maximum volume to be received per ship/arrival (m^3) (only domestic and maintenance)				3.5

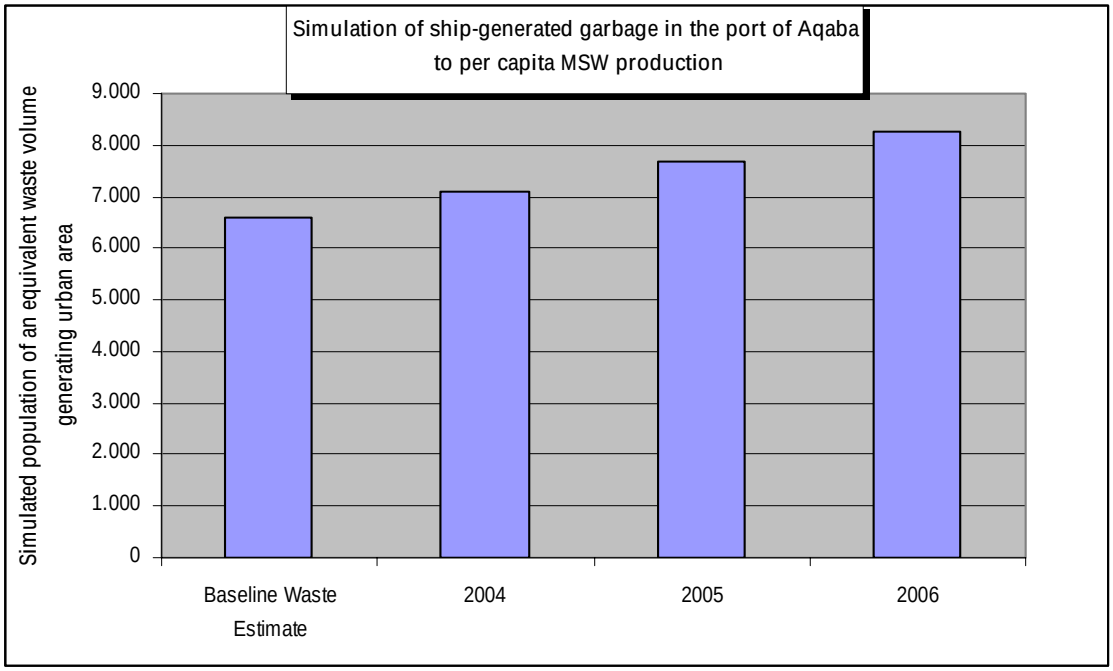
Port: Aqaba
Port Zone: Main Port Zone

- Estimates of ship-generated garbage that could be delivered at the port

Garbage	Domestic garbage	Maintenance waste	Cargo-associated waste	Total volume of garbage
Reduced weekly volume (m^3/week)	18.2	4.1	19.2	41.5
Average annual volume (m^3/year)	949.5	213.4	998.4	2,161.3
Maximum volume to be received per ship/arrival (m^3) (only domestic and maintenance)				3.5

It should be noted that solid waste remaining from the carriage of solid cargoes in bulk or in packaged form is extremely difficult to estimate because of the several factors that could influence the cargo handling and the volume of waste that would be eventually produced. During the mission, it was not possible for the Consultant to look at the way, every terminal where bulk or general cargoes are handled, arranges the cleaning of holds, their particular practice of cargo handling, etc. Considering a linear function of ship - generated waste production and delivery with the traffic growth, the projection of garbage flows in the near future is illustrated below as well as the simulation of the port as a solid waste generating town considering a 0.85 kg/day municipal solid waste production per capita which is almost identical with the respective production in the urban areas of the country.





From the above, it could be claimed that the estimated, baseline volume of ship generated garbage collected on an annual basis at the port is equivalent to the production of municipal waste from a 6.500 people, urban area.

The available facilities for collecting garbage could become capacity and operation - wise adequate to meet the needs of ships that normally call at the port, provided that some necessary improvements are made to the existing system, as outlined below:

Establishment of a central Environmental Station

The establishment of a central, preferably located in the geometric centre of the port area, Environmental Station, is recommended, to facilitate some basic waste management operations such as sorting, compaction, waste-tracking, maintenance of collection means, storage of receptacles, laboratory analyses, identification of hazardous items, etc. before final disposal or recycling.

While garbage characteristics from different type of ships might vary, the relatively low density of items such as packaging material, paper, plastics, etc. can increase the effectiveness of compaction vehicles used for transportation purposes but also of a small scale station used for compaction or other processes. The feasibility of compacting garbage collected in a separate form, from ships is determined by a combination of factors such as the anticipated quantities, the distance of the final disposal site from the port area and the proportion of low density components.

Transfer facilities for domestic garbage, are mechanized or not facilities where garbage is unloaded from relatively small capacity collection trucks and containers to larger means for transport to a final disposal or processing site. This type of operation is almost always associated with some kind of compaction, separation, and other waste handling options. Small scaled, garbage transfer facilities, are considered to represent sound, management practices for ports where large volumes of garbage are delivered from the incoming ships.

