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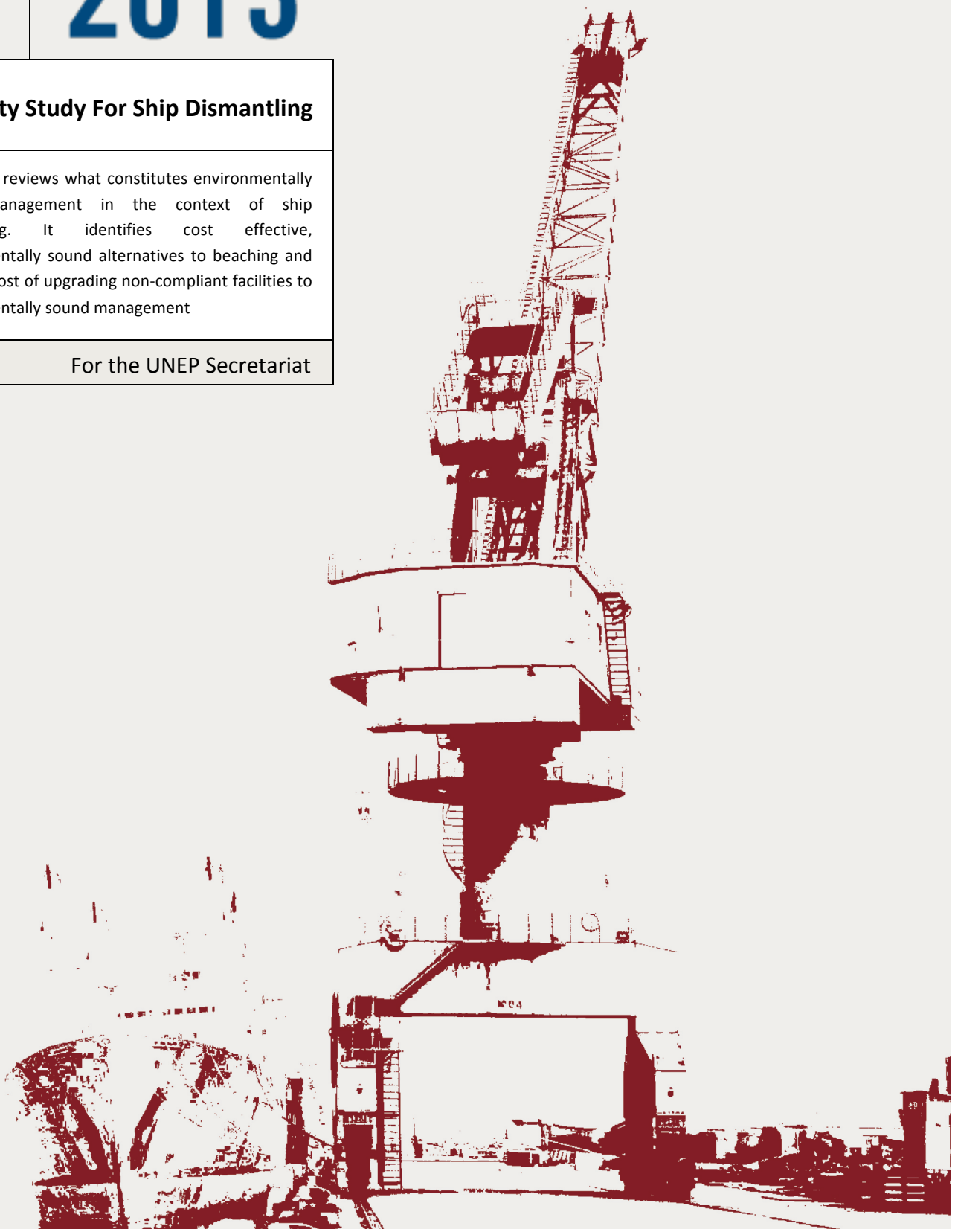
Feasibility Study For Ship Dismantling

This study reviews what constitutes environmentally sound management in the context of ship dismantling. It identifies cost effective, environmentally sound alternatives to beaching and presents cost of upgrading non-compliant facilities to environmentally sound management

For the UNEP Secretariat



EXECUTIVE SUMMARY

This study considers the concept of environmentally sound management in the context of ship dismantling.[1] It identifies cost effective, environmentally sound alternatives to the beaching method of ship recycling and presents the cost of upgrading non-compliant facilities to the standards of environmentally sound management. The defined basis for the present study is that those facilities employing alternative ship recycling methods, such as the pier-breaking method (also known as "alongside") as used in China and European countries or the landing and slipway method as employed in Turkey, are easier to upgrade to comply with the principles of environmentally sound management than a traditional beaching facility.

Environmentally sound management is considered in the context of the main international regulatory drivers of ship recycling: the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal, the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships and the relevant ILO instruments, recommendations and guidelines. During the course of the study a number of stakeholders in the ship recycling industry, facilities employing environmentally sound ship recycling methods and ship owners using such facilities were contacted to identify sound operational and infrastructural parameters. This included a field mission to China with meetings with responsible legislators, a ship recycling yard and several waste management facilities. Based on the international regulatory drivers and stakeholder meetings, this study assess environmentally sound standards for the following stages of ship recycling:

1. Documentation of hazardous materials prior to dismantling.
2. Procedures for identification of hazardous materials.
3. Procedures for handling of hazardous materials in the actual dismantling process.
4. Procedures for handling, disposal, storage and treatment of hazardous materials.
5. Quality assurance schemes.

The costs to upgrade to environmentally sound management were estimated for a model facility depending on its particular starting point. The main model facility is assumed to have a 100,000 LDT dismantling capacity per year, however to accommodate any need for comparing upgrade requirements for smaller facilities, a cost analysis for 25,000 LDT and 50,000 LDT is included. The differences in investments between the different sized model facilities are primarily due to less new infrastructure (concrete cost) and less use of heavy machinery (both directly proportional to capacity).

Four cases were developed with different starting points for the upgrade cost calculations. Two cases use an existing non-compliant facility as the starting point (case 1 and 2) and in the remaining two cases a site with no previous recycling operations is taken as starting point (case 3a and 3b). It is assumed for the cost estimations that port facilities and basic infrastructure such as quays and access roads

[1] Also referred to as ship recycling, breaking or scrapping.

are already in place and that establishment of major downstream waste management facilities is outside the budgeting of an individual model ship recycling facility.

The total investments needed for the respective cases are given in Table 1, together with a sensitivity analysis of potential variations in the key cost components. The key cost components comprise the construction of paved surfaces to contain spillage and investments in heavy machinery. A total of 35% of the investment is for heavy machinery and dismantling equipment, and 51% is for yard infrastructure and structures. The difference between upgrading to pier breaking and slipway breaking from a basic pier or a harbor area with no prior ship recycling activity is only 4%, with the additional cost for establishing the slipway facility due to the need for barges or floating piers to be able to provide sufficient access for cranes. Together the key cost components make up >90% of the investment for all upgrade cases and greatly impact the lower and upper cost boundaries for upgrading to a compliant model facility.

Table 1
Comparison of total upgrade cost to achieve compliance for ship recycling facilities of different capacity. Only the two main cost components comprising more than 90% of total costs are included. Rounded numbers are shown. For details see Section 8. Investment given in 2012 USD.

	Grand total cost (USD)	**Impermeable surfaces sensitivity.**	**Heavy machinery sensitivity.**	**Impermeable surfaces and used machinery combined.**	**Impermeable surfaces sensitivity.**
	Mean concrete price and new machinery used.	With low concrete costs.	With used machinery.	Lower range of total cost	Higher range of total cost
Large 100,000 LDT					
Existing pier (1)	9,500,000	7,600,000	8,100,000	6,300,000	12,100,000
Existing slipway (2)	21,000,000	17,000,000	17,500,000	13,600,000	26,500,000
Basic pier (3a)	23,900,000	20,000,000	20,100,000	16,200,000	29,500,000
Basic harbor (3b)	24,900,000	21,000,000	21,100,000	17,200,000	30,400,000
Medium 50,000 LDT					
Existing pier (1)	3,900,000	2,900,000	3,100,000	2,600,000	5,200,000
Existing slipways (2)	12,900,000	10,900,000	9,900,000	8,000,000	15,600,000
Basic pier (3a)	14,300,000	12,600,000	11,200,000	9,300,000	17,300,000
Basic harbor (3b)	14,800,000	12,900,000	11,700,000	9,800,000	17,600,000
Small 25,000 LDT					
Existing pier (1)	1,900,000	1,500,000	1,900,000	1,400,000	2,600,000
Existing Slipways (2)	7,500,000	6,500,000	5,300,000	4,300,000	8,900,000
Basic pier (3a)	9,500,000	8,600,000	6,700,000	5,700,000	11,000,000
Basic harbor (3b)	9,700,000	8,800,000	6,900,000	5,900,000	11,100,000

An incremental implementation timeline for upgrading a ship recycling facility were also developed that envisage how investments in the upgrade components are distributed over time. The implementation timeline outlined in the UNEP study "Case Study to Develop Models of Compliant Ship Recycling Facilities " (Final version from 2012) was used as basis with the three incremental steps: <1 year; 1-3 years and 3-7 years.

The analysis of the incremental investments shown in Table 2 reveals that the bulk of the investments for case 1 and 2 will need to be made within steps 2 and 3 and that the investments primarily consist of heavy machinery and dismantling equipment (31% - 35% of total) and yard infrastructure and structures (58% of total). For both

case 3a and 3b the bulk of the investments are attributable to Step 1 (45% and 46%, respectively), due to the fact that heavy machinery and dismantling equipment are not available from the start.

Table 2
Overview of how the cost of upgrade is distributed within the incremental steps.

Upgrade from		<1 year	1-3 years	3-7 years
Case 1	Existing pier breaking	16%	36%	48%
Case 2	Existing slipway	9%	37%	54%
Case 3a and 3b	Basic pier/harbor area	45%/46%	31%	23%

A number of locations with previous history of ship recycling could be appropriate for a case 1 pier breaking upgrade such as locations in ports in India and China that have existing pier breaking facilities. Other alternative locations which have little or no previous ship recycling industry could be locations in the Dominican Republic in the Caribbean and Mexico. The slipway method (case 2) is often used in rivers and estuaries with little tidal movement and where the sites are protected from waves, weather and changing currents. These sites often break ships that are somewhat smaller than those broken at pier-breaking sites. A case 2 upgrade may be appropriate for existing larger locations such as in Mumbai and on a number of small domestically-oriented locations. A number of locations globally could be appropriate for case 3a and 3b upgrade, because basically any port infrastructure or ship repair yard may meet the requirements. In Asia, the Philippines and Indonesia have already expressed their interest in this industry, also Vietnam and Thailand have previously engaged in ship recycling, and it should be emphasized that the ports of Karachi in Pakistan and Chittagong in Bangladesh are both close to the manpower and experience of existing ship recycling communities and can offer the basic port infrastructure needed.

The key stakeholders for the involvement in a shipbreaking model facility comprise a number of parties both national and international and will depend on the actual location of the facility. It is however of value to ensure the active participation of both authorities and local trade unions and industry associations.

The regulatory drivers for the development of safe and environmentally sound ship recycling are the international conventions addressing the issues of safety in the workplace and proper management of hazardous waste. The key barriers for moving towards a greener ship recycling industry comprise a lack of political will to legislate and enforce, fear of job loss, lack of contractual requirements in secondhand trade or scrap trade and a lack of a transparent way of identifying compliant ship recycling yards. A list of the key barriers and proposed actions to overcome them is provided in Table 3.

Table 3
General action plan for the establishment of a model ship recycling yard

Barrier	Actions to achieve progress (apply to recycling sector)	Stakeholders	Specific for model facility (assuming Asian location)
Little political will to legislate	To the extent possible, act within existing regulation; support ratification of Hong Kong and other conventions	National and/or state authorities: ministries of industry, work, environment and other relevant entities	Develop action plan to introduce incremental progress (based on Case Study)
Limited willingness within authorities to enforce regulation	Develop map and plan of incremental progress	Partnership with local industry association	Develop action plan to introduce incremental progress
Fear of job loss among workers	Provide training and upgrade competencies	Labourers and their organizations	Introduce long-term contracts, including training periods
Fear of loss of revenue among yard owners	Introduce "green recycling" market and long-term contracts with select owners	Responsible owner(s), support from shipowners organization	Establish formal agreement with shipowners on a number of vessels/year
Fear of costly public investments among downstream facilities such as disposal facilities	Establish an HW supply chain for local industries and provide donor funds for an HW facility	Industry organization(s), local authorities	Provide matching funds for permanent facility and establish an HW collection mechanism
Lack of embedded requirements from shipowners or lenders in secondhand trade or scrap trade	Introduce supply chain commitments on corporate social responsibility, Equator principles, BIMCO contracts and similar	Shipowners in the UN Global Compact	Agreement with responsible owner
Selection of verified ship recycling yards when considering safe and environmentally sound ship recycling	Introduce national ranking system, upgrade to EU listing and upgrade to HKC compliance	National ship breakers association, partnering with European Commission or the IMO	Ensure facilities' appearance on national and international lists of approved yards

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Foreword

This study was commissioned by the UNEP Secretariat of the Basel, Rotterdam and Stockholm conventions and funded through a grant received from the European Commission. The study was tendered under the title 'Feasibility study for ship dismantling and conducted in the period September 2012 to April 2013 by Svend Overgaard, Ditte Kristensen, Matthew Woods and Frank Stuer-Lauridsen, LITEHAUZ (Denmark).

List of Acronyms

BIMCO	Baltic and International Maritime Council
CPP	Contingency Preparedness Plan
DWT	Dead weight tonnage
EC	European Commission
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
ESM	Environmentally Sound Management
HEPA	High Efficiency Particulate Air
HKC	Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009
ICS	International Chamber of Shipping
IHM	Inventory of Hazardous Materials
ILO	International Labour Organisation
INTERCARGO	International Association of Dry Cargo Shipowners
IPTA	International Parcel Tankers Association
ISO	International Organization for Standardization
ITF	International Transport Workers' Federation
LDT	Light Displacement Tonnage
MP	Monitoring Plan
ODS	Ozone-depleting substances
OECD	Organization for Economic Cooperation and Development
PCB	Polychlorinated Biphenyl
PPE	Personal Protective Equipment
SRF	Ship Recycling Facilities
SRFP	Ship Recycling Facility Plan
SRP	Ship Recycling Plan
TBT	Tributyltin
WMP	Waste Management Plan

Glossary of Terms

Aframax	A ship smaller than 120,000 metric tonnes and with a breadth above 32.31 m. The term is based on the Average Freight Rate Assessment tanker rate system
Basel Convention	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, adopted March 1989
Dead weight tonnage	(DWT) measure of the carrying capacity of a ship when fully loaded. It includes cargo, fuel, water (potable, boiler, ballast), stores, passengers, and crew.
Decommission	The decision and process of taking a ship out of service.
Demolition	The process of taking a ship apart
Dismantling	The process of taking a ship apart
Displacement (tonnage)	The weight of the water that a ship displaces when it is floating with its fuel tanks full and all stores aboard; term originally used for naval vessels
Gas-free certificate	A certificate stating that the atmosphere in a tanker's cargo tanks is safe for work using cutting equipment
Gross tonnage	Total capacity of a ship's hull below upper deck
Hong Kong Convention	Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, adopted in Hong Kong May 2009
Inventory of Hazardous Materials	A list of hazardous materials on board a ship, a requirement of the Hong Kong Convention
International Labour Organization	A tripartite United Nations agency responsible for drawing up and overseeing international labour standards
International Organization for Standardization	International standards setting body (ISO) responsible for developing standards, hereunder are the environmental management standard series ISO14000 and ISO 30000 on Ship Recycling Management Systems
International Maritime Organization (IMO)	The United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships
Light displacement tonnes (or lightweight)	The weight of the ship excluding cargo, fuel, ballast, stores, passengers, crew, but including liquids in piping
Occupation Health and Safety Assessment Series (OHSAS 18001)	Internationally accepted system for managing the activities and processes in an organization in order to reduce or eliminate occupational health and safety risks to employees
Ship recycling	The process of taking a ship apart
Scrapping	The process of taking a ship apart
Ship breaking	The process of taking a ship apart; term used by ILO, EU, and many national ship breakers' associations
Ship Recycling Convention	Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships adopted, May 2009

1 INTRODUCTION

For the past decade, dismantling practices for large seagoing vessels have been the subject of international concern, particularly from a social and environmental perspective. Shipbreaking on beaches in Pakistan, India and Bangladesh has for a long time received criticism, and efforts aimed at addressing those concerns have emerged internationally. In particular, the Basel Convention (BC) and the International Labour Organization (ILO) published guidelines specific for the recycling of vessels in 2003 and 2004, respectively. The International Maritime Organization (IMO) published guidelines in 2003, and in May 2009 the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (the Hong Kong Convention or HKC) was adopted.

