Waste Management Guidelines

Prepared for Chiang Saen Commercial Port Area

Mekong River Commission

Navigation Programme

Cambodia • Lao PDR • Thailand • Viet Nam

For sustainable development

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MRC Staff
Mr. Satit Phiromchai, Director, Operations Division, MRCS
Ms. Thi Thanh Yen Ton Nu, Navigation Programme Coordinator, MRCS
Mr. Lieven Geerinck, Chief Technical Advisor, Navigation Programme, MRCS
Mr. Rory Hunter, Maritime Risk Management Specialist, Navigation Programme, MRCS
Mr. Bounphet Phommachanh, Programme Officer, Navigation Programme, MRCS
Mr. Tia Vannareth, Programme Officer, Navigation Programme, MRCS
Mrs. Lun Tharath, Programme Assistant, Navigation Programme, MRCS

Chiang Saen Port Staff
Mr. Songglodd Dounghaklang , Director of Marine Office 1, Chiang Rai Branch
Mr. Suranat Sirichote, Harbour Master, Marine Office 1, Chiang Rai Branch

Consulting Team
Mr. Bart Fonteyne, International Expert for Ports and Terminals
Mr. Peter Thys, International Expert for Vessels

National Working Groups
Mr. Itsranunt Chuaychoo, National Manager
Mr. Thanatip Jantarapakde, National Expert for Vessel
Mr. Pitak Wattanapongpisal, National Expert for Port
Mr. Pongnarin Petchu, National Expert for Dangerous Goods Training
Mr. Nuntasak Prasertchai, National Expert for Dangerous Goods Training
Mr. Suranart Sirichote, Liaison Officer, Marine Office 1, Chiang Rai Branch
Mr. Ongoert Malee, Liaison Officer, Thailand Marine

Thai National Navigation Coordinators
Mr. Suchart Sirijungsakul, National Navigation Coordinator
Ms. Nuanlaor Wongpinitwaradom National Navigation Coordinator

Design, Layout and Editing
Mr. Chheana R. Lotus, Design and Layout Expert
Mr. Peter Starr, Editor
Mr. Marty Sharples, Editor

Contents

Acronyms and Abbreviations

CSCP	Chiang Sean Commercial Port
EC	European Council
EIA	Environmental Impact Assessment
HCCP	Hachiang Commercial Port
HFO	Heavy Fuel Oil
INE	Inland Navigation Europe
IMO	International Maritime Organization
IT	Information Technology
MSDS	Material Safety Data Sheet
MARPOL	The International Convention for the Prevention of Pollution from Ships
MDO	Marine Diesel Oil
OWS	Oil Water Separator
PCBs	Polychlorinated Biphenyls
PRF	Port Reception Facility
PWMP	Port Waste Management Plan
SDS	Safety Data Sheet
WANDA	Waste management for Inland Navigation on the Danube
WMG	Waste Management Guidelines

1 INTRODUCTION

Figure 1:
Waste on the River

Waste management is the collection, transportation, processing and disposal of garbage, sewage, cargo residues and other waste products. Waste management encompasses management of all processes and resources for proper handling of waste materials and dumping facilities to compliance with health codes and environmental regulations.

The main purpose of Waste Management Guidelines and reception facilities is to reduce and eliminate dumping of waste illegally into the marine environment. The protection of the marine environment can be enhanced significantly by reducing discharges of all kind of ship-generated waste and cargo residues. It has been consistently demonstrated that unsatisfactory waste handling and/or illegal dumping takes place in many ports around the world due to inefficient waste management operations, lack of control, inadequate recovery systems and inefficient information flow. The International Convention for the Prevention of Pollution from Ships, MARPOL 73/78, and the European Council Directive provide an international framework on management of ship and port waste.

Figure 2:
Waste collection

The IMO has for many years addressed the delivery of ship-generated waste and cargo residues, mainly by aiming at improving the availability and adequacy of port reception facilities. Relevant requirements thereto have been adopted in the International Convention for the Prevention of Pollution from Ships (MARPOL). In general, MARPOL contains regulations and requirements defining which wastes can be discharged into the marine environment. MARPOL also imposes an obligation on the State Parties to provide facilities for the reception of ship-generated residues and garbage (that cannot be discharged into the marine environment). These reception facilities must be adequate to meet the needs of ships using the port, without causing undue delay for ships.

With well over 1,000 seaports, with an estimated total of 600,000 calls per year made by merchant ships and handling more than 3.5 billion tonnes of cargo every year, ship waste management in ports is a serious business in the European Union. In 2000 the European Community adopted Directive 2000/59/EC on port reception facilities, with the aim of substantially reducing discharges of ship-generated waste and cargo residues into the sea. This Directive especially aims at reducing illegal discharges from ships using ports in the EU by improving the availability and use of port reception facilities, thereby enhancing the protection of the marine environment.

Waste Management Guidelines and its implementation is an important economic, environmental, technical and administrative issue both on national and international level. Port waste management planning and it's implications is a rapidly growing area of interest within the city management context. Because ports are sources of considerable volumes of valuable waste, one of the main issues for local authorities dealing with urban sustainable development matters is ship and port waste management.

National statutes, regulations and directives must also be aligned to the strategies for the integrated sustainable management of ship and port waste. This strategy, within the legal framework, should be designed to ensure measures providing financial and operational incentives, as well as enabling economical and environmentally successful implementation of port waste management plans. However, many ports have not met related standards yet.

Ship and port waste management refers to the waste generated on board ships and by activities in the port area. The port waste management plan describes the waste streams and handling routines, as well as providing clear instructions for port users. The ports are responsible for developing and implementing their Waste Management Guidelines (WMG). The effectiveness of the WMG depends on each port's management resources and procedures. It is also important to establish effective ship waste handling systems in accordance with the WMG.

2 DEFINITIONS

Port Waste Management Plan (PWMP): is a document produced by a port or terminal unifying their policy on waste reception facilities for vessels and outlining the facilities available at the location.

Cargo residues: the remnants of any cargo material on board in cargo holds or tanks that remain after unloading procedures and cleaning operations are completed.

Oil petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined products.

Oily mixture: a mixture with any oil component.

Dunnage: loose materials used to support and protect cargo in a ship's hold.

Operational wastes: refers to all cargo associated waste and maintenance. For this purpose, cargo associated waste means all materials which have become waste as a result of use on board a ship for cargo stowage and handling. This includes dunnage, shoring, pallets, lining and packing materials, plywood, cardboard, wire and steel strapping.

Owner: the owner, charterer, manager or operator of the ship.

Passenger: any person carried by a ship except a person employed or engaged in any capacity on board the ship.

Ship generated waste: all wastes and residues that are generated during the service of a ship and which fall within the definitions of garbage, oil or oily mixtures but not including cargo residues.

Garbage: all kinds of domestic and operational waste generated during the normal operation of the ship that needs to be disposed of continuously or periodically, with the exception of sewage.

Hazardous waste: a controlled waste containing hazardous properties. This may include waste with explosive, flammable, oxidising, irritating, harmful, toxic, carcinogenic or corrosive properties.

Wastes: defined as substances or objects that have been disposed, to be disposed or required to be disposed in accordance with the provisions of national legislation.

Ship waste: all waste, non-hazardous and hazardous, that has occurred during ship navigation, as well as waste being transported by cargo vessels. In general, ship waste includes solid waste and liquid waste.

- **Solid waste:** solid municipal waste (from watercraft this waste is similar in composition to domestic waste) and ship cargo residues (residues of any type of ship cargo in ship warehouses or tanks that have occurred after debarking, cleaning or washing of ship warehouses, deck or tanks, including the excess and spilled cargo during loading/discharging operations).
- **Liquid waste:** includes waste oils (waste lubricating oil that needs to be changed periodically to ensure the lubricating function of motors) and wastewaters. Wastewaters can be divided into oily and non-oily wastewaters. Oily wastewaters originate from engine rooms and machinery spaces, e.g. pump rooms.

References: *Ship waste quantities prediction model for the port of Belgrade – Chemical Industry & Chemical Engineering Quarterly 17 (2) 239-248 (2011).*

Portland Harbour Authority, Port Waste Management Plan, 01/2008.