The establishment and operation of a transfer facility could be justified when some or all of the following reasons exist:

- The final, disposal site is situated far from the port area and there is a need for the collection trucks to travel a shorter distance to return quickly to their primary task of receiving garbage from ships. The fact also that several ports are located within or close to urban areas and the trend of building new landfills or other processing sites at a considerable distance from the collection service areas, could make attractive the operation of transfer stations.

- The collection trucks that are employed for accessing the berthing sites of a port to collect garbage are small and not suitable for the terrain they have to move to reach the disposal sites. The use of larger trucks, trailers or compacting vehicles can enable the disposal of larger volumes of garbage in longer distances increasing the collection productivity.

- When needs exist for inspecting any potentially hazardous waste from ships prior to final disposal, separating recyclable materials, removing bulky cargo-associated waste, etc.

The incorporation of such an Environmental Station into the ship-generated garbage management at the port of Aqaba should be studied in detail to provide its type and functions and most importantly to assess the feasibility whether its operation is economically viable in relation with the capital costs required, labor needs and the garbage collection fees.

In respect of the promotion of delivery of separated garbage, it should be mentioned that garbage management onboard ships varies from simple, collection schemes that enable delivery of garbage at port reception facilities and discharge at sea according to MARPOL 73/78, Annex V Regulations, to more complicated systems in particular on those types of ships that due to their type and voyage pattern, large volumes of garbage are generated, the handling of which often requires use of mechanical equipment, sorting out of materials, etc.

Cruise and passenger ships often represent a good example of ships which through either their shipping associations or independently adopted codes of practice carry out separate collection of recyclable items, aimed at recovering certain materials from the common waste streams prior to disposal. Paper, aluminum and glass items are among the most common recyclable materials that are collected separately. The provision of separate, reception means for recyclable materials is recommended when and where recycling initiatives take place in the wider area and also when practices of separate collection have been demonstrated to perform by ships that normally call. In ports that normally accommodate cruise liners and passenger ships, the collection of recyclable garbage is likely to have a considerable effect on the feasibility of recovering materials from both domestic and ship-generated garbage.

It is recommended that the Authority of the port requests or requires from ships that wish to deliver garbage to the available reception facilities, to separate prior the disposal, garbage produced onboard, to ensure its easy, safe and environmental sound handling. It should be mentioned that several ports worldwide have adopted a mandatory separation system as follows:

- Combustible items,
- Non – combustible items,
- Potentially hazardous waste, and
- Potentially infectious materials.

Handling of potentially hazardous waste

Regulations have been developed in a few countries across the world, aimed to ensuring that special wastes, in practice, potentially hazardous wastes from ships, are handled with responsibility from anyone who may carry and deliver or receive

them. Wastes from ships that could be hazardous are those listed or delineated in terms of the properties they display, in specific catalogues of basic legal instruments such as the Basel Convention, etc.

To indicate a few of these potentially, hazardous wastes from ships, the following table of Wastes and Substances that may be onboard a vessel has been extracted from the "List of hazardous waste and substances under the Basel Convention that are onboard or inherent in the ships' structure when a vessel arrives at a dismantling site" which is incorporated in the Technical Guidelines for the Environmentally Sound Management of the Full and Partial Dismantling of Ships, Decision VI/24 as adopted by the Sixth Meeting of the Conference of Parties to the Basel Convention, 13/12/2002.

Wastes (exluding those specified on List B of the Convention)	**Product where waste may be found**
A 1170 Unsorted waste baterries	Portable radios, torches
A 3140 Waste non halogenated organic solvents	Solvents and thinners
A 3150 Waste halogenated organic solvents	Solvents and thinners
A 4010 Wastes from the production, preparation and use of pharmaceutical products	Miscellaneous medicines
A 4030 Wastes from the production, formulation and use of biocides and phytopharmaceuticals including waste pesticides and herbicides which are outdated, off-specification or unifit for the intended use	Insecticide sprays
A 4070 Wastes from the production, formulation and use of inks, dyes, pigments and paints etc.	Paints and coatings
A 4140 Waste consisting of or containing off specification or outdated chemicals corresponding to Annex I categories and exhibiting Annex III hazard characteristics	Consumables

Using 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.

Development of a waste reception and handling plan for the port of Aqaba

A port specific waste reception and handling plan that could be developed by ASEZA could ensure the following:

- compliance of garbage and waste oils' management activities with the ASEZA environmental policy and regulations,
- sufficient capacity for managing ship-generated wastes to be always available in particular when changes in the maritime traffic and the infrastructure of the port might happen,
- control of technological measures by assisting in the early identification of technologies and practices that could ensure safe and environmentally sound waste management.

Further improvements to the waste management scheme

ASEZA and the Ports Corporation can take jointly action to improve further the existing procedures with which ships' requests are handled, monitored and in general waste management is carried out, in particular by:

- Standardizing notification, record-keeping, and monitoring of ships' requests to deliver wastes at the port of Aqaba as well as the actual use of the available reception facilities,
- Encouraging the introduction of procedures and technologies able to ensure a progressive reduction of the environmental impact from the waste collection and management. Environmental pressure from the land – based transport of wastes around the port area should be controlled through proper instruments and resources able to achieve tasks such as: promoting the use of less polluting vehicles, setting up of inspection and maintenance programs to enforce emission control standards, etc. The recommended, mobile means for collecting oily wastes and garbage from ships could pave the way for such an improvement.