A number of shipowners are now seeking greater control over the conditions under which their ships are demolished and hazardous materials (HMs) are handled and disposed of. While many shipowners have company environmental policies or are members of the UN Global Compact, these owners mainly maintain relatively young fleets and are rarely the owners of end-of-life ships. A minority of owners have started to consider the full environmental impact and the costs of building, operating and recycling ships. Though significant efforts to apply environmentally sound management have been made in China and Turkey, the major part of the globally recycled tonnage is still scrapped under conditions dominated by practices not decisively altered for decades.

The commercial process of trading a ship for recycling is different from other waste trades. This is because a ship is often not identifiable as waste upon export (i.e., when it leaves its last port under its own power and the owner has not signaled any intent to dispose of the vessel) but rather upon import to the shipbreaking country. Because the ship is typically owned by a company registered in a third country and is associated with a flag and legally governed by regulation of a fourth country, the proper and responsible enforcement by authorities is challenging.[2] The Hong Kong Convention was developed as a tailored instrument to regulate the global ship recycling industry by catering to the realities of world maritime transport which includes flag, port and recycling States. Opposed to the legal complexities of trading ships for recycling stands the absolute simplicity of the commodity: a standard merchant ship, such as an Aframax tanker, has easily 15,000 tonnes of valuable steel in one item, representing some six million USD in scrap value. The sheer scale and value of the asset makes trading attractive.

The choice between green recycling and conventional programmes is dictated in most shipping companies by a simple profit consideration, provided that the ship can operate under its own power. Consequently, more than 70% of ships are scrapped on the beaches in South Asia. In anticipation of the HKC and to comply with their own corporate social responsibility standards, a limited number of shipping companies have developed mechanisms for sending their end-of-life vessels to recycling facilities

[2] Here we are omitting the further complicating issues of the nationality of the owner's representative (the captain) and the possibility of intermediate ownership by cash buyers.

that operate under safe and environmentally sound ship recycling conditions. These facilities are primarily found in China.

In brief, the conventional trading of a ship will involve a decision by its owner that the vessel is too costly to operate and that its secondhand value is more attractive. The sale process may involve a broker looking to sell for further trading options; however, if the scrap market offers higher prices, quotes will be taken from cash buyers. Upon a complete sale, the cash buyer will have negotiated a price with the recycling yards, and either the ship will be delivered by the owner's crew directly to the yard or a special crew will take the ordinary crew's place and finalize the ship's voyage from an agreed upon port. Only rarely is the exporting country notified of the trade of a ship. This will occur if a vessel is destined for dismantling and the owners' intention has been declared to the state of export. In such case national authorities are obliged to ensure the prior informed consent procedure under the Basel Convention is followed. However, the reality is that the involvement of authorities is usually limited to the country of import, where various permits are issued and the scrapping is surveyed.

Currently, in the case of responsible recycling the shipowner engages typically with a specialized broker or has a firm relationship with a preselected, duly inspected facility. Despite Basel Convention requirements, the national authorities of the export country are not normally notified, but the importing country is notified. An important difference from conventional recycling is that responsible owners typically retain some control[3] over the dismantling process until the keel is broken and therefore assume responsibility for the recycling and disposal process. Under a future HKC regime, a notification process will be initiated involving both the flag state and the recycling state.

Most of the material extracted during the process of ship recycling is put to use once again. Steel is recycled or reprocessed as steel production from scrap offers a considerable saving in energy consumption as compared to ore refining. Also, equipment and electrical devices, lifesaving equipment, sanitary equipment, compressors, pumps, motors, valves, generators, etc., are recycled for alternative applications. In this respect, the recycling of ships complies with the principles of sustainability; however, in many cases the procedures of dismantling, extracting and regenerating do not comply.

A recent Case Study on ship recycling conducted for the United Nations Environment Programme (UNEP) Secretariat of the Basel, Rotterdam and Stockholm conventions (final report, July 2012)[4] describes models for compliant ship recycling facilities (SRFs) with respect to the requirements outlined by the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal and the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships. The focus of the Case Study is to identify actions to be undertaken with respect to environmentally sound management to facilitate compliance with the two conventions.

[3] For example through on-site monitoring and inspection

[4] http://www.basel.int/Implementation/TechnicalAssistance/ShipDismantling/CapacityBuilding/tabid/2764/Default.aspx#section2

The Case Study points to segregation and safe provisional storage of hazardous materials (HMs) at ship recycling facilities to be the main areas required for improvement. In particular, it specifies impermeable surfaces for provisional storage facilities; on-site infrastructure; and off-site specialist treatment facilities, such as engineered landfill for asbestos, safe incineration of polychlorinated biphenyl (PCB) waste and safe handling of ozone-depleting substances (ODS). The compliant ship recycling models presented apply a stepwise progression (as both mid- and long-term upgrades) of ship recycling facilities, including easily applicable, low-cost techniques; improved management; and more long-term investments in equipment and facilities.

This study reviews what constitutes environmentally sound management in the context of ship dismantling and identifies cost effective, environmentally sound alternatives to the beaching method of ship recycling. It provides models of alternative environmentally sound ship recycling operations and costing estimates for the establishment of such facilities as well as identifying potential sites and the regulatory drivers for the establishment.

1.1 Basel Convention

The Basel Convention on the Control of Transboundary Movement of Hazardous Waste and Their Disposal (the Basel Convention or BC) (BC, 1989) was adopted in March 1989 and entered into force in May 1992. The international agreement seeks, among other things, to provide for the environmentally sound management of hazardous and other wastes. According to Article 2.8 of the Convention:

> "Environmentally sound management of hazardous wastes and other wastes" means taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner, which will protect human health and the environment against the adverse effects, which may result from such wastes.

The provisions of the Basel Convention have the following principal aims:

- To reduce the generation of hazardous waste and to promote environmentally sound management of hazardous waste, wherever the place of disposal
- To restrict transboundary movement of hazardous waste except where it is perceived to be in accordance with the principles of environmentally sound management
- To provide a regulatory system applying to cases where transboundary movement is permissible

When becoming a party to the Basel Convention, a country is committed to introduce national legislation to regulate the transboundary movement of hazardous and other waste and to implement measures to prevent illegal traffic of wastes.

In 1995, the Basel Convention Ban Amendment was adopted which expands the scope of the BC to include prohibition of all transboundary movements of hazardous waste from Organisation for Economic Co-operation and Development (OECD) countries to

non-OECD countries. The Ban Amendment has not yet formally entered into force,[5] although currently 75 countries have ratified it. The full texts of the Basel Convention and Ban Amendment can be found on the Basel Convention website.[6]

The requirement of environmentally sound management under the Basel Convention relates to ship recycling on two main issues: 1) the fact that ships themselves may become waste (Article 2) while still be defined as a ship under other international rules, [7] and 2) that the Convention itself requires environmentally sound management of hazardous and other wastes generated from ship recycling (General Obligations under Article 4.2).

1.2 Hong Kong Convention

The Hong Kong Convention (HKC) (HKC, 2009) [8] was adopted at a Diplomatic Conference held in Hong Kong, China, in May 2009. The HKC is aimed at ensuring that ships, when being recycled after reaching the end of their operational lives, do not pose any unnecessary risks to human health, safety and the environment. The objective is to minimize, in the most effective, efficient and sustainable way, the environmental, occupational health and safety risks related to ship recycling, taking into account the particular characteristics of world maritime transport and the need for securing the smooth withdrawal of ships that have reached the end of their operating lives.

The regulations in the HKC cover the design, construction, operation and preparation of ships so as to facilitate safe and environmentally sound recycling without compromising the safety and operational efficiency of ships; the operation of ship recycling facilities in a safe and environmentally sound manner; and the establishment of an appropriate enforcement mechanism for ship recycling that incorporates certification and reporting requirements.

The HKC will enter into force, approximately 24 months after the date on which 15 states, representing 40% of world merchant shipping by gross tonnage, ratify the HKC, and the combined maximum annual ship recycling volume of these states during the preceding 10 years constitutes not less than 3% of the gross tonnage of the combined merchant shipping of the same states. Currently only France, Italy, the Netherlands, Saint Kitts and Nevis, and Turkey have signed the HKC, subject to ratification.

The HKC has not yet entered into force.[9] Upon the entry into force of the HKC, ships sent for recycling will be required to carry an inventory of hazardous materials (IHM),

[5] As of December 12, 2012.
[6] http://www.basel.int/text/documents.html and http://www.basel.int/Implementation/LegalMatters/BanAmendment/tabid/1484/Default.aspx.
[7] Decision VII/26, http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/cop/cop7/docs/33eRep.pdf#page=62
[8] http://www.imo.org/About/Conventions/ListOfConventions/Pages/The-Hong-Kong-International-Convention-for-the-Safe-and-Environmentally-Sound-Recycling-of-Ships.aspx
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which will be specific to each ship. An appendix to the HKC provides a list of hazardous materials:[10] the installation or use of which is prohibited or restricted in shipyards, in ship repair yards and on ships of parties to the HKC. Ships will be required to have an initial survey to verify the IHM, additional surveys during the life of the ship and a final survey prior to recycling.

Parties to the HKC will be required to take effective measures to ensure that ship recycling facilities under their jurisdiction comply with the HKC by introducing, implementing and enforcing legislation and other requirements, including measures to authorize or license recycling facilities.

Four voluntary guidelines have been developed and adopted to assist states in the early implementation of the HKC's technical standards:

- 2011 Guidelines for the Development of the Inventory of Hazardous Materials, adopted by Resolution MEPC.197(62)[11] (2011)
- 2011 Guidelines for the Development of the Ship Recycling Plan, adopted by Resolution MEPC.196(62)[12] (2011)
- 2012 Guidelines for Safe and Environmentally Sound Ship Recycling, adopted by Resolution MEPC.210(63)[13] (2012)
- 2012 Guidelines for the Authorization of Ship Recycling Facilities, adopted by Resolution MEPC.211(63)[14] (2012)

Two guidelines have been developed and adopted to assist states in the implementation of the HKC after it enters into force:

- 2012 Guidelines for the Survey and Certification of Ships Under the Hong Kong Convention, adopted by Resolution MEPC.222(64)[15] (2012)
- 2012 Guidelines for the Inspection of Ships Under the Hong Kong Convention, adopted by Resolution MEPC.223(64)[16] (2012)

1.3 International Labour Organization

The ILO is a tripartite UN agency with governments, employers and worker representatives. The agency currently has 185 member states. The ILO aims to set up labour standards, develop policies and devise programmes that ensure that the needs of workers are met, as it has done for a number of years. The ILO has been involved in a host of programmes to promote better working conditions and provide training within the area of occupational safety and health for workers and published Safety and Health in Shipbreaking: Guidelines for Asian Countries and Turkey in 2004.[17]

[10] In Appendix 8, document are available at: http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/Resolution%20MEPC.197(62).pdf
[11] http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/Resolution%20MEPC.197(62).pdf
[12] http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/RESOLUTION%20MEPC.196(62).pdf
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[16] http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/RESOLUTION%20MEPC.223(64)%20Inspection%20Guidelines.pdf
[17] http://www.ilo.org/public/english/standards/relm/gb/docs/gb289/pdf/meshs-1.pdf

1.4 European Commission

The European Council and European Parliament are currently discussing a proposal from the European Commission (EC) on new regulations on ship recycling for Member States (EC, 2012). This proposal would build upon the HKC and aim to implement its requirements quickly without waiting for ratification and entry into force. Ships covered by this new legislation would no longer fall within the scope of the EU Waste Shipment Regulation.

Under the new rules, ship recycling facilities would need to meet environmental and safety requirements to ensure the recycling safe is for workers and environmentally sound. This would be achieved by applying a system of surveys, certification, authorization and monitoring for large, commercial, seagoing vessels that fly an EU Member State flag. The system would cover a ship's whole life-cycle, from construction to operation to recycling. Shipowners would report to national authorities when a ship is destined for recycling. The new rule proposes that European ships carry an approved IHM and that the amount of hazardous material onboard (including in cargo residues, fuel oil, etc.) be reduced before the ship is delivered for recycling. Ship recycling facilities would need to be included on a list of authorized facilities worldwide, and European flagged ships would be allowed to be recycled only by facilities registered on this list. Though the proposal is based on the requirements of the Hong Kong Convention, the requirements to be met by ship recycling facilities are in some areas stricter.

1.5 National Regulation of Key Recycling Countries

The national regulatory frameworks regarding ship recycling and the environment, as applied by the major key recycling countries – Bangladesh, Pakistan, India, Turkey and China – range from the early development stage to nearly fully developed regimes.

Ship recycling in Bangladesh, is officially recognized as a formal industry under the Ministry of Industries; however the country has still little application or enforcement of laws concerning this sector. A few departments play a role though. The Bangladesh Department of Environment is responsible for authorizing facilities under the Environment Conservation Rules of 1997, and the country's Department of Shipping must provide a No Objection Certificate before a ship can be beached. The industries Minister Dilip Barua has expressed hope that the Ship Breaking and Recycling Law will be enacted by June 2013 to create a safe environment for the ship recycling sector.[18]

Almost the same can be said about Pakistan, where the main regulatory requirement is the No Objection Certificate issued by the provincial authority, the Balochistan Environmental Protection Agency, before beaching and breaking can commence.

In India, the Gujarat government supports ship breaking at Alang-Sosiya but also has concerns for the health and safety standards of the industry. There seems to be no coordinated approach to the industry: several ministries hold individual

[18] http://www.shipbreakingplatform.org/financial-express-govt-to-enact-ship-breaking-and-recycling-law-by-june-barua/

responsibilities for its various elements, and the industry is covered by broader-sector policies implemented by the Gujarat Maritime Board and Gujarat Pollution Control Board. The Supreme Court of India has played an active role in the industry for some time, after a series of high-profile investigations into health and safety compliance at Alang-Sosiya, and passed a judgment in 2003 stipulating a number of obligations relating to hazardous materials and the recycling of ships. In the most recent (July 2012) ruling, the court ruled in the case *of M/s Best Oasis Ltd,* that if any hazardous waste embedded in the ship's structure was discovered during dismantling, the disposal would be at the cost of the owner of the vessel and that the norms laid down in the Basel Convention should be strictly followed before permitting entry of any vessel suspected to be carrying toxic and hazardous material into Indian territorial waters in all future cases.