3 OVERVIEW

3.1 Current Situation and Regulations

The Public Health Act B.E. 2535 (1992) is the fundamental law to handle waste management. The Act consist of 16 Chapters: General Provisions, Public Health Committee, Disposal of Sewage and Solid Waste, Sanitary Building, Sources of Nuisance, Control of Animal Raising or Grazing, Business Detrimental to Health, Marketplaces, Places Where Meals Are Sold, and Places Where Foodstuff is Stored, Distribution of Merchandise in Public Places or Ways, Powers and Duties of Local Officials and Public Health Officials, Certificates of Notification, Licenses, Fees and Fines, Appeals, Penalties, Transitory Provisions.

Chapter 3 is dealing with the Disposal of Sewage and Solid Waste as described below:

Section 18: Disposal of sewage and solid waste shall be the responsibility and duty of local government.

The local government may entrust an individual on its behalf with the task of disposing of sewage and solid waste.

Section 19: Any individual is forbidden to operate a business of collecting, transporting, or disposing of sewage or solid waste, unless he has obtained a license from the local official.

Section 20: For the purpose of maintaining a clean and orderly process for collecting, transporting and disposing of sewage or solid waste, the local government shall have powers to issue local provisions as follows:

1 Forbid the discharge of sewage or solid waste in any place except that provided by the local government for such a purpose;

2 Prescribing that there be receptacles for sewage or solid waste available in public places and private places;

3 Prescribing the means of collecting, transporting and disposing of sewage or solid waste in order to ensure that the owner or occupant of all buildings or properties adheres to safe hygiene standards;

4 Prescribing the rate of fees for services provided by the local government on collection and transportation of sewage or solid waste not exceeding that prescribed in the ministerial regulation;

5 Prescribing rules, procedures, and conditions on collecting, transporting, and disposing of sewage or solid waste, for observance by persons obtaining a license pursuant to Section 19. Prescribing a rate of maximum charges collectable by the persons obtaining a license pursuant to Section 19 according to the nature of services provided; and

6 Prescribing any other requirements necessary for hygienic practice.

3.2 Waste Streams

Ports are a focus for many activities (e.g. shipping, storage, maintenance) so there is considerable scope for the production of a variety of types of waste. These wastes may be generated on land or from ships and can include products of industrial processes, domestic rubbish or spilt cargoes.

Port wastes can be classified as hazardous or non-hazardous, according to their origin, content and properties. Although both types, hazardous and non-hazardous, can be said to follow quite similar management processes, they are subject to different ways of disposal and recovery. Ports provide the interface to the land waste management and disposal system for ships.

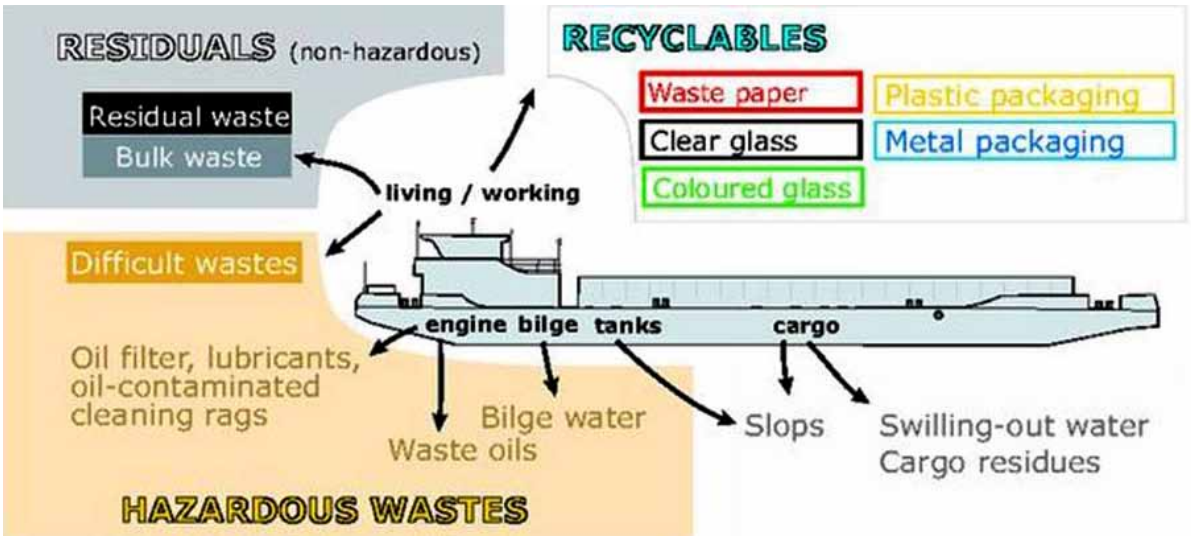

Figure 3: **Waste generated on board cargo vessel (Source: INE WANDA)**

3.2.1 Ships generated hazardous waste

Ship generated hazardous waste can refer to:

Oily waste: e.g. bilge water, sludge, used lubricating oil, dirty ballast water, oily tank washings, fuel residues.

Noxious liquid substances: e.g. dirty polluted ballast water, cargo residues containing noxious liquid substances, tank washings.

Sewage: drainage and other wastes from any form of toilets, urinals, and WC scuppers and drainage from medical premises (dispensary, sick bay, etc.) via wash basins, wash tubs and scuppers located in such premises. All other waste waters when mixed with the drainages defined above.

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

Maintenance waste: maintenance waste 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, oily rags, etc.

Ports are required to provide adequate waste reception facilities for the disposal of waste generated on-board and by the normal operation of the ships calling at the port. In parallel, the port has to ensure

that the treatment, recovery or disposal of ship-generated waste and cargo residues is carried out.

Ships waste management can be out-sourced to private external waste operators, fully or partly for collection of oily/hazardous waste and for garbage-domestic waste. In the case of ship-generated waste it can also include spills involving oil and noxious substances coming from ship accidents (e.g. fuel leaks, leakages of cargo during handling).

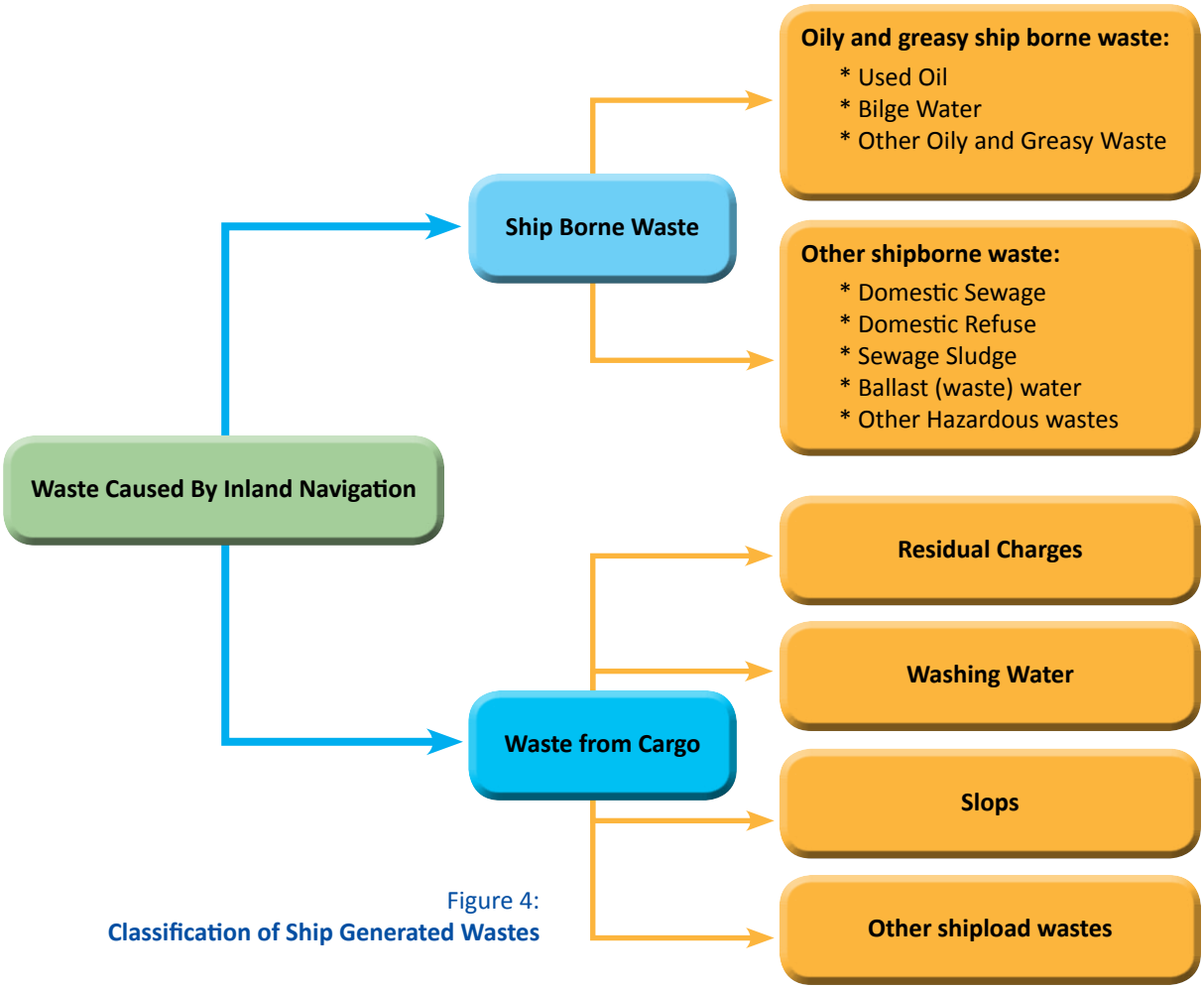

Figure 4:
Classification of Ship Generated Wastes

Figure 5:
Waste onboard cargo vessel

3.2.2 Port generated hazardous waste

On the dry side, ports comprise activities and operations from personal to industrial levels, so various types of hazardous waste can be generated:

Contaminated dredged material: Construction works and dredging may be subject to hazardous waste management. In case noxious substances or materials (e.g. heavy metals) are found in bottom sediments, the dredged material should be managed according to national regulations.

Packaging containing residues of hazardous material: Such packaging can be generated from offices, cargo storage or handling areas and workshops (e.g. packaging from pesticides, herbicides, fertilisers, surfactants, detergents, insecticides, white spirits, cartridges, varnishes, resins, paints, machine shops) and areas where machinery maintenance or repair activities take place (e.g. coolants, solvents, adhesives, oils, hydraulic fluids, brake fluids, greases).

Asbestos: Can be found in several places in a port such as roof sheets and slates, lagging on the boiler and central heating, boiler flue, interior walls and gaskets. These should always be removed by certified companies.

Polychlorinated Biphenyls (PCBs): Can be found as dielectric fluids in port electrical equipment such as transformers, capacitors, heat transfers and hydraulic systems. PCBs and equipment containing PCBs should be disposed as soon as possible.

Waste electrical and electronic equipment: IT and telecommunications equipment (e.g. personal computers, printers, facsimile), lighting equipment (e.g. fluorescent lamps, high intensity discharge lamps) and equipment used in various workshops are some of the electrical and electronic equipment used in ports (offices, vehicle workshops, warehouses, machine shops, carpenter's shops, headlamps, dome lamps).

Batteries and accumulators: Can be generated from offices, personnel uses (e.g. calculators, watches, radios, clocks, and cameras), maintenance/repair of vehicles and work machinery (e.g. auxiliary cars, forklifts, straddle carriers).

Waste oils: Oily wastes are a common element in port maintenance activities related to vehicles equipment and work machinery, as they are needed to allow engines and mechanisms to function. For example hydraulic oils, engine, gear and lubricating oils, insulating and heat transmission oils.

Hazardous cargo remnants: Leakage of bulk or dry cargo on quays during handling and storage activities is a daily occurrence in port areas.

Wastewater: Waterfront drainage, which may carry contaminated silt/sand, oils, minor hazardous cargo spills, storm water run-off from contaminated land or storage areas and untreated sewage discharges, are the main port land-based sources of waste water. An appropriate sewage system should be established in the port, while dead end sumps, combined with oil-water separators, are provided for specific waste water streams (e.g. from fuelling areas).

Oil/Noxious substances spills: During handling of cargo, fuelling and other port activities, accidents and incidents can occur involving the spill of oil products and/or noxious substances on quays or river surfaces. Appropriate spill response procedures must in place while adequate supplies of spill response means and equipment must be maintained in accessible port locations.

Other hazardous waste: This includes any material contaminated with oil or other hazardous substances, such as oily rags, oil filters, contaminated barrels etc., which cannot be classified in the above-mentioned categories.

Examples of Hazardous waste generated by port facilities and activities:

Vehicle and Equipment Maintenance: Solvents, cleaning agents, contaminated absorbent pads, oil filters, coolants, workshop oil/lubricant/grease packaging, antifreeze, brake fluids, hydraulic

fluids, batteries, accumulators, electronic and electrical equipment, waste oils, paints, detergents, contaminated rags and barrels, dry cleaning agents.

Building/Ground Maintenance: Herbicides, pesticides, insecticides, fertiliser packaging, asbestos, electrical & electronic equipment, paints, varnishes, white spirits, resins.

Lighting: Fluorescent lamps, high intensity discharge lamps, other electronic and electrical equipment.

Electrical Substations: PCBs, electronic and electrical equipment.

Warehouses: Electronic and electrical equipment, asbestos, hazardous cargo remnants.

Offices: Cartridges, surfactants/detergents containing hazardous substances, batteries, dry cleaning agents, electrical and electronic equipment, sewage.

Handling and storage of hazardous cargo: Cargo remnants, packaging containing residues of hazardous material, contaminated waterfront drainage and storm water run-off, oil and noxious substances spills.

Fuelling area: Contaminated storm water run-off, oily rags, oil leaks and spills.

Public access: Sewage, batteries.

3.2.3 Port and ship generated non-hazardous waste

There are also a number of waste products generated at ports that are not directly characterised as hazardous including glass, paper, plastic, scrap wood, brochures, coffee filters, magazines, newspapers, scrap metals, shrink wrap, aluminium cans, cardboard, metal, pallets, plastic bottles and wood dunnage. These materials can be subject to successful alternative management and recycling methods.

References: *Hazardous waste management in ports, Department of Civil Engineering, Aristotle University of Thessaloniki.*

PIANC (1999) Environmental management framework for ports and related industries, Report of Working Group 4, ISBN 2-87223-111-0, PIANC Publications, Brussels.

EMSA (2005).

A Study on the Availability and Use of Port Reception Facilities for Ship-Generated Waste – Executive Summary, Report prepared by Carl Bro a/s, December 2005.

Figure 6: **Drums for waste collection**

4 MANAGEMENT OF WASTE

4.1 General

Crew and shore personnel should be made aware of the consequences of pollution, the importance of pollution prevention, the necessity of garbage disposal ashore and the need to separate the garbage. A designated responsible person should explain the different methods for dealing with waste and motivate crew and shore personnel to cooperate. Compliance of the vessel with port regulations regarding waste disposal should be verified on board.

Apart from food waste, all garbage, liquid and solid waste, should be collected, segregated as far as possible, retained on board and given for disposal at the shore reception facilities. Garbage generated at the port should be collected, segregated and given to land-based waste treatment facilities.

Figure 7:
Land-fill of waste

4.2 Ports

4.2.1 General Recommendations

Waste disposal facilities and places where clean up materials are stored should be clearly marked on a plan that covers the entire port area. The development of adequate port reception facilities (PRF) for ship-generated waste and cargo residues, together with the establishment of systems which provide incentives for ships to use these facilities, are major elements in the process to reduce ships' discharges into the River.

A responsible person should be assigned for control and coordination of the garbage disposal facilities, the removal of the waste and to record the quantity of the different kinds of garbage disposed (non-hazardous waste and hazardous waste).

Port regulations should include strict prohibition of waste disposal from vessels and port into the river, including fines in case of non-compliance. Port regulations should include the strict prohibition of disposal of used oil and bilge water into the river (according the Thai Waters Navigation Act B.E. 2546), including penalties when violating this bylaw.

Prohibition signs for waste disposal into the river and penalties for non-compliance should be clearly posted at various places.