At the other end of the line are Turkey and China. Turkey is ready to ratify HKC and may submit its accession document to the depositary shortly. A ministerial committee has given approvals, which was followed by consent from the Turkish Council of Commissions and Sub-Commissions.

China regulated for environmental protection in relation to ship recycling as early as 1988 (Faure, 2008), requiring an environmental assessment to be passed by all the ship recycling yards, as well as an inspection structure and yearly license renewal to be carried out by local governmental authorities. The "General Regulations on Green Ship Recycling" were implemented in 2005 to promote environmentally responsive technology and practices in ship recycling. In 2006 the "Technical Guidelines for Pollution Prevention Related to Shipbreaking" were added. The 2010 regulation on solid waste applies additional environmental requirements on the management of the entirety of the waste stream.

2 COMPONENTS OF ENVIRONMENTALLY SOUND MANAGEMENT

The following section contains a review of environmentally sound management in the context of ship dismantling. The different components may be physical measures or operational measures. Physical measures concern the provisions at the facility, such as equipment and layout of the facility. Operational measures include procedures and practices at the facility.

2.1 Introduction

Unsafe ship-dismantling practices have consequences for the occupational safety and health of workers and for the environment. In some cases, a wider range of individuals may also be affected if involved in the handling and use of re-sold unsafe equipment or if their livelihood is threatened, e.g. fishing communities. It is emphasized that while in this study the focus remains on the feasibility of upgrading to environmentally sound practices, the interlinked issues of safety and occupational health are intrinsically included, e.g., the risk of explosion; training and procedures that can improve coordination of work and working procedures, because they may have a positive influence on the mitigation of environmental impact.

The potential environmental impact categories are described in the BC and include:

1) Pollution: Discharges and emissions to sea, ground and air cause both acute and long-term pollution. The lack of containment to prevent toxins from entering the environment is a major concern.

2) Spatial considerations: By occupying and expanding the areas required for breaking, the dismantling industry affects the local surroundings, environment and society. The established local community may be relying on basic industries such as fishery and agriculture, so a conflict of interest may become an issue.

The issues presented are based on the Basel Convention Technical Guidelines for the Environmentally Sound Management of the Full and Partial Dismantling of Ships and the Hong Kong Convention guidelines.[19] The guidelines provide information and recommendations on procedures, processes and practices that must be implemented to attain environmentally sound management at ship recycling/dismantling facilities. This includes provisions for the proper removal of HMs and substances and the collection, sorting and disposal/recycling of waste.

[19] http://www.imo.org/OurWork/Environment/shiprecycling/pages/Default.aspx

Environmentally sound management (ESM) must be embedded in all stages of the dismantling/recycling process, and in particular should be factored into:

1. Documentation on hazardous materials – precutting phase
2. Identification of Hazardous Materials – precutting phase
3. Equipment for Dismantling Activities
4. Yard Facilities and Handling of Hazardous Materials
5. Quality assurance schemes and procedures

There are, in addition, specific considerations regarding the need for special dismantling equipment associated with the applied method of dismantling, whether using the pier breaking/alongside method or the slipway/landing method. These are associated with both the actual dismantling process and subsequent waste handling at the yard, and they will be separately addressed in Section 2.4.2.

2.2 Documentation on Hazardous Materials – precutting phase

The HKC sets requirements for the facility regarding authorization and the availability of a Ship Recycling Facility Plan (SRFP). The SRFP should fully describe the operations and procedures that are in place at the ship recycling facility for protecting the environment, human health and worker safety to ensure compliance with the HKC and demonstrate knowledge and understanding of all applicable statutory and regulatory requirements. The SRFP is the main document that the competent authority or organization recognized by it will rely on in authorizing a ship recycling facility, and it will have a direct influence on the level of quality control at the recycling yard and therefore presumably an impact on the environmental performance of the yard, see Appendix B for more information.

To ensure ESM, the location and amount of HMs and potentially containing hazardous materials (PCHMs) located in the vessel superstructure and in stores onboard must be identified prior to taking the ship apart. Both the BC and the HKC address this issue in the form of a vessel survey that results in an inventory of hazardous substances (BC) or an inventory of hazardous materials (HKC). The IHM can be used for the purpose of planning the sequence and nature of the work to be executed. In addition to the IHM referred to in the BC, the BC also highlights that chemical safety data sheets should be made available for each of the hazardous substances identified in the inventory.

Under the HKC, a ship destined for recycling must carry a fully updated inventory that comprises three parts, as included in the International Ready for Recycling Certificate. This acts as the basis for the SRF to develop a ship-specific Ship Recycling Plan (SRP). The SRP should take into account any information provided by the shipowner, such as inventories in the form of Green Passports or IHMs, and include the removal sequence of materials and liquids prior to the actual cutting phase and a safe and practical cutting sequence. If no inventory is available, this should be produced (see next section).

An overview of the components that constitute environmentally sound operations with regard to documentation prior to dismantling is given in Table 4.

Table 4
Documentation needed prior to commencement of dismantling

Documentation on hazardous materials – precutting phase
Green Passport/inventory of hazardous materials
Chemical safety data sheets
Approved Ship Recycling Plan

2.3 Identification of Hazardous Materials – precutting phase

The SRP is used by the SRF staff to ensure that hazardous materials are managed in an environmentally sound manner. The locations of HMs and/or PCHMs are identified and marked and structures and equipment are labeled with information on the type of HMs and quantity of embedded HMs. With this information, proper procedures and methods of dismantling can be applied.

If an inventory has not been fully updated prior to decommissioning, the yard or others should initiate sampling, analysis and/or visual inspection before and/or during the dismantling process to enable the identification of HMs. Procedures on how to address equipment and structures containing PCHMs need also be applied, whether they will be treated as HMs or whether sampling and analysis should be conducted to determine the type of material.[20]

An overview of the components that constitute environmentally sound operation during the identification phase is given in Table 5.

Table 5
Procedures to mark and label hazardous materials for the removal phase

Identification of Hazardous Materials – precutting phase
Use of inventory of hazardous materials
Identification and locations of HMs

2.4 Equipment for Dismantling Activities

The ship recycling facility's approach to proper management of each of the HMs found on board a ship should be in place, including the process, control and abatement methodologies which will be applied during all steps of the recycling process, hereunder called the sequence of removal of HMs. These components, which constitute environmentally sound operations during the dismantling process, can be viewed as part of the precutting and cutting phases.

2.4.1 Precutting phase

Prior to commencement of the cutting phase, the ship should be cleared of as many HMs as possible (asbestos, PCB, ODS etc.), all loose equipment and instruments, operationally-generated waste and stores, and any residual liquids. Specific ESM standards associated with removal of certain HMs are outlined in Appendix A. A substantial amount of the HMs are often integral to a vessel's construction and will only become accessible as the dismantling process uncovers more of the ship's interior during the cutting phase. The ESM components described in Table 6 therefore also relate to the cutting phase.

[20] http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf

Table 6
Overview of environmentally sound management components applied during the precutting phase

Equipment for dismantling activities – precutting phase
Asbestos
Area isolation items
Ventilation and filter systems
Air monitoring equipment
Vacuum cleaners
Bags for asbestos
Decontamination facility
PCB
Airtight drums for PCB materials
Oils and fuels
Pumping and draining equipment
Drums for oil
Oil booms
Oil dispersant
Oil skimmers
Cleaning solvents
Paints
Abrasive blasting equipment
Chemicals for stripping paint
Power tools for mechanical removal of paint
ODS-containing materials
Airtight containers
Ship-generated waste and stores
Pumping equipment for sewage and for bilge and ballast water
Oil-water separation equipment
Disinfectants for ballast water
Cleaning solvents for remediation
Tanks for sludge and bilge water

2.4.2 Cutting phase

Ship-specific procedures should be in place to enable environmentally safe removal and handling of the HMs on board during the cutting phase, including procedures for cleaning after the removal of any HMs before work can be reinitiated.

In the cutting phase special consideration should still be given to the HMs listed below, because it is not always possible to remove them during the precutting phase:

- Asbestos
- PCB
- Paints and coatings that contain heavy metals
- Oily waste and sludge

Using the ship dismantling processes applied in the pier-breaking/alongside and slipway/landing methods, where hard surfaces are present on land, a host of different equipment can be used that will support more environmentally sound dismantling, such as cranes, spider grabs/magnetic lifts, mechanical movers, etc.

An overview of the components that constitute environmentally sound operations during the cutting phase is given in Table 7.

Table 7
Elements of environmentally sound ship recycling during dismantling

Equipment for dismantling activities – cutting phase
Miscellaneous
Hydraulic shears
Mechanical movers
Forklifts
Dump trucks
Gas detectors and oxygen meters
Fixed cranes
Mobile cranes
Spider grabs/magnetic lifts
Lifting gears
Transformers
Gas-burning equipment
Hand lamps
Hand tools and communication equipment
Sounding tape
Portable air fans and trunking
Temporary lighting
First aid kits
Protective clothing and equipment
Breathing apparatus sets

2.5 Yard Facilities and Handling of Hazardous Materials

The management of waste and recyclables at the facility that are derived from the dismantling process comprises extraction, sorting, creation and maintenance of provisional storage areas, and transport within the yard. The majority will be recyclable steel and benign industrial waste, with a small fraction being hazardous waste. In order to facilitate safe extraction of HMs and sorting from other materials, the yard design needs to include special process areas that accommodate control measures toward spills, leaks and releases and separate areas for secondary dismantling and storage. Incorporating segregated areas for different operations into the design of the yard is a key feature of both the BC Technical Guidelines and the HKC facility guideline.[21]

A ship recycling facility should include at least the following key items:

- A primary block breaking area equipped with a secure containment system
- Workstations for secondary dismantling and sequential breakdown into component elements
- Specially equipped workstations, including the provision of appropriate containment for hazardous and toxic material removal

[21] http://www.basel.int/TheConvention/Publications/TechnicalGuidelines/tabid/2362/Default.aspx and http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf

- Temporary storage areas for benign materials and steelwork
- Secure storage areas for hazardous waste
- Storage areas for fully processed equipment and materials that are ready for reuse, recycling or disposal
- Office buildings and emergency facilities
- Roads that run between the different yard sections that can accommodate heavy traffic

A layout for a model facility from the BC Technical Guidelines is shown in Figure 1. It contains these key items:

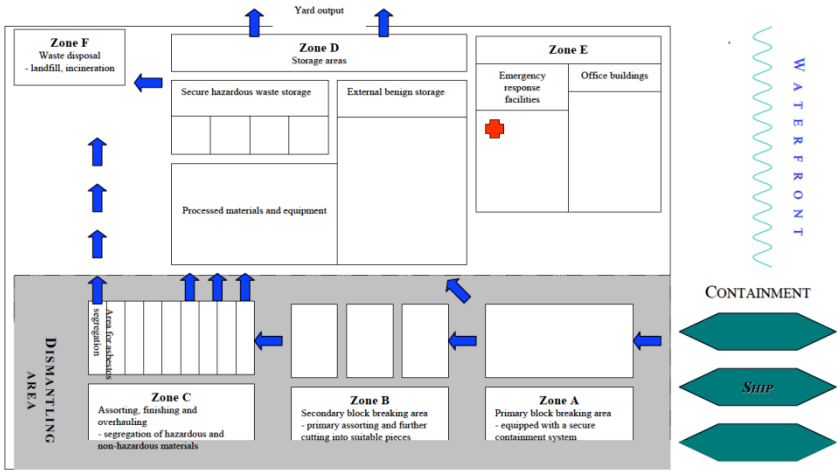


Figure 1
Yard layout of a model facility (Basel Convention Technical Guidelines, 2004)

Specific considerations regarding the extraction and sorting areas include impermeable floors and gullies to minimize the potential for spillage into the marine environment by rain, storm drains, tides and runoff. A fraction of the materials are recyclables and non-recyclables mixed together that would otherwise be considered waste if not separated. In order to minimize this fraction, specific tools (e.g., a shredder and a magnet) can be applied for sorting recyclable metal from nonmetal. A shredder is quite costly and is not considered a feasible investment for a yard, but one may be available at a local waste management center.

The issues that should be considered regarding the provisional storage areas of HW, recyclables and industrial waste include:

Hazardous waste:

- Oil- and fuel-holding tanks and containers should be dedicated to a specific substance and be placed within a secondary containment area to ensure leakage collection and protection from corrosion. The floor should be covered to prevent soil contamination. Monitoring devices for leakage detection and overfill monitoring may also be applied.

- Asbestos should be kept in a sheltered provisional storage area until final disposal in a landfill.[22]
- PCB-containing material and any water or other liquid used for decontamination should be kept in provisional storage until final treatment. The storage should include impermeable floors without floor drains, sufficient curbing to contain any accidental release, and roofing and walls that prevent rainwater from reaching PCB waste. PCB should be kept in labeled transport containers, sealed for liquids and covered for solids, in a separate area from other HMs.
- Paint and blasted paint flakes containing heavy metals should be stored in a manner that ensures that no secondary dispersal is possible.
- Liquid ODS listed in Part I of the HKC should be collected from any equipment in airtight containers. If a provisional store is used, it should be sheltered to avoid potential corrosion of the containers.
- Adequate provisional storage facilities should be designated to ensure against secondary release into the environment for e.g. paint, batteries, radiation sources, and items containing wood preservation.

Recyclable and industrial waste:

- Stores for recyclables, such as equipment, instruments and anodes, should be designated.
- Cables and metals should be stored in containers.
- Ballast water should be stored in an evaporation pit with safe storage of sediments and control measures for spreading.

Some additional considerations of importance are the availability of spill response equipment and properly trained personnel to respond to spills or similar emergencies.

The different environmentally sound operations that can be applied during handling and storage of hazardous waste are given in Table 8.

Table 8
Environmentally sound operations that can be applied during handling and storage of hazardous waste

Yard facilities
Dismantling area
Impermeable floors for handling areas
Designated area for segregation of HMs handled
Building for segregation of asbestos, with limited access
Roads for heavy transport
Gullies
Storage area
Impermeable floors for storage area
Asbestos
Roofing of HM storage
Paints and coatings
Roofing of HM storage
Oils and fuels

[22] Asbestos is usually buried underground.

Yard facilities
Roofing of HM storage
PCB
Roofing of HM storage
ODS
Roofing of HM storage
Tanks for ODS
Ship-generated waste and stores
Roofing of HM storage
Tanks for sludge and bilge water
Equipment
Roofing of area for equipment for reuse/recycling
Miscellaneous
Spill response equipment
Containers for cables
Containers for metal
Warning signs
Winch
Strain gauge and alarm
Pumping equipment
Magnet
Administration area (on-site)
Domestic building that contains emergency response facilities
Office buildings
Waste disposal (off-site)
Waste disposal (landfill)
Treatment facilities for hazardous waste

Hazardous materials and waste that are sent off-site should be transferred only to authorized waste treatment facilities and landfills that adhere to relevant national standards and requirements. The treatment facilities should take into account applicable international standards and requirements of environmentally sound treatment and disposal. Procedures for documenting the hazardous materials and waste under transport, storage and disposal/treatment should also be in place.