In order to ensure safe cargo handling and storage, areas where dangerous goods are stored should be monitored on a regular basis by a designated responsible person (s) to check packaging conditions and make sure that possible leaks are detected and segregation requirements are followed.

Figure 8:
Prohibition Sign

Areas designed for fuel transfer (truck to vessel) for bunkering or cargo operations, considering waste, require additional provisions and equipment to prevent oil spills including driptrays, oil absorbent material, and drums with lid to collect oil contaminated rags, contaminated saw dust as well as drums to collect small amounts of cargo (gasoline, oil) that ends up in the driptray when connecting or disconnecting the cargo hose (according Marine Department's notification No. 412/2543).

Practical implementation:

General: 100 or 200 litre waste containers should be put at various relevant locations, nearby buildings, warehouses and residential areas.

Maintenance shop and repair shop: should make arrangements such as putting oil drums to collect used oil and other harmful liquids and make provisions to limit the impact of (small) oil spills resulting from leaks.

Cargo handling equipment (cranes) and other port related equipment: should be well maintained in order to prevent leaks and keep all equipment fully operational (waste reduction).

Rain and water collecting channels, storm water drains: should be well separated from storage areas containing dangerous goods or hazardous waste where spills are possible so as to prevent disposal in the river.

Absorbent materials: such as saw dust should be available at maintenance and repair areas and at storage areas, in order to clean up small spills from leaks or due to repairs.

Oily rags: used saw dust or other material that is (oil) contaminated should be collected in a separate container with a lid that can be closed.

4.2.2 Current Situation

In order to collect the waste on a regular basis (e.g. three-time a week), agreements should be made with the Vieng Chiang Saen sub-district.

100 or 200 litre waste containers are ordered and will be put at various relevant locations, nearby buildings, warehouses and the residential area.

There are a number of locations around Chiang Saen Commercial Port (CSCP) that can accommodate significant waste.

4.3 Vessels

On board every vessel at least two garbage containers should be installed at obvious places, one for dry waste and one for wet waste. The International Chamber of Shipping estimates that between 1.4 and 2.5 kg of wet garbage and 0.5 -1.5 kg of dry garbage is produced per person per day on board.

Vessels carrying dangerous goods should have the appropriate Material Safety Data Sheet (MSDS)/ Safety Data Sheet (SDS) on board in order to ensure safe cargo handling and correct waste treatment.

Vessels should have separate drums installed to collect waste oil, and collect oily rags. These drums should have a lid that can be closed.

Even if installed, generally the oil-water separator is not used, and therefore the bilge content should be pumped over to a sloptank or other means, which should be then pumped later ashore to a reception facility. If delivery ashore is not possible, the bilge content ends up in the river causing potentially dangerous environmental damage.

References: *Translated from Environmental Impact Assessment Report (Full Report), Chapter 5: Environmental Impact Mitigation and Prevention Measures*.

Clean Ships, Clean Ports, Clean Oceans: Controlling Garbage and Plastic Wastes at Sea, Committee on Ship borne Wastes, National Research Council (1995).

5 AWARENESS

5.1 Current Situation and Consequences

5.1.1 Ports

Currently the majority of ports along the Mekong River have no dedicated waste reception facilities, nor do they have a waste management guidelines.

Chiang Saen Commercial port has ordered several 200 litres containers that will be placed on dedicated locations throughout the port. Hachiang Commercial Port has provided some drums for the collection of waste. However both ports have no actual plan for handling different kinds of waste.

Figure 9: **Drums used for Waste collection at HCCP**

Figure 10: **Examples of garbage left behind in port**

5.1.2 Vessels

It is clear, given that there are no waste reception facilities in ports, that all garbage, solid and liquid, is thrown or pumped overboard into the Mekong River.

5.1.2.1 Liquid Waste – Bilge Water

Different studies have indicated that about 1 % of the daily marine diesel oil (MDO) consumption leaks in the bilges of the engine room of the barges and mixes up with water, the so called bilge water or sludge.

In a typical vessel, the main sources of contamination in bilge water and bilge holding tanks include:

- Diesel engine aftercoolers (clean water);
- Sludge from decanting/bottom draining storage and sludge tanks. Lube oil and fuel oil purification (oily water);
- Fuel oil storage and settling tanks (oily water);
- Lube oil and fuel oil filtration (oil);
- Machinery leakages;
- Condensation from air compressors and compressed air systems;
- Diesel engine piston stuffing box leakages and piston underside blow-down (slow-speed diesels only);
- Boiler water/condensation drains (different than piston cooling water because these include other types of chemicals (e.g., solvents), causing different concerns);
- Equipment and engine-room washing;
- Economiser water washing;
- Seawater/freshwater cooling (a potential source of biological contaminants);
- Fire-fighting foam;
- Water treatment chemicals;
- Engine coolant;
- Grey water drains;
- Sanitary system leaks and overflows; and
- Air conditioning and refrigeration condensate.

Some or all of these contaminants can be present in the bilge at any time. Solvents, detergents, and soot are often found after equipment cleaning in machinery spaces. Iron oxide particles and biologicals are common in older ships (leaking pipes, rusting equipment and hull) or when bilge treatment systems have not been operated regularly.

There is evidence that the oil-water separator, if installed can leak if it is not used for various reasons (out of order, time consuming, not effective).

Presently bilge water is disposed in the following way:

Flexible connection from the bilge pump discharge to the cooling water outlet

Flexible connection from the bilge to the bilge pump inlet

Discharge of bilge pump mixed with cooling water of the engine (reasonable flow)

The bilge water is mixed with enough cooling water so the pollution becomes "invisible"

Figure 11:
Current Bilge water disposal

Disposal of liquid waste:

Table 1: **Vessels calling at Chiang Saen Commercial Port, January – December 2011**

Vessels calling at Chiang Saen Port - January > December 2011										
Month	Inbound vessels (Number of Vessels)					Amount of Cargo (Number of Vessels)				
	China	Laos	Thai	Myanmar	Total	China	Laos	Thai	Myanmar	Total
January	129	204	-	-	333	134	197	-	-	331
February	121	193	-	-	314	111	185	-	-	296
March	148	280	-	-	428	150	274	-	-	424
April	86	230	64	38	418	87	225	64	39	415
May	109	161	78	28	376	102	155	78	23	358
June	82	283	29	22	416	83	269	29	25	406
July	75	232	14	23	344	80	243	14	22	359
August	111	208	12	22	353	97	206	13	21	337
September	98	138	14	9	259	104	144	15	10	273
October	21	414	10	29	474	38	420	10	29	497
November	5	608	9	64	686	5	603	9	63	680
December	59	479	8	46	592	57	488	7	49	601
Total	**1,044**	**3,430**	**238**	**281**	**4,993**	**1,048**	**3,409**	**239**	**281**	**4,977**

Assumption of the yearly quantity of liquid waste, mainly the bilges, generated by 5,000 barges calling at Chiang Saen Commercial Port (Statistics 2011 – See Table 1) on the Mekong River and taking into account the following conditions:

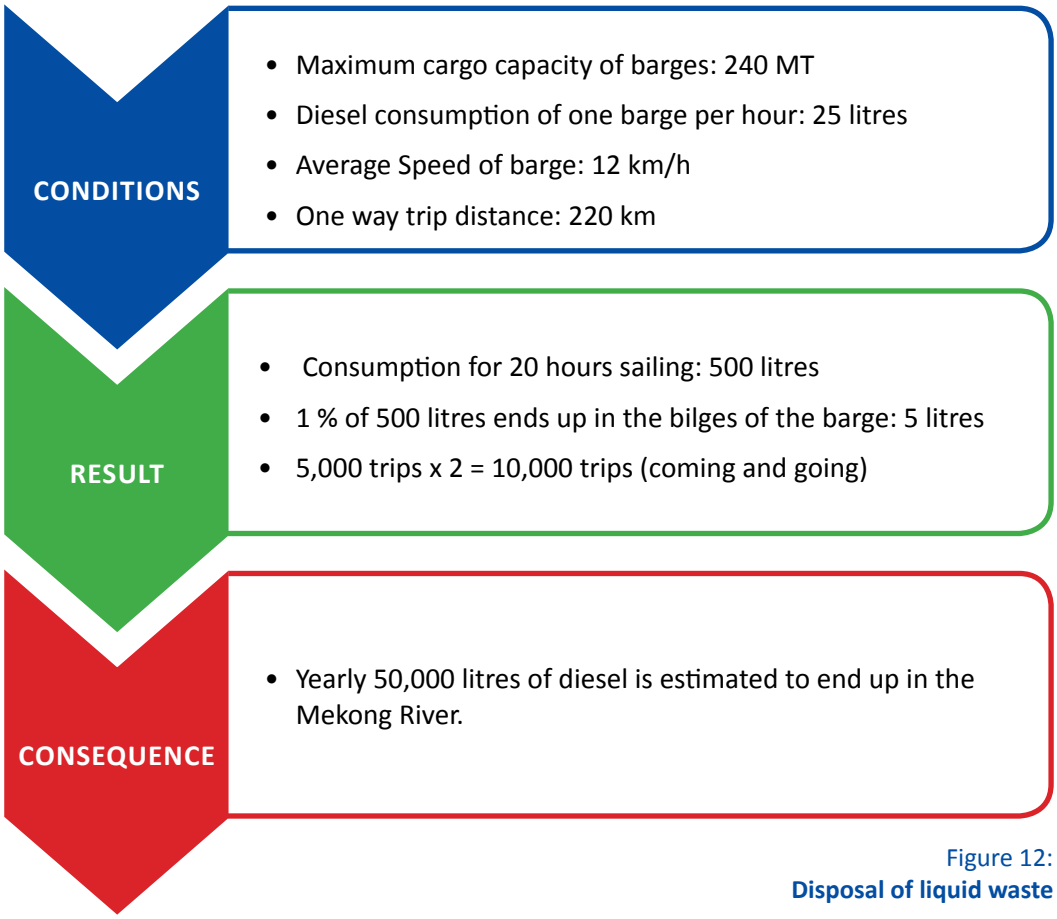

Figure 12:
Disposal of liquid waste

5.1.2.2 Solid Waste

Disposal of solid waste:

Assumption of the yearly quantity of solid waste generated by 5,000 barges calling at a port on the Mekong River and taking into account the following conditions:

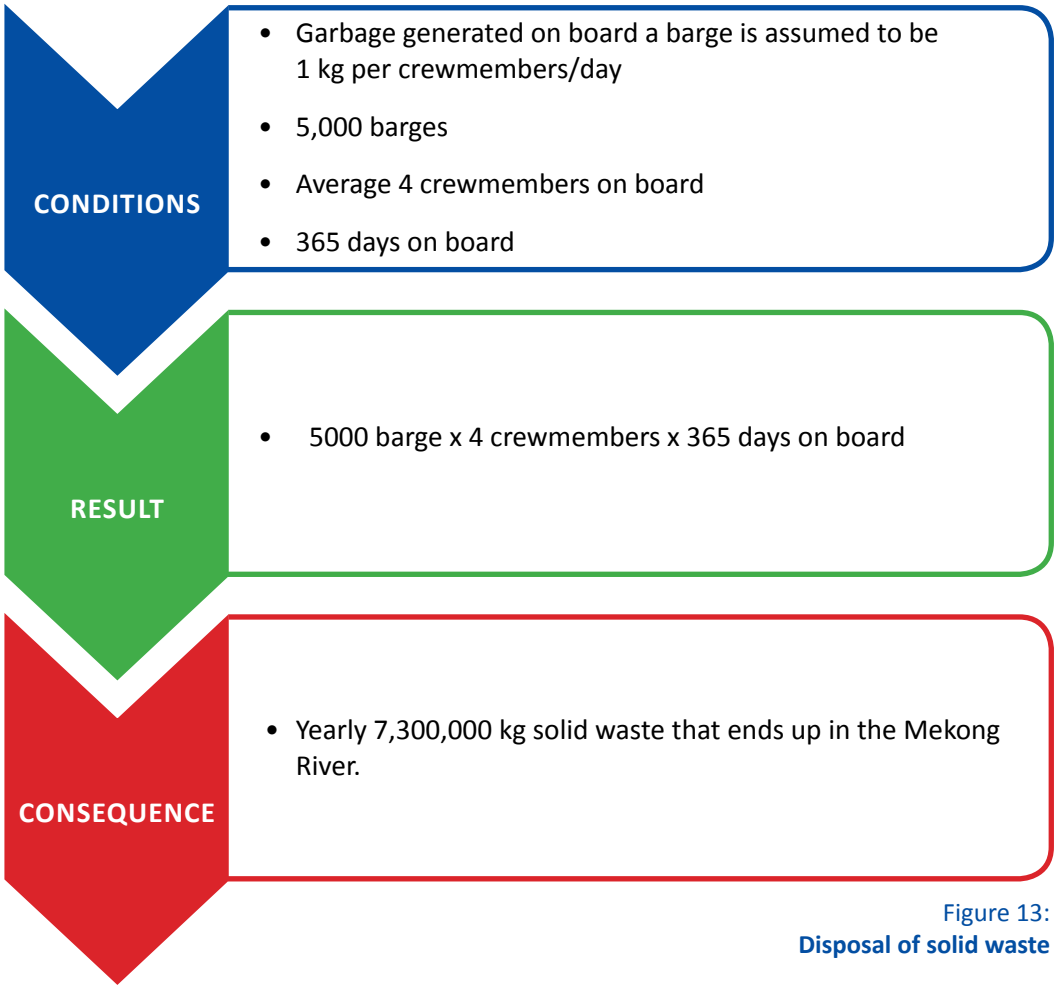

Figure 13:
Disposal of solid waste

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- Ship waste quantities prediction model for the port of Belgrade – Chemical Industry & Chemical Engineering Quarterly 17 (2) 239-248 (2011).
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- Guide to diagnosing contaminants in oily bilge water to maintain, operate and troubleshoot bilge water treatment systems, IMO – MEPC.1/Circ.677 22 July 2009.
- Intertanko – A guide for correct entries in the ORB (Part I – Machinery space operations) 11/2009.

5.2 Training and Education

Education and training have important strategic roles to play in the implementation of a waste management guidelines. Moreover, it is clear that, given the vast size of the Mekong River, violations of waste disposal are, and will continue to be difficult to detect and prosecute; accordingly, implementa-

tion must rely heavily on motivation and education of crew and shore personnel, to persuade them to comply voluntarily and give them, through training, the requisite skills and tools. What is needed is behavioural and ethical change.

Education and training programmes must be long-term. Education is a key tool for influencing a vessel's crew and port personnel, due to limited enforcement capabilities and the difficulty of reaching these sectors in any other way. There are three basic audiences for waste management education and training:

- the public;
- employees and/or visitors on vessels and in ports and in the supply chain; and
- managers of vessel, port, and supply operations.

Different types of programmes must be developed for each audience. The goal of all three types of programmes is implementation of the waste management guidelines, but the objectives should vary depending on audience characteristics.

5.2.1 Public Awareness Campaigns

Public awareness campaigns are directed at informing the general public about waste management and fostering support for compliance. The ultimate goal of such campaigns is social and cultural change. An example would be a multimedia campaign in riverside areas explaining the ecological harm caused by marine debris.

5.2.2 Education and Training for Employees

Education and training for employees in ports can help ensure that proper waste reduction, sorting, and disposal procedures are followed. Education would have to be a major component of Waste Management implementation efforts, because few crewmembers and shore personnel recognise the adverse effects of disposing garbage in the river. The greatest impact of early educational efforts can be in helping crewmembers and others recognise that improved handling of vessel and port related garbage is in their self-interest.

5.2.3 Management Education and Training

Education and training programmes must target management, including owners and operators of vessels and shore-based garbage management systems as well as government managers. These are the agents of change—professionals who oversee and influence others and establish organisational culture. Because they select organisational practices and materials, managers must be the key audience for information exchange programmes.

5.2.4 Role of the Government Sector

The role of the government is to provide leadership and limited funding. The private sector, including non-profit organizations, scientists, teachers, and community activists, can provide the experience and expertise needed to design and implement the programmes.