2.6 Quality Assurance Schemes

In order to ensure and facilitate an adequate implementation of ESM at a ship recycling facility, a number of programmes, plans and operational measures are needed. To ensure the quality of a facility's efforts, an environmental management system (EMS) should be implemented to assist the SRF in achieving its environmental goals and demonstrate environmentally sound performance.

Preferably, it should be a structured EMS that complies with an international environmental standard, such as the ISO 30000 guidelines.[23] This standard specifies requirements for a management system that enables the ship recycling facility to

[23] http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=51244

develop and implement procedures, policies and objectives that ensure safe and environmentally sound ship recycling operations in accordance with national and international standards. Another option is the more generic ISO 14001.[24] The ISO standard is a procedural standard and there are no absolute requirements for environmental performance within the ISO framework beyond committing to comply with applicable legislation and regulations and to continually work systematically for further improvements. Other guidance documents are available for ship recycling and waste management, such as the Basel Convention Technical Guidelines series[25] and, more specifically, the Technical Guidelines for the Environmentally Sound Management of the Full and Partial Dismantling of Ships (Basel Convention, 2004),[26] the IMO 2012 Guidelines for Safe and Environmentally Sound Ship Recycling[27] (MEPC.210(63), 2012) and Safety and Health in Shipbreaking: Guidelines for Asian Countries and Turkey[28] (ILO, 2004). The aforementioned standards and guidelines are covered in greater depth in Appendix B.

In addition, it is crucial that a legislative framework be developed in the recycling nation that specifically targets the requirements of the ship recycling facility and provides an auditing and enforcement structure to ensure compliance with national/regional legislation and a successful progression toward more environmentally sound ship recycling.

[24] http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=31807
[25] http://www.basel.int/TheConvention/Publications/TechnicalGuidelines/tabid/2362/Default.aspx.
[26] http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf
[27] http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf
[28] http://www.ilo.org/public/english/standards/relm/gb/docs/gb289/pdf/meshs-1.pdf

3 REVIEW OF CURRENTLY APPLIED SHIP RECYCLING METHODS

This section offers a brief introduction to the currently applied ship recycling methods and the most common procedures and installations needed for upgrades to pier breaking and slipway breaking.

Table 9
Overview of recycling methods and areas of application

Recycling method	Countries applied
Docking	A few places in Europe
Pier breaking/alongside	China, Europe and the US
Landing/slipway	Turkey
Beaching	South Asia: Bangladesh, India and Pakistan

3.1 From Beaching to Dry-Docking

Beaching methods are not detailed in this report, which focuses on alternatives to beaching and the feasibility of upgrading the pier breaking/alongside and slipways/landing methods. The potential for using dry docks to meet the world's ship recycling demand is also outside the scope of this report in terms of cost-effectiveness and feasibility, but a brief introduction to both methods is given here.

Beaching is currently by far the most-used method for scrapping of ships, and the conditions under which this has taken place historically have been a major driver for the development of the HKC. The countries using beaching as a recycling method are located in Southeast Asia, specifically Bangladesh, India and Pakistan, and have at any given time during the past 25 years accounted for 60%-90% of the international market for recycling of oceangoing vessels (World Bank, 2010). In beaching a vessel, which is lightened of cargo and ballast and is sailed full steam onto a tidal flat at spring tide in areas with a large tidal gauge (e.g., 10-11 m in Alang-Sosiya, India), "dry" access to a ship is possible for workers. The scuttled ship is typically cut from the bow and deck, and these cut pieces and the lightened hull are dragged closer to the beach with the use of winches.

At the opposite end of the spectrum we find recycling in dry docks. With dry-docking the ship is sailed into a dock and the water is pumped out, leaving the ship in a dry environment. The ship is thereafter dismantled piece by piece. On completion of the dismantling process, the dock is cleaned and flooded again. The risk of spillage and pollution to the surrounding waters is very low during dismantling because the process is conducted within an enclosed area. It is not a commonly used method because the facility is relatively cost-intensive with regard to buildings and dock maintenance, and the surplus dry-dock capacity is situated mainly in countries with high labour costs. Therefore, very few vessels are recycled in this manner and dry-

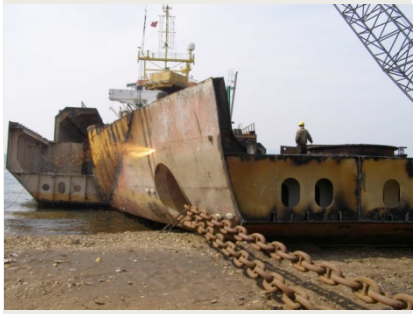



Figure 2
1) Slipway/landing method, Aliaga, Turkey; 2) Ship removed piece by piece by a mobile crane from the shore, Aliaga, Turkey; 3) Pier breaking by use of a crane, Changjiang Ship Recycling Yard, China; 4) Remaining hull lifted out of the water by means of floating dry dock, Changjiang Ship Recycling Yard.

dock services have not entered the commercial market, although government vessels and salvaged vessels are occasionally recycled by this method.

3.2 Slipway/Landing

When the method of slipway/landing (hereafter referred to as slipway) is used, the ship is sailed against the shore or a concrete slipway extending into the sea. Slipway recycling is characterized by it being conducted at sites that have little or no tide, making the size and distribution of the intertidal zone easy to predict and providing better control and opportunity for measures to contain accidental spillages.

The ship is dismantled by removing pieces with a mobile crane onshore or from barges while dragging the ship up on the shore as it is lightened. A temporary quay or semi-permanent jetty may also be used at the site to provide access for heavy lifting and cutting equipment to aid the dismantling process.

3.3 Pier Breaking/Alongside

With pier breaking/alongside (hereafter referred to as pier breaking), the vessel is secured alongside a wharf, quay or similar structure in sheltered waters. Pieces of the ship are removed by crane in a top-down process, with the superstructure and upper pieces removed first. The dismantling is continued along the ship into the engine room until the bottom of the hull is reached. The aft and forward ends are thereafter lifted further out of the water while being reduced until the vessel is either lifted in one piece or sent to a dry dock for final cutting. Pier breaking takes place in harbors or rivers, often located in sheltered and calm waters, which makes containment and remediating measures easier to apply, thereby limiting the dispersal potential.

Pier breaking is the main method used by Chinese yards in the Yangtze and Pearl rivers and by certain ship recycling facilities in Turkey. Work can be done on ships berthed at piers in ports and shipyards globally for repairs and installations not requiring dry-docking. In other words, the technology is available in ports. Pictures on the recycling methods are seen in Figure 2.

3.4 Application of Current Ship Recycling Methods

The pier breaking and slipway methods are generally considered to allow for an easier implantation of ESM, and yards employing these methods may have less of a gap to bridge that an a typical beaching facility in meeting the standards necessary to be authorized under the HKC or under the proposed EU list of approved facilities. Most of the upgraded pier breaking and slipway facilities are located in countries that have either had a political and enforced decision to abandon the substandard practices often associated with beaching and pier breaking (e.g., China) or are placed in countries that typically have a well-developed enforcement regime (e.g., the EU, the US, Turkey). The pressure for developing and introducing acceptable standards in the industry has taken place over the two past decades and although beaching facilities are not the topic here it should be noted that during this time progress has been achieved in a number of the beaching facilities in India. This section will focus on the greatest priorities to be addressed for pier breaking and slipway yards, and as there is

no distinct difference between the two methods when it comes to safe and environmentally sound recycling, they will be treated as one unless otherwise noted.

On a general note, the implementation of quality assurance schemes has typically been an important part of the process of upgrading ship recycling facilities. This is due partly to the pressure from national authorities for documentation of the activities and fate of materials on the yard, and due partly to responsible shipowners directly asking for ISO 9001 and 14001 certifications to create a paper trail.

3.4.1 Containment installations

Scrapyards are often situated on cheap plots out of the main area of ports, so for historic reasons many facilities were originally placed on soil, which, although often infused with bitumen in ports and yards, is permeable to oil, solvents and water. One of the first actions, therefore, is to pave large areas. This serves several purposes:

- It contains spills, because paved areas are impermeable. Meeting this objective obviously requires simultaneous planning of drainage and detainment mechanisms for oil in the drainage system.
- It provides firm access for heavy traffic of trucks, cold cutters, forklifts and cranes, which are often employed to avoid the heavy manual lifts and increase throughput.
- It is an adamant requirement for the storage areas when it comes to hazardous materials. The bunding of storage areas is part of simple spill management, and it should be accompanied by roofing, because heavy rains may flood the area.

3.4.2 Work processes – precutting

Traditionally, there wasn't any information on hazardous materials in ship recycling, and a crucial part of the planning of the cutting of the vessel included an estimation of the hazards and assessment of the risks. However, this was directed toward occupational hazards, such as safety for hot work, safe entry into confined spaces and exposure to asbestos. The added focus on environmental contaminants driven by the BC Technical Guidelines and the HKC Guidelines on IHM, and the voluntary Green Passport preceding them, has led to procedures on how to identify, remove and store/dispose of blast grit, transformer and hydraulics oil, ozone-depleting substances, mercury in gyro-compasses PCB in cables, etc.

Even though ship's IHMs will be available in the future, it will remain the yard's responsibility to perform all dismantling work in a safe and sound manner, and upgraded yards will still need to have access to either in-house or professional expertise for the development of a proper ship-specific recycling plan. Adding environmental issues to the training of staff/experts and developing the necessary protocols for identification of hazardous materials are important upgrade activities.

The actual removal of identified hazardous materials during pre-cleaning is an unfamiliar topic in many yards. This is particularly the case when it comes to those materials embedded in equipment, and if the equipment has a resale or reuse value as

an entity; the motivation to remove crucial components or liquids will be limited. Procedures for identifying and controlling the fate of such equipment, structures, components and materials are also a typical challenge requiring an upgrade.

3.4.3 Work processes – cutting phase

The actual cutting is typically what the recycling yard does very well, and the mechanisms to avoid explosions, fires and spills are not new to the yard. A few new areas of environmental concern have arisen and need addressing:

- PCB, heavy metals and tributyltin (TBT) in sealed paints may require special handling depending on the storage facilities and recycling process of the steel.
- The cutting of cables is often intertwined with the cutting of structures, and the possible occurrence of cables with PCB in old vessels requires frequent testing and possibly remediation measures.
- When opening up new sections of the vessel, care must be taken to divert precipitation and avoid flooding and overflowing of compartments with bilge water, creating spills of polluted water into the environment.

As a precautionary measure, an oil spill boom is often placed around the vessel. Such equipment and other equipment for environmental protection are often not available in the yard.

3.4.4 Waste management on-site

When introducing greater care for environmental issues the general management of materials on-site becomes very important. Contamination by hazardous materials of a waste fraction or stored items for reuse or recycling is a common problem. A large part of the solution is simply good housekeeping at the yard (i.e., the various fractions of steel plates, beams, combustible items, low-grade industrial waste, etc., are not mixed with one another or, in particular, the hazardous materials).

3.4.5 Disposal of hazardous materials

Disposal of hazardous materials is hardly a new activity for the yards (although it has not necessarily been undertaken in a proper manner in the past) and in most cases the national authorities are cognizant of hazardous material management in the ship-recycling sector. However, in some cases the requirements of the responsible shipowner or flag state may exceed the capacity of the facilities available in the recycling country or only temporary disposal is available. The minimum requirement of a yard is that the downstream capability to treat or dispose of the relevant hazardous materials must be available, and if the capacity is currently unavailable, then the safe and sound management is well-documented through contracts with suppliers and other paper trails, also for intermediate storage. The procedure to establish this is often new to yards, and the responsibility for a downstream activity is not always readily present.

4 ASSESSMENT OF QUALIFIED LOCATIONS FOR FACILITIES

This section presents an analysis of potential suitable locations for a model environmentally sound ship recycling facility.

4.1 Analysis of Existing Recycling Nations

The decision-making parameters for identifying locations or areas in which it would be feasible to place (or upgrade to) a model facility are not only the added costs for improvements (World Bank, 2010), but also the following:

- A history of ship import for scrapping
- Enforced regulations on environmental pollution
- Access to hazardous waste management centers (WMC)
- Strong domestic demand for steel not readily available from other sources (plates and rebar)
- A market for ship equipment and consumables
- Low wages

The top 10 recycling nations in 2010 (Intermodal Research, 2011) and their key credentials are presented in Table 10.

Table 10
Key characteristics of the top 10 recycling nations: PB=Pier breaking, DD=Dry-docking, SW=Slipway, BE=Beaching, S=Small, M=Medium, L=Large, Y=Yes, N=No, LM=Limited

	Recycling method	Scrapped amount [DWT]	Number of ships scrapped	Steel demand * [per capita]	Scrap steel import [million tonnes]	Monthly wages [USD]	Regulation	Market for equipment and consumables	Access to WMC
India	BE	9,287,775	451	57	2.929*	70-174[2]	Medium	L	Y
Bangladesh	BE	6,839,207	110	12[1]	n/a	157[3]	Medium	L	N
China	PB/DD	5,769,227	189	460	6.767	80-212[4]	Strong	L	Y
Pakistan	BE	5,100,606	111	507	n/a	256-307[5]	Low	L	LM
Turkey	SW	1,082,446	226	342	21.460	483	Strong	M	Y
United States	PB/DD	217,980	15	285	4.003	1,293	Strong	S	Y
Romania	PB	16,064	4	149	3.676	216	Strong	M	Y
Denmark	PB	15,802	25	205*	3.676	4,828[6]	Strong	S	Y
Japan	PB/DD	13,684	1	507	n/a	1,338[7]	Strong	S	Y
Belgium	PB	8,807	12	423	5	1,922	Strong	S	Y

1) Steel use in the respective countries is based on figures from the World Steel Association publication (2012) Bangladesh and Denmark (marked with *), which is from World steel association statistical yearbook, 2011.
2) Based on wages from unskilled workers and skilled cutters, 150 to 375 Indian Rupees, respectively (Demaria F., 2010). Monthly wages assumed as 25 working days.
3) World Bank, 2010 (converted from Bangladeshi TK to USD at conversion rate of 0.01023).
4) http://en.wikipedia.org/wiki/List_of_minimum_wages_in_People's_Republic_of_China#cite_note-autogenerated6-5.
5) World Bank, 2010 (converted from Pakistani rupees to USD at rate of 0.01023).
6) Based on average wage of a blacksmith, http://www.danskmetal.dk/Loen%20og%20arbejdsforhold/Loen/Loenstatistik.aspx.
7) Average 749 Japanese yen, http://stats-japan.com/t/kiji/11521. Monthly wages are based on 40 hours a week and four weeks a month.

Amongst the recycling nations within the top 10 ranking nations the most obvious potential candidate countries for a model environmentally sound ship recycling facility are India, Bangladesh and Pakistan as they all are major players in the recycling industry. In applying the beaching method they fall outside of the scope of the study, but facilities in major ports in India, Pakistan and Bangladesh could be potential locations.

The recycling industry in the US is strictly domestic because federal regulations prohibit the import of vessels for recycling. The level of wages (and land prices) may be too high for the recycling countries in Europe to be able to compete on the international market, given the scrap metal prices and the presence of substandard facilities elsewhere in the world.