5.2.5 Projects

The development of a binder of informative materials to assist vessel operators, owners, crew and shore personnel in complying with waste management rules, is an important step in this process. The binder, distributed to shipping organisations, vessel owners and port authorities, include placards, the plastic control and minimization plan, sample waste management guidelines, examples of port reception facilities, guidelines for implementation, and various regulation and policies.

Five criteria that must be satisfied to create strong educational programmes:

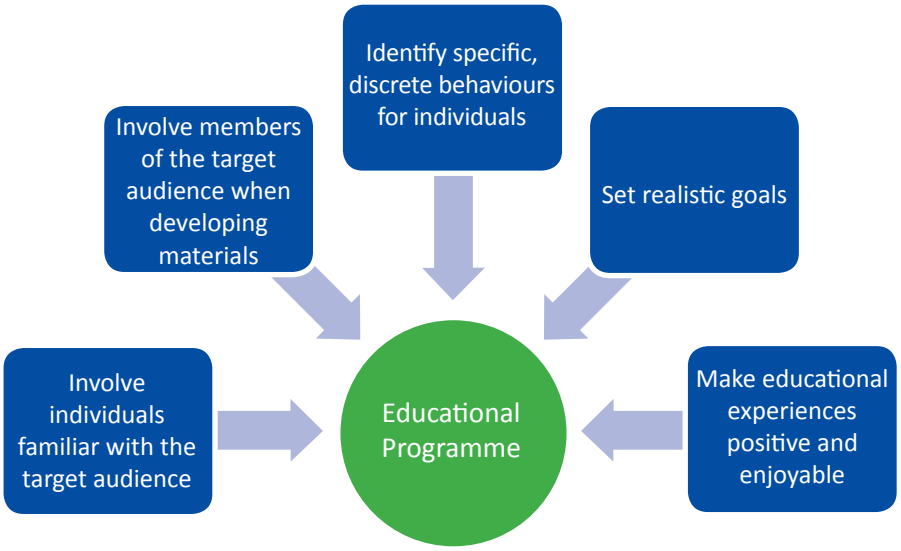

Figure 14: **Criteria for educational programmes**

The educational programme could include the following elements:

- *Targeted, Coordinated Efforts to Reach Multiple Audiences.* Education and training programmes need to be well-defined;
- *Appropriate Messages, Media, and Settings.* Education and training are most effective when the message clearly defines the problem in terms relevant to the target group, identifies with and responds to the specific needs of the target group, and offers viable solutions to the problem;
- *Train the Trainers.* Explore ways to enable the newly educated members of target groups, particularly unorganised groups such as recreational boat users, to become agents of change. These individuals could be taught how to conduct training for others and be given access to educational and other materials provided by the lead agency;
- *Evaluation.* The programme must include an evaluation process that emphasizes the strategic impact of different activities; and
- *Information Exchange.* The model programme would include a formal information exchange network reaching all maritime sectors, to assure that decision makers have access to knowledge about the latest waste management education and training strategies, garbage treatment equipment, and data.

References: *Clean Ships, Clean Ports, Clean Oceans: Controlling Garbage and Plastic Wastes at Sea, Committee on Ship borne Wastes, National Research Council (1995).*

6 RECOMMENDATIONS

6.1 Introduction - Waste Disposal Options

The waste management sector follows a generally accepted hierarchy. The hierarchy started as the "three Rs" – Reduce, Reuse, Recycle – but now a fourth **R** is frequently added – Recovery. The hierarchy responds to financial, environmental, social and management considerations.[1]

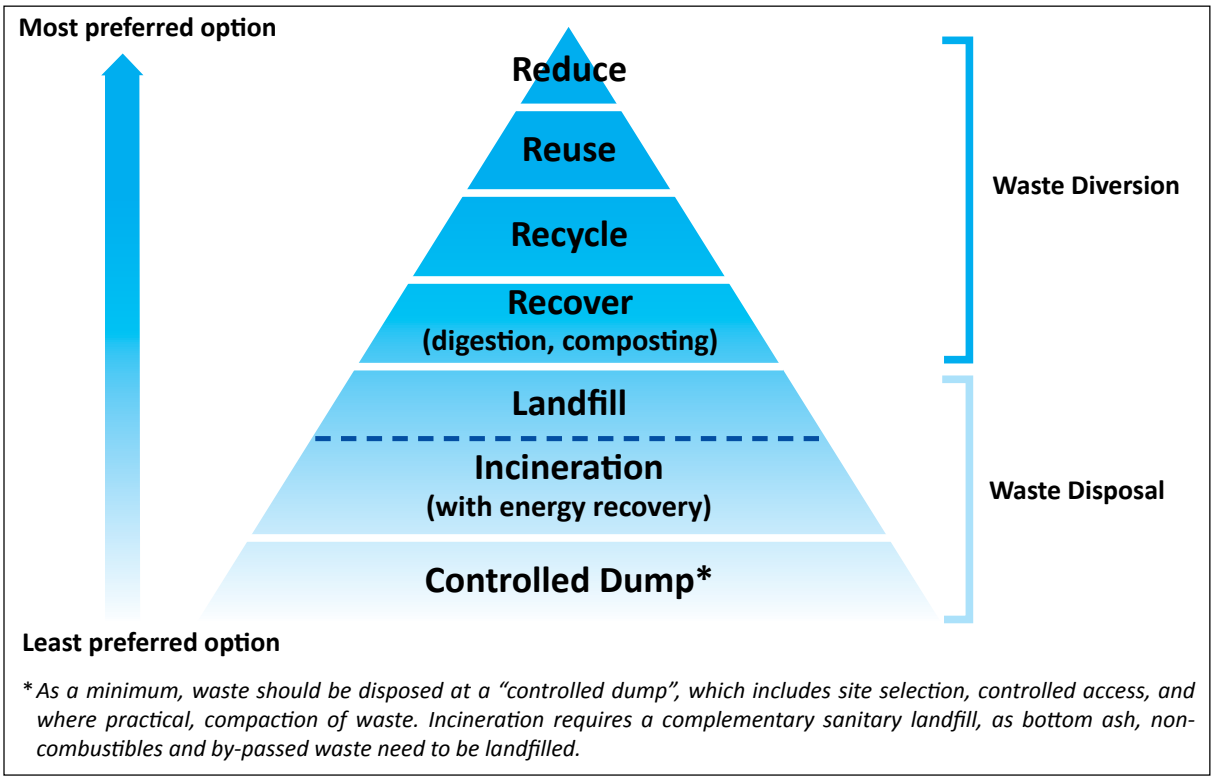

Figure 15: **Waste Hierarchy**

The Thai National Working group has assigned priorities for the waste disposal options according to capacities and available resources at Chiang Saen Commercial Port.

6.2 Integrating Vessel and Shoreside Garbage Management – General Recommendations

If a comprehensive, effective WMG is to be developed and implemented, a systems perspective is needed that views vessels and their ports of call as part of the same system.

[1] What a waste: A global review of solid waste Management, Urban development Series Knowledge Papers, Daniel Hoornweg and Perinaz Bhada-Tata, March 2012, No. 5, Urban Development & Local Government Unit, World Bank

The vessel garbage management system has two elements: the vessel and the port, which is the transfer point to the landside solid waste management system. Viewing the vessel and port as a system (henceforth referred to as the vessel garbage management system) significantly improves prospects for control and opens the door to solutions.

The challenge is to maximize the garbage handling capabilities of both the vessel and port and then establish a seamless interface. If this can be achieved, the goal of the waste management guidelines implementation can be achieved. Waste management alternatives include source reduction, recycling, composting, energy recovery, and landfilling.

Implementation of a WMG to date has been guided—or misguided—by a perception that the effort to implement controls over vessel garbage should be separated from other initiatives to control land-generated solid waste. In fact, vessel garbage is simply a poorly controlled solid waste stream that, logic dictates, would best be managed using principles and systems similar to those developed for land-generated waste.

Integration of the two systems, rather than development of redundant and parallel regimes for vessel and port garbage, could simplify implementation and minimize the burdens on regulatory agencies and the regulated mariners and ports, in that all could pursue compliance with a consistent national standard, operating within a coordinated regulatory régime. This approach would require the establishment of professional standards for waste management throughout the vessel-port system, as well as oversight and enforcement comparable to that carried out for land-based systems.

The vessel garbage management system depends on the key players to carry out the following roles:

- The role of vessel operators is to minimize waste through source reduction and to dispose of garbage in compliance with the law through on-board techniques and by delivering all other garbage to a port reception facility.
- The role of terminal operators and the port reception facility is to receive the remaining garbage and provide a simple process to transfer it to the well-developed disposal system for land-generated waste.
- The role of the existing land-based systems and their operators is to integrate the needs of vessel garbage handling into the system and to transfer technologies and methods into the vessel garbage management system.
- The role of boat manufacturers and shipyards is to ensure that all new vessels are designed to incorporate convenient garbage storage spaces and, where appropriate, garbage treatment technologies.
- The role of Provincial government is to help port and terminal operators establish and maintain garbage reception facilities.
- The role of the National government is to provide clear legislation, criteria, and guidelines to ensure that the transfer of waste is simple, and cost-effective.

6.3 Port Waste Reception Facilities

Presently at certain ports along the Mekong River, the port reception facilities seem partially insufficient to deal with ship generated waste. The lack of adequate facilities may result in waste being disposed into the Mekong River and then transported by wind and currents to shore often in locations distant from the original source. Therefore the port has to provide adequate port reception facilities for waste generated by shipping activities.

The main scope of port reception facilities for waste generated by shipping activities can be defined as follows:

- Provisions of receptacles for garbage. Segregation of various types of garbage may be useful and in some cases necessary;
- A regular collection service; and
- Recycling and/or final disposal of garbage.

Port reception facilities could be in one place or at several areas depending on the size of the port and the type and volume of waste to be collected. After determining the location of port reception facilities, receptacles should be placed in a compound or a shelter which can keep them safely. This will be effective in preventing garbage from blowing away. When deciding upon the location of the port reception facilities, the following issues should be considered:

- Other port operations should not be hindered;
- The risk of wastes entering the water should be minimized;
- The site should be in a convenient location for both the ship's crew and port personnel and vehicles;
- The site should have sufficient lighting to allow for and encourage garbage collection 24 hours a day;
- Garbage reception areas must be secure to prevent abuse or misuse and ensure the safety of the ship's crew and port personnel using them;
- The impact of the facilities on the surrounding community should be minimized, especially with respect to noise, odour and outer appearance;
- The facilities must comply with national, local and other applicable legislation on garbage collection and processing;

Port reception facilities require adequate capacity for efficient collection of ship generated waste; the following should be taken into consideration:

- Facilities should be capable of receiving those residues and mixtures that are handled within that port and which must be discharged to reception facilities;
- All ports shall provide adequate facilities to receive garbage and waste oil from engines;
- Receptacle capacity should meet demand in terms of size, the number of receptacles required, and space availability;
- Requirements for handling seasonal fluctuations in demand for waste disposal should be considered when determining receptacle capacity;
- Container sizes for receiving wastes will affect the servicing schedule. This has implications for labour and collection vehicle requirements. More frequent collection reduces health and safety concerns and requires less storage space, but may increase costs through the use of more vehicles and labour; and
- The receiving capacity shall be at least appropriate in time and availability to respond to the needs of ships using the port.

6.4 Waste Inventory – Priority: High

To apply the principles of integrated solid waste management, ports and vessel operators must first conduct a needs assessment, which includes determining how much and what sort of garbage is generated and the disposal restrictions. A waste management guidelines is then developed.

6.5 Waste Reduction – Priority: Medium

An important step in integrated waste management is the effort to reduce the amount of materials brought on board and in the port that will become garbage. This type of early intervention in the hazard evolution process has been largely overlooked in the past but is an important aspect when implementing a waste management guidelines. Source reduction demands the cooperation of vendors as well as vessel operators and crews.

A typical target in source reduction plans is plastic packaging. Each vessel operator tailors a source-control approach to fit the circumstances. Needs and supplies are examined, and excess packaging can be left on shore. Consumable items such as cleaning supplies and table condiments can be purchased in large receptacles for refilling smaller containers for daily use. Another approach is to discontinue the use of disposable plates, cups, and cutlery and equip the vessel with durable serving pieces. Waste minimization can be encouraged or required as a condition for bids, contracts, and purchase orders. Options available to decrease the amount of potential garbage include the following:

- Bulk packaging of consumable items may result in less waste being created.
- Reusable packaging and containers can decrease the amount of garbage being generated.

On board generation of garbage may and shall be minimized by:

- Limiting and/or replacing disposable items such as cups, utensils, towels and other convenience items with washable items when possible.
- Using provisions packaged in materials other than disposable plastic.
- Preferring consumable items with adequate shelf life once their packaging is open.

The generation of waste is specific to individual ship and shore activities and cargoes. Action should be taken to minimize the generation of garbage associated with various categories of cargoes. Available options are listed below:

- Consider replacing disposable plastic sheeting used for cargo protection with a permanent, reusable covering material.
- Consider stowage systems and methods that reuse coverings, dunnage, shoring, and lining and packing materials.
- Dunnage, lining and packaging materials generated in port during cargo discharge should preferably be disposed of in the Port Reception Facilities (PRF) and not retained on board for discharge.

Cargo residues are created through inefficiencies in loading, discharging and on board handling:

- Cargo residues are potential pollutants and may be difficult for port reception facilities to handle. It is recommended that cargo be unloaded as efficiently as possible in order to avoid or minimise cargo residues.
- Spillage of the cargo during operations should be carefully controlled, both on board and from

dockside. Since this spillage typically occurs in port, it should be completely cleaned up prior to sailing and either delivered into the intended cargo space or into the PRF. Shipboard areas where spillage is most common should be protected so that the residues are easily recovered.

- Plastic Refuse Bags; Vessels and ports should avoid using plastic bags for collecting garbage (to the extent this is feasible). Instead of plastic bags, craft paper, or water resistant bags, should be used.

6.6 Waste Segregation and Reuse – Priority: High

Both clients and providers of waste reception facilities should wherever possible segregate waste into different categories to facilitate the reuse, recycling or disposal of the resources or waste. With the increase in recycling and waste processing, the segregation of materials within the waste stream is becoming of increasing value. Managers of reception facilities should ensure that wastes are not mixed by their clients or when stored within the reception facility.

Where possible, waste should be segregated for reuse or partially treated to a reusable state rather than being sent for disposal. In some areas the ability to reuse materials such as organic waste is becoming an option for disposal. The precise requirements for storing the material for reuse will need to be determined with the user of this material during the planning phase of the establishment of the reception facility. Reuse of waste is feasible in some situations, such as storage of water used for tank washing to allow their reuse for future washing of tanks.

Segregation is best accomplished with standard, colour-coded containers and simple, appropriate training programmes. Each vessel operator tailors training to fit the circumstances. Short video presentations, followed by practice and demonstrations, greatly assist in crew and harbour personnel training.

To reduce or avoid the need for sorting after collection, the categories of distinctively marked garbage receptacles must be provided in order to receive garbage as it is generated.

These separate receptacles would receive:

- Plastics and plastics mixed with non-plastic garbage;
- Food wastes;
- Paper products, rags, glass, metal bottles, crockery etc.; and
- Oily rags and any other oily material.

These receptacles shall be fitted with a tight cover. All types of garbage collection receptacles shall be clearly marked with the type of garbage they are receiving.

Table 2: **Colour Codes of Receptacles - Example**

COLOUR	RECEPTACLES FOR
	Food Waste
	Paper products, rags, glass, metal bottles, crockery, etc
	Plastics
	Oily rags and other oil material

Figure 16:
Colour coded waste bins - Example[2]

[2] http://www.thekitchn.com/kitchen-recycli-28484

6.7 Waste Recycling – Priority: Medium

Waste recycling is defined as using valuable components of waste in other processes. Recycling is preferred to disposal. However some reception facilities may not have access to recycling systems due to remoteness or other local reasons. Where plastics can be received for reuse or reprocessing, reception facilities should indicate clearly which plastics are acceptable to the local system. Similarly, receptacles for all recyclable materials should be labelled clearly showing the degree of segregation required. The recycling of used oils has significantly increased in recent times and every opportunity should be taken to ensure that recycling of used oils is carried out.