It is not envisaged that Turkey and Japan will be suitable locations for an upgraded facility: Turkey already has a recycling industry, which is quite progressed in its compliance process. Japan has little recent history of ship recycling and as a developed country with high wages it will be difficult for a facility to compete in the ship recycling market.

At first glance China meets all the requirements of a feasible location for a model facility. However, a large number of compliant or near-compliant facilities are already available, including the new model facility Jiangmen Zhongxin Shipbreaking & Steel Co which has received a statement of compliance based on the Hong Kong Convention from ClassNK, the world's first yard to receive such a credential (IMO, 2012).

Because the top 10 recycling nations do not present any obvious candidates, alternative locations are investigated. A number of other locations are used worldwide on an interim basis for scrapping of vessels. These are typically opportunistic enterprises using existing repair yards and dry docks to develop a shipbreaking service for one or a few special cases. Most often the vessels in question are either salvaged wrecks that cannot safely be towed very far or vessels for which it is uneconomical to sail or tow to Turkey or Asia.

4.2 Non-Beaching Facilities in South Asia

There are a limited number of shipbreaking locations in ports throughout India and some of these employ non-beaching methods. This does not seem to be the case for Pakistan or Bangladesh despite the proximity of Karachi and Chittagong, respectively, to the beaching areas.

It has not been possible to confirm first-hand the activities of the non-beaching yards in India. The table below shows the non-beaching shipbreaking locations in India in 2001.

Table 11
Non-beaching facilities in India

State	Ship breaking activity locations	Activity
Andhra Pradesh	Visakhapatnam	Active, landing smaller vessels
Karnataka	Tadri	Appears not to be active
	Mangalore	Appears not to be active
	Malpe	Appears not to be active
Kerala	Beypore	Last ship in 2008
	Cochin	Appears not to be active
	Azhikkal	Limited activity
Maharashtra	Mumbai	Landing method
Tamilnadu	Tuticorin	Appears not to be active
West Bengal	Kolkata	Active, pier breaking

Figure 3
Images of ships under breaking in Darukhana shipbreaking site, Mumbai (photos by pegasus_xiii found on www.panoramio.com)

It has proven difficult to ascertain the exact methodology and current activities of the sites reported earlier, but in 2012 ICRA Limited (an associate of Moody's Investors Service) reported shipbreaking in Maharashtra (Mumbai) and West Bengal (Kolkata).

The method used in Mumbai at the site in Darukhana (see Figure 3) resembles a mix of landing and beaching methods, presumably due to the smaller tidal gauge compared to Alang-Sosiya, but the site and working conditions are reportedly much poorer.

Shipbreaking in Kolkata is associated with the Kolkata Dock System, and the Kolkata Port Trust levies tariffs for occupation of shipbreaking berths and the adjacent land area. Compared to the activity in Mumbai and Alang-Sosiya, only a few ship breakers are active in Kolkata. The conditions otherwise encountered are not known, but the MJR One recycling company is branding itself as a green facility.

4.3 South and North America

Historically, demolition has been reported in Mexico, Brazil, Peru and Venezuela, and because certain wrecks cannot be safely towed or because it is uneconomical to tow a wreck to Turkey or Asia, such popup demolition yards have appeared in Mexico and other sites in Latin America, and most recently the Dominican Republic (Robin Des Bois, 2013). The yards operating in the US recycle mainly government vessels and are not open to import of scrap vessels from the global commercial market.

4.4 Africa

One continent that has yet to see any ship recycling of scale is Africa. Apart from the notorious ship graveyard in the Bay of Nouadhibou, Mauritania, which comprises mainly larger fishing vessels, little demolition of ships takes place. However, that may soon change. A greenfield development in Senegal is being spearheaded by the Spanish company Ferrometal. It is reportedly a major facility with a capacity of recycling two million tonnes of steel annually on a 315-acre plot near the town of Potou in the Louga Region. It is intended to open for business sometime in 2013.

4.5 Asia

Over the past 20 years shipbreaking on a commercial scale has occasionally been attempted in several other locations in Asia, including sites in the Philippines, Vietnam, Thailand and Indonesia, but for differing reasons these facilities were not viable at the time.

The recycling of a car carrier, according to IMO Hong Kong Convention procedures, was carried out in Muroran, Japan, in 2010 as a demonstration project Shimizu et al. (2012). Also, several entrepreneurs are known to be engaged in the development of such facilities at various locations in Asia, but have not yet produced tangible results.

Nations with no prior experience in ship recycling, such as Cambodia and Myanmar, and with lower wage rates than Pakistan's (World Bank, 2010) could present a possible alternative since the (low) wages are comparable to the levels in Bangladesh. In 2010, a Dutch engineering company Greendock looked into the potential of establishing a "green dock wharf" facility in Cambodia (IRIN, 2009).

The yards mentioned above have almost exclusively employed the alongside or pier-breaking method.

4.5.1 The Philippines

The more active role taken by the Philippines in recent years in preparing for a ship recycling industry makes it interesting to elaborate more on this country. The Philippines has 384 domestic ships covered by the retirement programme for ships 31 years or older under the Domestic Shipping Development Act of 2004[29] (Lopez, 2011). These are projected to be dismantled and recycled and are proposed to be used as a basis for building up an industry for ship recycling and sale of recyclables (Marina, 2011). The IMO approved a technical assistance and cooperation programme for the Philippines in 2010 that included a three-day workshop in November 2011.[30]

In order to accommodate the need for waste stream management, the Philippines is establishing a WMC in Bataan that also can safely destruct PCB (Calonzo, 2012). The facility was planned to open in 2012 (Teves, 2012), however, it has yet to be established if it is in fact open. With regard to PCB, beginning in 2014 they cannot be produced, imported, sold, transferred, distributed, used or stored for reuse in the Philippines. This includes PCB-contaminated equipment, articles, packaging and waste.[31]

Though the Philippines is not a top steel importer (BIR, 2012), the market is growing and imports of iron and steel products reached 3.2 million metric tonnes (MT) in 2003, constituting 93.6% of the total consumption need. There are a few mini steel plants in the country that melt scrap steel by electric arc furnaces (Garcia and Vicente, 2005). Wages are comparable with the levels in India, Pakistan, Bangladesh and China.

[29] Republic Act No. 9295 May 03, 2004. An act promoting the development of Philippine domestic shipping, shipbuilding, ship repair and ship breaking that ordains reforms in government policies toward shipping in the Philippines and for other purposes.
[30] National Workshop on the Growth of an International Ship Recycling Industry in the Philippines Based on Compliance to International Safety and Environmental Standards.
[31] Chemical Control Order from 2004 issued by the Department of Environment and Natural Resources.

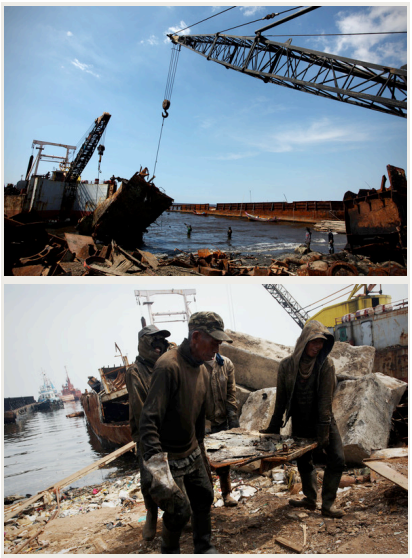


Figure 4
Beaching in Indonesia. Both cranes and manual lifting is applied

4.5.2 Indonesia

Little affirmative information could be obtained on ship recycling practices in Indonesia, apart from the beaching conducted at the Cilincing shipbreaking yard in Jakarta. This dismantling takes place on a 10-km beach strip where ships are run ashore at high tide. Cranes and some mechanization are applied (see Figure 4) and salaries as low as 5 USD per day have been reported.[32]

Indonesia has had a hazardous waste regulation since 1994 that was improved in 1999. The regulation includes the prevention and minimization of the generation of hazardous waste and regulates the whole area of management: control, storage, transport, treatment and final disposal, including recycling and recovery processes, as well as import and export of hazardous waste (Damanhuri and Padmi, 2009).

The steel demand is high, with Indonesia being the third largest steel-consuming country in the region. In 2010 it had a total import of iron and steel products of 7.8 million tonnes (Research and Markets, 2011). The wages in Indonesia are low and compatible with the other low-wage recycling nations. See Table 12 for compiled information on the Philippines and Indonesia.

Table 12
Key characteristics of the Philippines and Indonesia: BE=Beaching, H=High, Y=Yes

	Recycling method	Scrapped amount [dwt]	Number of ships scrapped	Steel demand per capita [kg crude steel eq.]	Steel use 2011 [tonnes]	GNI per capita per month [USD]*	Regulation	Market for equipment and consumables	Access to WMC
Philippines	n/a	n/a	n/a	44	4*	184	Medium	H	Y
Indonesia	BE	n/a	n/a	45	9*	245	Low-medium	H	Y

*Gross national income per capita in 2011 is calculated using the World Bank Atlas method (found at http://data.worldbank.org/indicator/NY.GNP.PCAP.CD) and divided by 12 months/year.

[32] Only one source, and it has not been possible to validate the accuracy of the statement.

5 REGULATORY DRIVERS

The regulatory drivers for the development of safe and environmentally sound ship recycling are the international conventions addressing the issues of safety in the workplace and proper management of hazardous waste.

5.1 Regulatory drivers

The principle regulatory drivers for the implementation of safe and environmentally sound management of ship recycling are international or regional agreements acting as catalysts for improvements as they are implemented in national legislation. Although, a prominent and direct regulatory driving force is the ratification process of international agreements, national legislation developed independently of international obligations may obviously play a similar role.

The Case Study[33] (UNEP, 2012) mentions a number of the international agreements that form part of the regulatory landscape on ship recycling and on environmental- and labour-related issues, including the following:

- Multilateral environmental agreements such as the Basel Convention, including the Ban Amendment, as well as the Stockholm Convention and the Montreal Protocol on substances that deplete the ozone layer
- The ILO agreements on worker's rights and occupational safety and health conditions
- The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships

In the immediate future the HKC is foreseen to instigate a number of profound changes in the *modus operandi* of ship recycling.

National strategies to address and enforce regulations on the export of ships in nations that supply vessels for recycling may also play a role, and such initiatives were taken early on in the US and in several European countries (the UK, Denmark, France)[34]. National strategies to regulate scrapping of vessels from the international market for merchant vessels were also developed on the recipient side in China and India, although China does not allow beaching and India does. In certain countries, court rulings may have a profound effect on the pace of change. This applies to the Indian Supreme Court rulings on the issue. Over the past decade and more recently in 2011-2012, a legal battle was fought in Bangladesh with a ruling in favor of the

[33] http://www.basel.int/Implementation/TechnicalAssistance/ShipDismantling/CapacityBuilding/tabid/2764/Default.aspx#section2

[34] Examples include the US ban on export of vessels, the UK Ship Recycling Strategy, the proposals from the French Interministerial Committee on Ship Dismantling, and the Danish work on case of export of a DFDS ro-ro vessel.

complainant (i.e., the labour and environmental side), which may suggest the emergence of a new reality for the local ship recycling industry.

The recent regulatory initiative from the European Commission and the European Council on Ship Recycling is clear in its attempt to provide transparency as to the quality of ship recycling. It proposes to allow recycling of European flagged vessels only in yards listed on an approved list (to be identified). If European flagged vessels are not reflagged prior to sale for recycling this may have a significant bearing on the trade of scrap vessels and may motivate an upgrade in the practices of recycling of ships.

5.1.1 Drivers on Environmental Issues

The Conference of Parties to the Basel Convention has considered the matter of ship dismantling at its meetings and considers that the transboundary movement of a vessel destined for recycling may be a breach of the BC due to the transport of large amounts of hazardous materials which are integral to the ship's structure (Decision VII/26 (COP 7, 2004)).

A number of studies have examined the possibilities for pre-cleaning such vessels of hazardous materials. However, all have fallen short of devising practical solutions that would allow the vessel to continue sailing under its own power to the recycling destination or even, if the vessel were to be tugged, to maintain a seaworthy condition. Part of this challenge lies also with the lack of definition of a "clean" vessel, a definition no country involved has yet attempted.

The actual recycling process has received significant attention under the BC, driving the issue ahead and comprehensive BC technical guidelines are available on the dismantling of ships:

- Technical guidelines for the environmentally sound management of the full and partial dismantling of ships

The BC has also developed a number of guidelines for the environmentally sound management of waste containing PCB and other hazardous materials[35] e.g.:

- Technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with polychlorinated biphenyls (PCB), polychlorinated terphenyls (PCT) or polybrominated biphenyls (PBB)
- Technical guidelines for the environmentally sound management of wastes consisting of elemental mercury and wastes containing or contaminated with mercury
- Technical Guidelines on Used Oil Re-Refining or Other Re-Uses of Previously Used Oil (R9)

[35] E.g. PCB, waste oils, mercury. For a full list of technical guidelines and titles please see http://www.basel.int/TheConvention/Publications/TechnicalGuidelines/tabid/2362/Default.aspx

- Technical Guidelines on the Environmentally Sound Management of Biomedical and Healthcare Wastes (Y1; Y3)

In the ship recycling nations the existence of facilities for treating or disposing of hazardous waste (HW) is sometimes lacking or capacity is limited. The facilities may range from relatively simple lined open disposal facilities to advanced high-temperature incineration. Recently, the BC has also developed guidelines for the safe co-processing of hazardous waste in properly controlled cement kilns,[36] which may serve to expand the capacity of ESM of HW in emerging economies.

Obviously, the regulatory drivers for green recycling in the future will include the Hong Kong Convention and its guidelines:

- Guidelines for the Development of the Inventory of Hazardous Materials (Resolution MEPC.197(62), 2011) [37]
- Guidelines for the Development of the Ship Recycling Plan (Resolution MEPC.196(62), 2011)[38]
- Guidelines for Safe and Environmentally Sound Ship Recycling (Resolution MEPC.210(63), 2012)[39]
- Guidelines for the Authorization of Ship Recycling Facilities (Resolution MEPC.211(63), 2012)[40]
- Guidelines for the Survey and Certification of Ships under the Hong Kong Convention (Resolution MEPC.222(64), 2012)[41]
- Guidelines for the Inspection of Ships under the Hong Kong Convention (Resolution MEPC.223(64), 2012)[42]

Of these guidelines, the first four are related to the work in the recycling facilities. The first on Inventory of Hazardous Materials is carried out on the vessels, but the information is crucial for the actual dismantling process and should be followed and further updated in the yards. The requirements for the Ship Recycling Plan and Authorization of Ship Recycling Facilities are key components of the documentation of an upgrade, but the corner stone regarding the procedures to follow and the actual implementation is the Guidelines of Safe and Environmentally Sound Ship Recycling, also known as the "Facility Guidelines".

[36] Co-processing of selected waste streams in properly controlled cement kilns provides energy, material recovery and cost-effective options for industry and waste generators (Secretariat of the Basel Convention, 2012).
[37] http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/Resolution%20MEPC.197(62).pdf
[38] http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/RESOLUTION%20MEPC.196(62).pdf
[39] http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf
[40] http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/211(63).pdf
[41] http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/RESOLUTION%20MEPC.222(64)%20Survey%20and%20Certification%20Guidelines.pdf
[42] http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/RESOLUTION%20MEPC.223(64)%20Inspection%20Guidelines.pdf

5.1.2 Drivers for Safety and Workers' Health

Although they are not the main focuses of the current study, worker safety and occupational health are integral to safe and environmentally sound ship recycling. Not all recycling nations have ratified the eight conventions considered fundamental by the ILO:

- C029 – Forced Labour Convention, 1930
- C087 – Freedom of Association and Protection of the Right to Organise Convention, 1948
- C098 – Right to Organise and Collective Bargaining Convention, 1949
- C100 – Equal Remuneration Convention, 1951
- C105 – Abolition of Forced Labour Convention, 1957
- C111 – Discrimination (Employment and Occupation) Convention, 1958
- C138 – Minimum Age Convention, 1973
- C182 – Worst Forms of Child Labour Convention, 1999

These conventions relate to general worker conditions, but a number of conventions and recommendations relate more specifically to occupational safety and health and worker conditions, and the following list is provided in the ILO guidance on ship recycling:

- Radiation Protection Convention (No. 115) and Recommendation (No. 114), 1960
- Reduction of Hours of Work Recommendation, 1962 (No. 116)
- Guarding of Machinery Convention (No. 119) and Recommendation (No. 118), 1963
- Employment Injury Benefit Convention (No. 121) and Recommendation (No. 121), 1964
- Maximum Weight Convention (No. 127) and Recommendation (No. 128), 1967
- Workers' Representatives Convention (No. 135), 1971
- Benzene Convention (No. 136) and Recommendation (No. 144), 1971
- Occupational Cancer Convention (No. 139) and Recommendation (No. 147), 1974
- Working Environment (Air Pollution, Noise and Vibration) Convention (No. 148) and Recommendation (No. 156), 1977
- Occupational Safety and Health (Dock Work) Convention (No. 152) and Recommendation (No. 160), 1979
- Occupational Safety and Health Convention (No. 155) and Recommendation (No. 164), 1981
- Protocol of 2002 (recording and notification of occupational accidents and

diseases) to the Occupational Safety and Health Convention (No. 155), 1981

- Occupational Health Services Convention (No. 161) and Recommendation (No. 171), 1985
- Asbestos Convention (No. 162) and Recommendation (No. 172), 1986
- Chemicals Convention (No. 170) and Recommendation (No. 177), 1990
- Night Work Convention (No. 171) and Recommendation (No. 178), 1990
- Prevention of Major Industrial Accidents Convention (No. 174) and Recommendation (No. 181), 1993
- Maternity Protection Convention (No. 183) and Recommendation (No. 191), 2000
- List of Occupational Diseases Recommendation (No. 194), 2002

The Conventions can be found at the ILO homepage.[43] The above-mentioned recommendations also address topics covered by some of the ILO conventions, and both local and international NGOs, trade unions and donor communities are pushing for changes in the industry. It should be mentioned that the IMO Guidelines for Safe and Environmentally Sound Ship Recycling also provides guidance on occupational health.

However, in the leading ship recycling countries i.e., the beaching nations India, Pakistan, and Bangladesh, a full implementation of the relevant conventions and recommendations (sometimes already in force) will also affect e.g. a textile or construction industry, and fear of the impact for the wider industry sectors are frequently impeding the implementation.

This is not the case only in the existing recycling nations; such reluctance from industry and authorities may also come into play in potential bidding for a future ship recycling industry in a location without existing facilities.

5.2 Other Drivers for Shipowners

Information from a number of shipowners suggests that the driving force in their (currently voluntary) transition to more environmentally sound ship recycling can be attributed to 1) a general trend of having a policy of conducting good husbandry within the environmental arena (and complying with it) and 2) wanting to minimize the risk of receiving negative publicity as a polluter. For shipowners that own their vessels throughout their lifetimes, it is often of great importance to remain in control of the ship all the way to the end of the dismantling process for the two aforementioned reasons. However, a controlled recycling policy may also be pursued to protect company-specific ship design and ensure that specific ships do not re-enter the market operating for competing companies.

Some of the key challenges that shipowners experience in their pursuit of a transition to ESM-compliant recycling lie within the areas of:

[43] http://www.ilo.org/global/standards/lang--en/index.htm

1) *Identification of a qualified recycling yard.*
   Shipowners find that there are not many ESM-compliant yards to choose from and it can be difficult to assess whether the environmental documentation that is produced can be verified (e.g., national certifications and ISO certifications). It is not uncommon for there to be discrepancies between what is believed to be compliant ESM standards by the recycling facility and what the shipowner requires to comply with its internal policies.

2) *Consistency between what is promised and the actual work undertaken.*
   Another major challenge for shipowners is to ensure that what is promised by the facility is also delivered. There may, after all, be an economic incentive to provide sub-standard services if the customer is not continuously monitoring the actual dismantling. Establishing procedures and allocating staff to continuously validate the dismantling work and ensure compliance can be a challenge for a shipowner with a smaller fleet.

3) *Use of subcontractors.*
   Recycling facilities often use subcontractors for various tasks, which complicates the effort of the responsible shipowner to ensure that all downstream service suppliers are adhering to the agreed standard, e.g., that the HMs in the waste stream are correctly disposed of.

Most of the contacted shipowners report that they experience no direct customer relationship benefits from applying ESM-compliant recycling. The cost difference between former applied recycling procedures and more environmentally sound recycling are not experienced as a key barrier.

Common requirements for environmentally sound recycling which are requested by shipowners, some of which are more explicit than others, focus on compliance with the Hong Kong Convention, the need for adherence to local government regulations, and the application of internal standards for safety and protection of the environment, such as ISO 14001, ISO 9001 and OHSAS certifications. One shipowner explains that a recycling facility contracted by it during the process of conducting several recycling projects for the shipowner reached better understanding of the environmental and commercial benefits associated with conducting environmentally sound recycling.

Though efforts are made to protect a shipping brand by utilizing recycling facilities that are recognized to apply environmentally sound methods, there remain cases of what could be perceived as “misplaced” public outrage. A recent example of this is the Danish ferry company DFDS. The company did all the necessary preparations, was (believed to be) in full compliance with the requirements of the Basel Convention, provided a Green Passport (stating that it had no HMs except a limited amount of asbestos in a number of gaskets) and opted for a certified non-beaching facility, as well as communicated their intent and initiatives to the public. Even so, it became exposed to a media storm of considerable size, with pictures of substandard facilities in India, although the ship was actually destined for China. Eventually, the vessel was approved for scrapping in China by Danish authorities, but various wastes were containerized on the site and transported back to Denmark for disposal.

A major class society has for some years worked with yards in South Asia and China to develop partnerships for upgrading the ship recycling industry by addressing some of the issues mentioned above. In China the combined action of a persistent shipowner and the Chinese government has conquered many of the barriers, but the Chinese yards remain concerned over lost business to substandard facilities in South Asia. The progress elsewhere in Asia is on a more limited basis except for a select number of facilities in Alang-Sosiya, India, still employing beaching but improving on the procedural side of occupational, safety, health and environmental issues. A significant number of the facilities both in Alang-Sosiya and Chittagong also boast various ISO certificates as a claim to improvement (series 9000, 14000, and/or 30000). While the specific ISO 30000 series on ship recycling is meant to assist shipowners in identifying acceptable facilities, the wide awarding of it to beaching facilities appears to have compromised the "brand value" amongst shipowners. It is worth mentioning here that the ISO standard is aimed at improving procedures and management, it does not apply criteria.

Another major class society has stated that until the Hong Kong Convention is ratified they cannot issue certificates of compliance to recycling facilities. They also do not issue other public statements regarding the yard's compliance level that would allow shipowners to identify suitable facilities upfront, but reports are that they perform a number of inspections of yards on behalf of shipowners in specific cases.[44]

5.3 Barriers to Be Addressed in a Future Model Facility

The barriers encountered when attempting to implement and/or enforce the regulations mentioned are diverse and challenging, but lessons from several countries and projects on ship recycling provide a knowledge base for establishing a ship recycling facility in accordance with international standards.

The feasibility and costs of a model ship recycling facility are addressed in a later section that considers the investments required in both infrastructure and capacity building. Obviously, producing regulation, implementing legislative structures and enforcement will also be a component of the costs incurred by a country's responsible authority(ies). However, because the actual legislation necessary will depend on the regulatory context already in place, costs will vary by location, and thus the feasibility section will not attempt to estimate specific costs related to regulation.

From interviews carried out during the stakeholder consultations and earlier work, it is clear that, in broad terms, the main observed barriers to the improvement of existing conditions in ship recycling yards are the following (these experiences are related almost exclusively to recycling in Asia):

- **There is an incomplete regulatory regime in recycling countries.** Often there is little political will to provide clear legislation, and occasionally there is limited willingness within authorities to enforce regulation.

[44] Communications with K. Martinsen, DNV (March 2013).

- **The recycling sector fears economic consequences.** Among the concerns are job loss among workers, loss of revenue among yard owners and fear in the public sector of costly investments for downstream facilities such as disposal facilities.

- **Commitment to "walk the talk" in shipping**. Embedded contractual requirements from shipowners or the financial sector compelling borrowers, i.e. new owners in the secondhand or scrap trade, to use green ship recycling facilities are not common.

- **Opaque management procedures in yards.** It is costly and difficult to select safe and environmentally sound ship recycling yards and there is little verified information to assist in this process.

In emerging economies with or without existing recycling facilities, the barriers and legislative gaps remain more or less the same. The table below presents a generic picture of the challenges.

Table 13
General action plan for the establishment of a model ship recycling yard

Barrier	Actions to achieve progress (apply to recycling sector)	Stakeholders	Specific for model facility (assuming Asian location)
Little political will to legislate	To the extent possible, act within existing regulation; support ratification of Hong Kong and other conventions Apply Basel and Hong Kong guidelines	National and/or state authorities: ministries of industry, work, environment and other relevant entities	Develop action plan to introduce incremental progress (based on Case Study)
Limited willingness within authorities to enforce regulation	Develop road map and plan of incremental progress	Partnership with local industry association	Develop action plan to introduce incremental progress
Fear of job loss among workers	Provide training and upgrade competencies	Labourers and their organizations	Introduce long-term contracts, including training periods
Fear of loss of revenue among yard owners	Introduce "green recycling" market and long-term contracts with selected owners	Responsible owner(s), support from shipowners organization	Establish formal agreement with shipowners on a number of vessels/year
Fear of costly public investments among downstream facilities such as disposal facilities	Establish an HW supply chain inventory for local industries and provide donor funds for a HW facility	Industry organization(s), local authorities	Provide matching funds for permanent facility and establish an HW collection mechanism

Table 13
General action plan for the establishment of a model ship recycling yard

Barrier	Actions to achieve progress (apply to recycling sector)	Stakeholders	Specific for model facility (assuming Asian location)
Lack of embedded requirements from shipowners or financial sector in secondhand trade or scrap trade	Introduce supply chain commitments on corporate social responsibility, Equator principles, BIMCO contracts and similar	Shipowners in the UN Global Compact	Agreement with responsible owner
Selection of verified ship recycling yards when considering safe and environmentally sound ship recycling	Introduce national ranking system, upgrade to EU listing and upgrade to HKC compliance	National ship breakers association, partnering with European Commission or the IMO	Ensure facilities' appearance on national and international lists of approved yards

It is emphasized that the implementation and enforcement of these drivers may prompt opposition from industry and society that are not associated with the recycling sector, because the regulations will impact many activities besides recycling. This may be wider not only qualitatively but also quantitatively (e.g., the impact in the textile industry from working hours regulation).

6 FEASIBILITY ANALYSIS

The feasibility analysis is based on the findings of the previous activities and comprises model descriptions and costs of upgrading existing non-compliant facilities to ESM compliance. The feasibility analysis also contains a sensitivity analysis and recommendations on suitable locations for a model recycling facility.

6.1 Methodology

The feasibility analysis is based on a comparison of the requirements and investments needed to upgrade from three different baseline facilities to compliant model facility ship dismantling.

The baseline facilities comprise the following:

1. An existing non-compliant pier-breaking facility
2. An existing non-compliant slipway facility
3. A basic pier and harbor that have not previously been used for recycling

The following approach is used:

- The compliant model facility is described.
- The unit prices are estimated.
- Upgrade requirements are determined for baseline facilities.
- Upgrade investments are calculated for baseline facilities.
- An incremental implementation schedule is provided.
- A sensitivity analysis is conducted on key investments.

The data on the existing capacity and technologies are taken from existing studies; the China field trip study undertaken as part of this; and previous site visits in Turkey, China, Bangladesh, India and Pakistan. The information is used to update the cost model in the COWI-DHI study for the DG ENV (EC, 2007)[45], supplemented with telephone interviews and web-based research.

The economic analysis is based on a bottom-up analysis, where each type of upgrade investment needed is quantified and priced for each of the baseline facilities. The investments are given for the five dismantling phases: documentation/identification, dismantling equipment – precutting, dismantling equipment – cutting, yard facilities, and hazardous waste handling and operational measures. Though the focus of this study is on measures to reduce environmental impacts, the model also includes the costs of activities and equipment for occupational safety and health measures. The included measures are estimates for the model facility, based on the standards given in the Hong Kong Convention and Basel Convention. Also included are investments in

[45] http://ec.europa.eu/environment/waste/ships/pdf/ship_dismantling_report.pdf

courses in capacity building for leading staff and training of labourer staff in the areas of environmental management, OHSAS and handling of HMs.

The cost analysis shows the overall level of investments needed. It is not a fully detailed financial cash flow analysis that includes operating costs and revenues.

6.2 Description of a Compliant Model Facility

The model facility described will allow for the estimation of the upgrade demands from different baseline scenarios to a common annual capacity of 100,000-light-displacement-tonnes (LDT). It is assumed that access to a waste management treatment center and disposal site is available. The number of key equipment, operational measures and staff needed to reach a compliant level are described below. A detailed table is presented in Appendix C. The annual capacity of the model facility compares to other upgraded facilities in countries operating on the world market: In Turkey it is a medium to large facility (50,000 - >120,000 LDT) and in China it is a small to medium sized yard (100,000- 1,000,000 LDT).

The heavy machinery and key dismantling equipment required for the dismantling process are four cranes and a number of movers. Paved areas of the pier/slipway used for segregation of materials and transport roads within the yard are assessed to be an area equivalent to 50,000 m^2. The impermeable floors and bunds for the HM handling and storage areas to prevent leakage are assessed at a total of 20,000 m^2. A closed building to segregate asbestos materials is assessed at 200 m^2, and 6,500 m^2 is allocated for a shed to store HMs. The administration building and domestic building for catering, changing of clothes and treatment of first aid are assessed at 900 m^2. The operational measures needed comprise the development of a Ship Recycling Facility Plan (as called for by the HKC). Also included are ISO and OHSAS certifications or national equivalents.

The assessed leading staff requirement constitutes five managers, six technical specialists and four supervisors. The managerial staff includes a project leader and managers in the areas of ESM, quality assurance, human resources and waste management. The technical specialists include engineers and demolition experts, and the supervisory staff includes project foremen and store personnel for dismantling and storage (UK Defra, 2006). The number of leading staff and technical specialist that need capacity building courses is assessed to 12 persons. Store personnel is included elsewhere (in the training courses), see Appendix D for more information.