Figure 17: **Signs for Recyclable and Non-Recyclable Waste**

Assuming adequate on-board storage space is available, port waste disposal volumes can be reduced if recyclable materials are separated. Easily recycled materials include aluminium and steel cans, glass bottles, plastic bottles, newspapers, and cardboard packaging. Other materials that may be recycled include metal parts, fishing nets, ropes, and other gear. Materials that cannot be recycled are polystyrene food trays, multi-laminated plastic foils, paints, solvents and glues.

Obviously, recycling only makes sense if the port reception facility and the land-based waste management facilities can accept the specific, separated recyclable materials and have the capacity to provide recycling services.

Table 3: **Waste Reusable or Recyclable**

WASTE CATEGORY	WASTE DESCRIPTION	REUSABLE OR RECYCLABLE
SOLID	Hazardous substances	NO
	Paper	YES
	Metals, glass	YES
	Plastics	SOME
	Fishing nets and other equipment	NO
	Medical Waste	NO
	Hold sweepings	NO
	Galley Waste	NO
	Fish, animal or livestock wastes	SOME
	General garbage	NO
LIQUID	Waste Oil	YES
	Oily mixtures including fuel residues	YES
	Oily mixtures containing chemicals	POSSIBLY
	Tank wash water	YES
	Noxious liquids	NO
	Sewage	NO

Figure 18:
Waste recycling

Figure 19:
Recycle symbol

6.8 Bilge Water /Oily–Water Disposal – Priority: High

6.8.1 Collection

On a ship, oil often leaks from engine and machinery spaces or from engine maintenance activities and mixes with water in the bilge, the lowest part of the hull of the ship. Oil, gasoline, and by products from the biological breakdown of petroleum products can harm fish and wildlife and pose threats to human health if ingested. Even in minute concentrations, oil can kill fish or have various sub-lethal chronic effects. Bilge water may also contain solid wastes and pollutants containing high amounts of oxygen-demanding material, oil and other chemicals.

Different sources estimate that about two percent of daily Heavy Fuel Oil (HFO) consumption and about 0.5 percent of the daily MDO consumption remains as sludge. To maintain ship stability and eliminate potentially hazardous conditions from oil vapours, the bilge spaces need to be flushed and periodically pumped dry. Bilge water should be pumped over to reception facilities or bilge barges designed for collecting bilge water.

Engine bilge water is specific and hazardous to the environment as it is a liquid compound of water and oil products capable of making steady emulsions. It also acquires specific properties during various technological processes. In order to manage this specific waste it is important that the correct equipment is used and that technological process are sound to ensure that any combustible and flammable elements are controlled. For this reason, separation of this oily water from the common oil-polluted waste, and analysis of these streams of waste treatment, are of great importance in enhancement of the effectiveness of environmental protection during the management process of this oily waste.

Figure 20: **Oil spill**

6.8.2 Disposal

The residues and mixtures can be «disposed of » in two environmentally friendly ways: by using the oil-water separator or pumping to a shore reception facility.

Using the oil-water separator: An Oil Water Separator (OWS) is a piece of shipboard equipment that allows a vessel's crew to separate oil from bilge water before the bilge water is discharged overboard. Bilge water is an almost unavoidable product in ship operations. Bilge water that is generated in proximity to shipboard equipment (such as in the engine room) often contains oil and its direct discharge would result in an undesirable transfer of waste oil to the marine environment.

Bilge waste water is pumped out from the bilge spaces of the machine room and collected and separated by an oily water separator called the 15 ppm separator; if the fluid produced by the separator has a ppm reading of less than 15 ppm, the fluid can be pumped overboard.

Research has however determined that, the oily-water separator is not always a reliable working instrument. The oily-water separator is produced and then tested in labs but is often out of use or not working properly due to the movement of the vessel, vibrations, high temperatures, and the quality of the residues it has to treat (fuel oils, lube oils, grease and chemicals). These are not reliable operating conditions.

Pumping to a shore reception facility: Therefore, the only proper and efficient way to dispose bilge water and prevent pollution from contaminated (oil, chemicals, grease) water is by discharging and pumping ashore, which requires specialized equipment, infrastructure and specific waste management in the port for storage and treatment.

Current situation: This facility is, as in many ports, not available, leaving vessel's crews no other choice than pumping bilge water and sludge overboard, despite the fact that any form of pollution from vessels is forbidden and sanctioned under different regulations.

According to a realistic (optimistic) calculation, presently every year 50,000 litres of diesel ends up in the Mekong River as a mixture of oil and water or bilge water. (page 17).

Figure 21: **Oil-water separator on board cargo barge**

Figure 22: **Oil-water separator**

References: *Managing engine room residues, H.Ardillon, Association Francaise des Captaines de Navires.*

Analysis of Polluted Oily Water Management in Klaipėda Sea Port, Gediminas Stonkus, Jolanta Dvarionienė, Goda Zobėlaitė, 2010.

6.9 Compactor – Priority: Low

Among equipment for processing garbage such as incinerators, compactors and comminuters, the compactor is a useful working tool. Compaction can reduce the volume of garbage to a compaction ratio which may be as high as 12:1. Most garbage can be compacted. The exceptions include ground plastics, fibre and paperboard, bulky cargo containers and thick metal items. Pressurized containers should not be compacted as they present an explosion hazard.

Figure 23:
Waste compactor

Table 3: **Compaction characteristics for shipboard- and port- generated waste**

Typical examples	Special handling by vessel personnel before compaction	Compaction characteristics			Onboard storage space
		Rate of alteration	Retainment of compacted form	Density of compacted form	
Metal, food and beverage containers, glass, small wood pieces	None	Very rapid	Almost 100%	High	Minimum
Comminuted plastics, fibre and paper board	Minor - reduce material to size for feed, minimal manual labour	Rapid	Approximately 80%	Medium	Minimum
Small metal drums, uncomminuted cargo packing, large pieces of wood	Moderate - longer manual labour time required to size material for feed	Slow	Approximately 50%	Relatively low	Moderate
Uncomminuted plastics	Major-very long manual labour time to size material for feed; usually impractical	Very slow	Less than 10%	Very low	Maximum
Bulky metal cargo containers, thick metal items	Impractical for shipboard compaction; not feasible	Not applicable	Not applicable	Not applicable	Maximum

Table 4: **Incineration characteristics for shipboard- and port- generated garbage**

Typical examples	Special handling by vessel personnel before incineration	Incineration characteristics				Onboard storage space
		Combustibility	Reduction of volume	Residual	Exhaust	
Paper packaging, food and beverage containers	Minor - easy to feed into hopper	High	Over 95%	Powder ash	Possibly smoky and not hazardous	Minimum
Fibre and paper board	Minor - reduce material to size for feed; minimum manual labour	High	Over 95%	Powder ash	Possibly smoky and hazardous based on incinerator design	Minimum
Plastic sheeting, netting, rope and bulk material	Moderate manual labour time for size reduction	High	Over 95%	Powder ash	Possibly smoky and hazardous based on incinerator design	Minimum
Rubber hoses and bulk pieces	Major manual labour time for size reduction	High	Less 95%	Powder ash	Possibly smoky and hazardous based on incinerator design	Minimum
Metal food and beverage containers, etc.	Minor - easy to feed into hopper	Low	Less 10%	Slag	Possibly smoky and not hazardous	Moderate
Metal cargo, bulky containers, thick metal items	Major manual labour time for size reduction (not easily incinerated)	Very low	Less 5%	Large metal fragments and slag	Possibly smoky and not hazardous	Maximum
Glass food and beverage containers, etc.	Minor - easy to feed into hopper	Low	Less 10%	Slag	Possibly smoky and not hazardous	Moderate
Wood, cargo containers and large wood scraps	Moderate manual labour time for size reduction	High	Over 90%	Powder ash	Possibly smoky and not hazardous	Minimum

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Office of the Secretariat in Phnom Penh (OSP)
576 National Road, #2, Chak Angre Krom,
P.O. Box 623, Phnom Penh, Cambodia
Tel: (855-23) 425 353
Fax: (855-23) 425 363

Office of the Secretariat in Vientiane (OSV)
Office of the Chief Executive Officer
184 Fa Ngoum Road,
P.O. Box 6101, Vientiane, Lao PDR
Tel: (856-21) 263 263
Fax: (856-21) 263 264