The number of working staff members to be included in the training courses depends on the degree of mechanization. A model facility can be highly mechanized (see Table 1, Models 1 and 2) or labour-intensive (Model 3). A total of 117 trained working staff members are assessed to be needed in the highly mechanized upgraded facilities, whereas 434 trained working staff members will be required for the highly labour-intensive and less-mechanized facilities. The working staff includes operators, skilled workers, security staff and clerical staff. The training courses are envisaged to be led by national or international experts. An overview of key figures is given in the table below. The subjects to be addressed during capacity building and training courses are listed in Appendix D.

Table 14
Key assumptions for a model facility

Overview of Model Facility Basics	
Heavy machinery and key dismantling equipment	Four cranes and a number of movers
Paved areas	50,000 m^2
Impermeable floors	20,000 m^2
Closed buildings	200 m^2
Sheds	6,500 m^2
Administration and domestic buildings	900 m^2
Ship Recycling Facility Plan (required by the HKC)	-
ISO and OHSAS certifications	-
Managerial staff	12
Labourers	117/434*
Capacity building/training	Five-day course/two-day course**

*For labour-intensive baseline facility.
**Only two-day course for baseline facility with prior training programme implemented.

6.3 Upgrade Requirement

For all of the baseline facilities it is assumed that basic installations and logistical infrastructure are available. This includes electricity, water, pier access (harbor area access for slipways), and basic access roads to the yard area, waste treatment facilities and disposal facilities in the form of landfills.

The respective baseline facilities are presented in Table 15 and the specific upgrade requirements for each of the baseline facilities are described in the next sections.

Table 15
Overview of upgrade facilities to ESM-compliant dismantling

Upgrade facilities			
	Model 1	Model 2	Model 3a and 3b
Baseline facility	Existing (noncompliant) pier-breaking facility	Existing (noncompliant) slipway facility	Basic pier/harbor area
Target	Model pier-breaking facility	Model slipway facility	Model pier-breaking or slipway facility

6.3.1 Model 1 – Upgrade to ESM-compliant pier-breaking facility

The Model 1 baseline facility comprises an existing pier-breaking facility that already has access to a sufficient number of quays to handle the dismantling of 100,000 LDT per year. There is access to a floating dock facility or a slipway. Cranes are available in nearly sufficient capacity, and only one additional crane and a number of other pieces of heavy machinery are needed to allow for simultaneous dismantling of three vessels. There is only a limited need for upgrade of paved areas in the yard; however, buildings and pavement for storage and HM handling areas are needed. Training programmes for shipbreaking are in place, and only a two-day brush-up is anticipated for capacity building of leading staff and training courses for labourer staff.

6.3.2 Model 2 – Upgrade to EHS-compliant slipway facility

The Model 2 baseline facility is an existing slipway facility that has no quays and dismantles one vessel at a time from the bow. In order to increase capacity to 100,000 LDT on the site, simultaneous dismantling of two to three vessels is needed. Therefore, deployment of pontoons/barges to be used by cranes is foreseen, allowing for topside dismantling of one or two berthed vessels while a third vessel in a more advanced stage of dismantling can be pulled up a slipway. Two additional cranes and other pieces of heavy machinery are assessed to be needed. No areas (except the slipway itself) are paved in the baseline facility. All leading staff and labourers need five-day courses.

6.3.3 Model 3 – Establishment of EHS facility from basic pier/harbor area

The Model 3 baseline facility is a site, which has not previously been used for recycling of ships. The site is an established pier, model 3a, for upgrade to compliant pier breaking and a harbor area with limited pier access for upgrade to slipway, model 3b. As no previous recycling operation is assumed, a full upgrade is needed. This model is different with regard to the size of workforce necessary to accommodate a scenario where a model facility is established in a labour-intensive country. Thus, this model assumes less mechanization (fewer movers and no hydraulic shears). All leading staff and labourers need five-day courses.

6.4 Incremental Implementation

The environmentally sound management components for the process of upgrade to a model ship recycling facility follow the implementation schedule facility approach of the Case Study[46] (UNEP, 2012), where the upgrade components are adopted in three incremental steps over a seven-year time horizon.[47] The steps are shown in Figure 5. The time periods for the actions to be completed are indicated, as are the investments within each incremental step. The respective actions and how they correlate to the suggestion laid out in the Case Study are presented in Appendix E.

Figure 5
Incremental steps with suggested components

[46] http://www.basel.int/Implementation/TechnicalAssistance/ShipDismantling/CapacityBuilding/tabid/2764/Default.aspx#section2

[47] The schedule uses a slightly modified implementation time span from that of the BC technical guideline, under the assumption that, with current technological development, it is possible to progress to full environmental compliance in a shorter time span. Originally a 10-year time span was applied.

6.5 Cost Analysis

6.5.1 Model 1 – Upgrade of existing pier-breaking facility

The cost analysis for an existing noncompliant pier-breaking facility presented in Table 16 shows that a total investment of 9.5 million USD is required to upgrade to ESM compliance. The bulk of the investment is done within Steps 2 and 3 and consists primarily of heavy machinery and dismantling equipment (31% of the total investments) and yard infrastructure and structures (58%).

Table 16
Upgrade investment for existing pier-breaking facility to achieve ESM-compliant standard in incremental steps (2012 USD)

	<1 year	1-3 years	3-7 years	**Total**
Documentation and identification – precutting phase		$30,000	-	**$30,000**
Equipment for dismantling activities – precutting phase	$53,000	$113,000	$10,000	**$176,000**
Equipment for dismantling activities – cutting phase	$267,000	-	$3,027,000	**$3,295,000**
Yard facilities and hazardous waste handling	$915,000	$3,245,000	$1,475,000	**$5,635,000**
Procedures	$43,000	-	-	**$43,000**
Leading staff – capacity building	$21,000	-	-	**$21,000**
Labourer staff – training	$254,000	-	-	**$254,000**
Grand total	**$1,552,000**	**$3,388,000**	**$4,512,000**	**$9,452,000**
Percentage of total	**16%**	**36%**	**48%**	**100%**

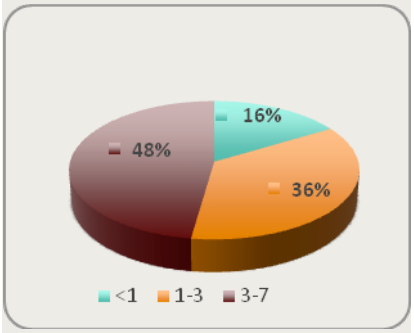


Figure 6
Investment of total in incremental steps

6.5.2 Model 2 – Upgrade of existing slipway facility

The investment needed to upgrade an existing slipway to ESM compliance is approximately 21 million USD (see Table 17). The bulk of the investments in this upgrade is also within Steps 2 and 3 as shown in Figure 7 and comprises heavy machinery and dismantling equipment as well as yard infrastructure, with shares of 35% and 58%, respectively.

Table 17
Upgrade investment for existing slipway facility to model facility (2012 USD)

	<1 year	1-3 years	3-7 years	Total
Documentation and identification – precutting phase		$30,000	-	**$30,000**
Equipment for dismantling activities – precutting phase	$48,000	$113,000	$10,000	**$171,000**
Equipment for dismantling activities – cutting phase	$325,000	-	$7,436,000	**$7,760,000**
Yard facilities and hazardous waste handling	$935,000	$7,595,000	$3,896,000	**$12,426,000**
Quality assurance schemes and operational measures	$44,000	-	-	**$44,000**
Staff – capacity building	$52,000	-	-	**$52,000**
Staff – training of working staff	$507,000	-	-	**$507,000**
Grand total	**$1,912,000**	**$7,737,000**	**$11,342,000**	**$20,991,000**
Percentage of total	**9%**	**37%**	**54%**	**100%**

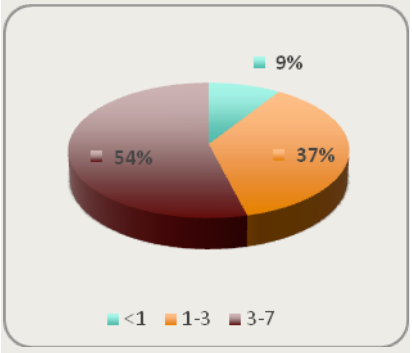


Figure 7
Investment of total in incremental steps

6.5.3 Model 3 – Establishment of facility from basic pier/harbor area

The cost analysis of Model 3, as shown in Table 18 and Table 19, reveals that investment of 24-25 million USD is required to establish a model facility from a basic pier (Model 3a) or a harbor area (Model 3b). The difference between upgrading to pier breaking and slipway breaking from a basic pier or a harbor area with no prior ship recycling activity is approximately 4%, with the additional cost for the slipway facility due to the need for barges or floating piers to be able to provide sufficient access for cranes. The bulk of the investments are attributable to Step 1 (45% and 46%, respectively), see Figure 8 and Figure 9, due to the fact that heavy machinery and dismantling equipment are not available from the start. A total of 35% of the investment is for heavy machinery and dismantling equipment, and 51% is for yard infrastructure and structures. Also, the cost of training and capacity building is higher due to the more labour-intensive model.

Table 18
Model 3a. Investment needed for establishment of ESM-compliant pier breaking from basic pier (2012 USD)

	<1 year	1-3 years	3-7 years	Total
Documentation and identification – precutting phase	-	$30,000	-	**$30,000**
Equipment for dismantling activities – precutting phase	$53,000	$113,000	$10,000	**$176,000**
Equipment for dismantling activities – cutting phase	$7,714,000	-	$1,741,000	**$9,455,000**
Yard facilities and hazardous waste handling	$895,000	$7,595,000	$3,800,000	**$12,290,000**
Quality assurance schemes and operational measures	$42,000	-	-	**$42,000**
Staff – capacity building	$52,000	-	-	**$52,000**
Staff – training of working staff	$1,882,000	-	-	**$1,882,000**
Grand total	**$10,638,000**	**$7,737,000**	**$5,551,000**	**$23,927,000**
Percentage of total	**45%**	**31%**	**23%**	**100%**

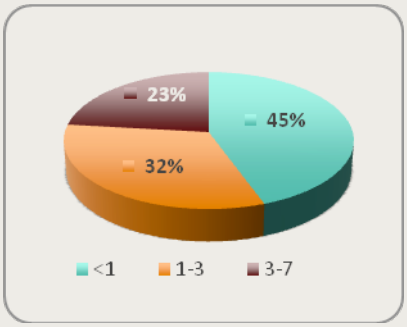


Figure 8
Investments of total in incremental steps

Table 19
Model 3b. Investment needed for establishment of ESM-compliant slipway breaking from basic harbor area (2012 USD)

	<1 year	1-3 years	3-7 years	Total
Documentation and identification – precutting phase		$30,000	-	**$30,000**
Equipment for dismantling activities – precutting phase	$53,000	$113,000	$10,000	**$176,000**
Equipment for dismantling activities – cutting phase	$8,491,400	-	$1,738,000	**$10,229,000**
Yard facilities and hazardous waste handling	$955,000	$7,595,000	$3,936,000	**$12,486,000**
Quality assurance schemes and operational measures	$42,000	-	-	**$42,000**
Staff – capacity building	$52,000	-	-	**$52,000**
Staff – training of working staff	$1,882,000	-	-	**$1,882,000**
Grand total	**$11,476,000**	**$7,737,000**	**$5,684,000**	**$24,898,000**
Percentage of total	**46%**	**31%**	**23%**	**100%**

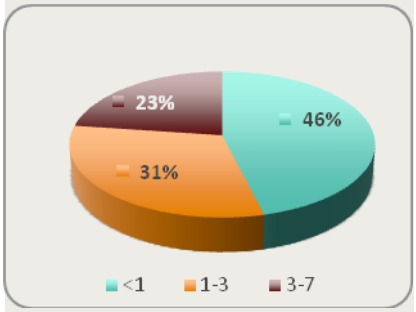


Figure 9
Investment of total in incremental steps

6.6 Sensitivity Analysis

As can be seen from the overview in Table 20, the cost of upgrading or establishing an environmentally sound ship recycling facility is largely dominated by the acquisition of two components:

1. Heavy machinery and equipment, such as cranes and other machinery, to lift and move dismantled parts of the ship
2. Concrete, to establish pavement for HM handling and storage areas and to construct office and storage buildings

These investments, therefore, are chosen as subjects for the sensitivity analysis. Also included is an analysis of a floating dry dock, a waste treatment facility and disposal sites. The focus in the sensitivity analysis is placed on equipment and infrastructure, nevertheless, it should be noted that capacity building and procedural measures are of equal importance for an upgrade to ESM compliance, though not investment intensive and will not alter the total investment in any significant way.

Table 20
Cost, as a percentage of the total, associated with each phase of environmentally sound management for the respective models

	Model 1: Pier breaking	Model 2: Slipway	Model 3: Pier/harbor area	
Documentation and identification – precutting phase	<1%	<1%	<1%	<1%
Equipment for dismantling activities – precutting phase	1%	2%	1%	1%
Equipment for dismantling activities – cutting phase	37%	35%	40%	41%
Yard facilities and hazardous waste handling	59%	60%	51%	50%
Quality assurance schemes and operational measures	<1%	<1%	<1%	<1%
Capacity building in leading staff	<1%	<1%	<1%	<1%
Training of working staff	2%	3%	8%	8%

6.6.1 Heavy machinery and equipment

The cost of heavy machinery and equipment such as cranes, movers, forklifts and dump trucks is versatile and highly dependent on factors such as national taxes, knowledge of market and freight rates. The baseline cost estimation for all heavy equipment is priced as the cost of new machinery at European market prices. Due to the higher overall cost in Europe, it is also assumed as the high boundary for the sensitivity analysis. To establish a low investment range boundary, the cost of used equipment is used for comparison. See Table 21.

In a scenario where used equipment is purchased instead of new, the total investment may be reduced by as much as 17%.

Table 21
Analysis of differences in investments when used heavy machinery is purchased instead of new

	Cost difference of used equipment	Cost difference of total
Model 1 – Upgrade to EHS pier breaking	-43%	-14%
Model 2 – Upgrade to EHS slipway	-47%	-17%
Model 3 – Establish from basic pier/harbor	-46%/-45%	-16%/-15%

6.6.2 Concrete slabs and buildings

A large part of the cost of upgrading to an ESM facility or establishing a new facility is linked to the impermeable floors, areas, gullies and roads to minimize the risk of leaching of HMs into the soil or water. The pavement is made from cement, concrete aggregate[48] and water. The cost of concrete varies largely depending on the specific country.

The price of concrete is identified for Turkey and a number of countries in Asia. The lowest costs are 70 USD/m^2 in South Korea and Vietnam and 86 USD/m^2 in China, and the highest cost is 142 USD/m^2 in India.[49] Variations in construction costs for warehouses range from 368 USD/m^2 in Turkey to 973 USD/m^2 in China and 525 USD/m^2 and 1,639 USD/m^2, respectively, for basic office buildings (Gardiner & Theobald, 2011; Turner and Townsend, 2012). The costs exclude preliminaries[50] and builders' margins. The figures presented in Table 22 should be regarded as indicative, because construction costs vary significantly throughout the year and from area to area. The cost of pavement is also influenced by bulk carrier freight rates, which account for more than half of the cost price of cement (GCL, 2006).

Table 22
Analysis of costs for concrete and construction buildings – cost range

	Low price	High price	Mean (USD/m^2)*
Concrete slab	-32%	+37%	96
Warehouse building	-25%	+61%	594
Office building	-46%	+70%	893

*Used in cost calculations.

Using the low and high price figures as boundaries to analyze the sensitivity to changes in the cost of concrete,[51] it is found that the total cost for the respective models may vary with up to almost 20% to the cheaper side and up to almost 30% on the more expensive side. Consequently, in a scenario where both the lower cost boundary of concrete and heavy machinery are used, the total investment may be up to 40% lower for a model facility. Using only concrete as high boundary, the investment may be up to 35% higher. A full overview of cost ranges is presented in Table 23.

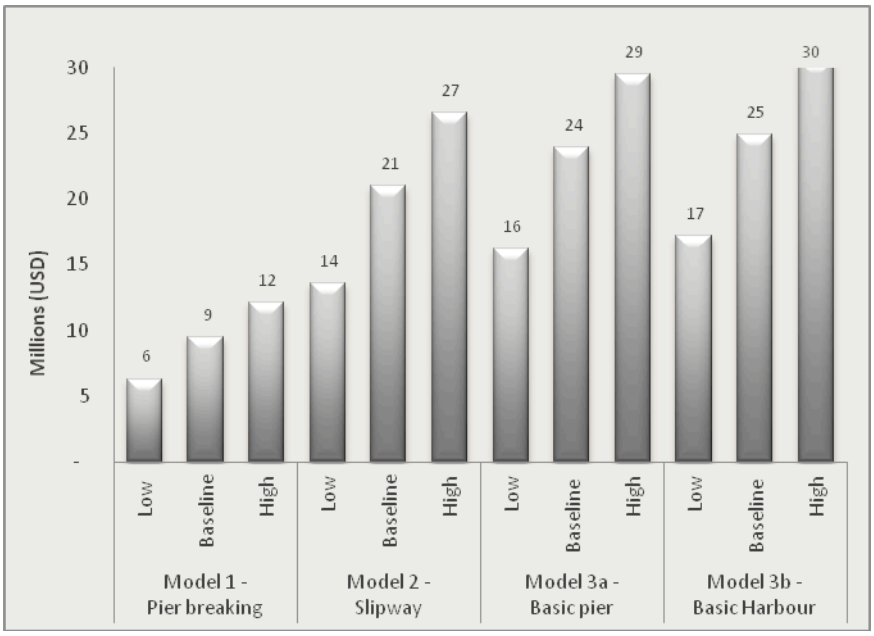
[48] Aggregate is a category of coarse particulate material that comprises gravel, sand, crushed stone, slag and recycled concrete.
[49] Cost per m^2 for a concrete slab of at least 1,500 m^2.
[50] Preliminaries include job setup costs such as scaffolding, approvals, insurances, power and water, cleaning and handover, and work supervision.
[51] It is assumed that building price follows the material cost of concrete (i.e., the low concrete cost corresponds to the low building cost). Wages are not included.

Table 23
Variation in total cost of the respective upgrade models with regard to sensitivity to change in cost of concrete

	Low boundary	High boundary
Model 1 – Upgrade to EHS pier breaking	-19%	28%
Model 2 – Upgrade to EHS slipway	-19%	26%
Model 3 – Establish basic pier/harbor area	-16%	23%

The baseline facilities in Figure 10 represent the upgrade investment for the respective models, compared to the cumulative low and high boundary investment estimate from the concrete and used equipment sensitivity analysis. It is evident from the figure, that the Model 1 upgrade to pier breaking represents the least investment compared to the other models, even when new equipment and high cost of concrete is considered. The difference between model 2 and 3 is less pronounced and whether one or the other is more costly is highly dependent on choice of equipment /(used/new) and specific cost of concrete at the location of choice.

Figure 10
Comparison of investment cost of baseline facilities to low- and high-cost boundaries. Accumulated low-cost of concrete and used equipment are used as component cost in the lower boundary scenario, and high price of concrete as the higher boundary.



6.6.3 Slipway vs. pier breaking

The main difference between establishing a pier breaking facility and a slipway facility from a basic pier of harbor area is the use of winches at the slipway. The cost of winches and strain gauges is negligible (<1% of the total investment) compared to the overall cost of establishing a slipway facility. Pier-breaking facilities sometimes also use a slipway to lift the remaining part of the hull out of the water; however, it is more common to use a floating dry dock. In a case where the basic pier does not have a slipway and does not offer access to a floating dry dock, an additional investment in a floating dry dock would be needed for establishing a pier breaking facility at a basic pier.

A used floating dry dock that can hold a typical Aframax (32-m beam)[52] can be purchased for around 10.5 million USD. This would bring the total investment of establishing a pier-breaking facility from a basic pier up to the approximate level of establishing a slipway facility (less than 5% difference).

6.6.4 Waste Management Centers (WMC)

If a SRF is to be established in a location where there are no waste treatment facilities or management of the waste streams outside the yard, then sufficient landfill capacity and an appropriate waste treatment facility are required to be constructed. This is to ensure full ESM of the HMs from the dismantling process. The additional establishment cost is approximately four million USD for a landfill (150,000 m^3 capacity) and six million USD for a simple incineration plant. There may be additional costs associated with enabling a safe incineration treatment of PCB in the form of emissions control technologies and additional training. This could amount to a further investment of five million USD[53] (see Table 24). Costs associated with developing regulations, policies or enforcement of WMCs are not included in the reported costs.

The additional costs associated with establishing facilities for hazardous waste treatment represent an addition of some 15 million USD to the cost of establishing or upgrading to an ESM compliant ship recycling facility (Table 24). The waste stream from a sole SRF may not in itself provide a suitable business case for a WMC, and the extra investment needed may not be borne by the SRF. The construction of a model facility in a location with no existing WMC would be considered economically unfeasible unless the business case of the WMC was tied to other contributors of HM (e.g., local industries).

Table 24
Investments needed for hazardous waste treatment

Hazardous waste treatment	Investment (USD 2012)
Landfill (150,000 m^3 capacity)	4 million
Incineration plant	6 million
Emissions control technology and additional training for PCB handling	5 million
Total	**15 million**

[52] www.tmt-llc.com/drydocks/TM2542DD.htm and www.marine-consultant.com/p414.htm
[53] Personal communication with representative of Jiangyin solid waste disposal center.

6.6.5 Comparison of cost with different model sizes

Two additional model facility sizes are presented in Figure 11 and compared to the investment needed for a 100,000 LDT capacity model facility.

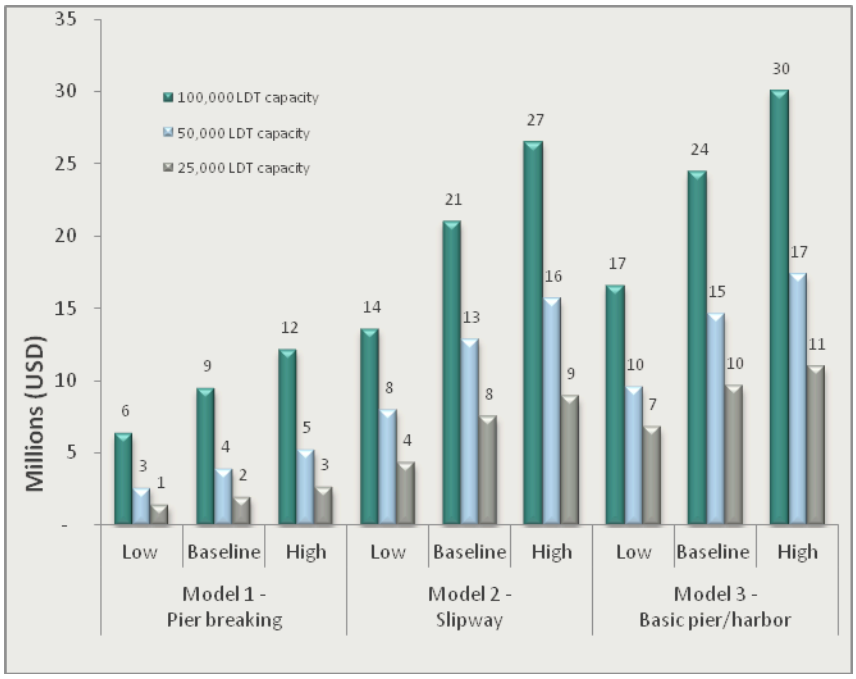


Figure 11
Comparison of total investment in three different sized model facilities with yearly scrapping capacity facilities of 100,000 LDT, 50,000 LDT and 25,000 LDT.

The differences in investments are primarily due to less use of concrete (directly proportional to capacity) and fewer heavy machinery components, which is also directly proportional to capacity, but with minor differences due to round off, see Appendix C for details on upgrade number for the respective upgrade components. The calculations of investments in Model 3 are based on an average of Models 3a and 3b, as they only differ by approximately 4%.

The total investments needed in order to achieve ESM compliance for the different capacity yards are given in Table 25 together with the lower and higher range cost boundaries. The boundaries are based on accumulated low cost of concrete and used equipment and high cost of concrete. These components constitute more than 90% of the investment.

Table 25
Comparison of total upgrade cost to achieve compliance for ship recycling facilities of different capacity. Only the two main cost components comprising more than 90% of total costs are included. Rounded numbers are shown. For details see Section 8. Investment given in 2012 USD.

	Grand total cost **Mean concrete price and new machinery used. (USD)**	Impermeable surfaces sensitivity. **With low concrete costs (USD).**	Heavy machinery sensitivity. **With used machinery. (USD)**	Impermeable surfaces and used machinery combined. **Lower range of total cost. (USD)**	Impermeable surfaces sensitivity. **Higher range of total cost. (USD)**
Large 100,000 LDT					
Existing pier (1)	9,500,000	7,600,000	8,100,000	6,300,000	12,100,000
Existing slipway (2)	21,000,000	17,000,000	17,500,000	13,600,000	26,500,000
Basic pier (3a)	23,900,000	20,000,000	20,100,000	16,200,000	29,500,000
Basic harbor (3b)	24,900,000	21,000,000	21,100,000	17,200,000	30,400,000
Medium 50,000 LDT					
Existing pier (1)	3,900,000	2,900,000	3,100,000	2,600,000	5,200,000
Existing slipways (2)	12,900,000	10,900,000	9,900,000	8,000,000	15,600,000
Basic pier (3a)	14,300,000	12,600,000	11,200,000	9,300,000	17,300,000
Basic harbor (3b)	14,800,000	12,900,000	11,700,000	9,800,000	17,600,000
Small 25,000 LDT					
Existing pier (1)	1,900,000	1,500,000	1,900,000	1,400,000	2,600,000
Existing Slipways (2)	7,500,000	6,500,000	5,300,000	4,300,000	8,900,000
Basic pier (3a)	9,500,000	8,600,000	6,700,000	5,700,000	11,000,000
Basic harbor (3b)	9,700,000	8,800,000	6,900,000	5,900,000	11,100,000

6.7 Considerations of Suitable Locations for Model Facilities

6.7.1 Locations suitable for Model 1 upgrade

The upgrade of an existing pier-breaking facility may take place only in ship recycling locations that already employ the alongside method. A number of locations in harbors in the EU and US use this method, but these locations should already be compliant. The primary country for pier breaking is China, where many facilities are active in ship recycling. Some non-compliant pier breaking facilities in China may be considered candidates for upgrade. However, in this case a model facility will entail competition to privately operated compliant yards already established. However, in a few locations in ports in India, pier breaking is carried out, and this is reportedly also the case in the Dominican Republic. Historically, Mexico has carried out ship recycling by pier breaking, and the facilities, now operating as repair yards, may fall into this Model 1 upgrade category of roughly 9.5 million USD over seven years.

6.7.2 Locations suitable for Model 2 upgrade

The investments needed for a Model 2 upgrade of an existing slipway to a compliant model comprise mainly heavy machinery and yard infrastructure. This method, which is comparable to the landing method, is used in Turkey and some locations in the EU. Outside of Turkey the method is often used in rivers and estuaries with little tidal movement and where the sites are protected from waves, weather and changing currents. These recycling sites often break ships that are somewhat smaller than those broken at pier-breaking sites. Active ship recycling that employs this method is also

found in Mumbai and several other sites in India that would fall into a Model 2 upgrade category of roughly 21 million USD over seven years.

6.7.3 Locations suitable for Model 3 upgrade

The most versatile upgrade is Model 3 – establishment of a ship recycling facility from a basic pier in a harbor area – because it does not place any demands on the site. The cost is 24-25 million USD, depending on whether it is pier breaking or slipway, albeit local prices and purchasing secondhand equipment can lower this 16% and 15%, respectively. A number of locations globally will qualify, because any port infrastructure or ship repair yard may meet the requirements. In Asia, the Philippines and Indonesia have already expressed their interests in this industry, and recently Vietnam and Thailand did also, and it should be emphasized that the ports of Karachi in Pakistan and Chittagong in Bangladesh are both close to the existing ship recycling communities and can offer the basic port infrastructure needed.

7 Conclusion

This study has reviewed environmentally sound management in the context of ship dismantling. It identified cost effective, environmentally sound alternatives to beaching and presented the cost of upgrading non-compliant facilities to environmentally sound management. The basis for the present study was to focus on alternatives to beaching – namely the pier-breaking method (also known as "alongside") as used in China and European countries and the landing and slipway method as employed in Turkey.

The feasibility assessment of safe and environmentally sound management of ship recycling takes into consideration the requirements for environmental issues as outlined in the main driving regulations of (future) ship recycling: the Basel Convention, the ILO conventions and the Hong Kong Convention.

The costs of the upgrade components were estimated for a model facility depending on the starting point of departure. In two cases an existing non-compliant facility would be assumed present to build upon (Model 1 and 2) and in two cases a site with no previous recycling operations (Model 3a and 3b) was used as basis. It is assumed for the cost estimations that port facilities and basic infrastructure are already in place and that establishment of major downstream waste management facilities is outside the budgeting of an individual model ship recycling facility.

The total investment needed for the respective models ranges from

- 9,500,000 – 24,900,000 USD for a large facility (100,000 LDT/year)
- 3,900,000 – 14,800,000 USD for a medium facility (50,000 LDT/year), and
- 1,900,000 – 9,700,000 USD for a small facility (25,000 LDT/year)

The differences in investments between the different sized model facilities are primarily due to consumption of less concrete in construction (almost directly proportional to capacity) and fewer heavy machinery investments, which is also directly proportional to capacity. The capacity building and various operational measures, of equal importance to the upgrade process have less impact economically.

The key upgrade actions for ship recycling facilities were outlined in the UNEP commissioned study "Case Study to Develop Models of Compliant Ship Recycling Facilities " (Final version from 2012) [54] and used here for the incremental implementation over seven years in three steps: <1 year; 1-3 years and 3-7 years.

The results presented in Table 26 reveal that the bulk of the investments are made within steps 2 and 3 for existing pier breaking and existing slipway facilities, and are obviously more equally distributed across the steps of implementation than if established from a basic pier/harbor area.

[54] http://www.basel.int/Implementation/TechnicalAssistance/ShipDismantling/CapacityBuilding/tabid/2764/Default.aspx#section2

Table 26
Overview of how the cost of upgrade is distributed within the incremental steps

Upgrade from	<1 year	1-3 years	3-7 years
Existing pier breaking	16%	36%	48%
Existing slipway	9%	37%	54%
Basic pier/harbor area	45%/46%	31%	23%

A number of countries may be suitable for the establishment of a model shipbreaking facility. A few locations in ports in India carry out pier breaking (in addition to a number of location in China). This is reportedly also the case in the Dominican Republic and both the Indian sites and the Caribbean site may be suitable for a model 1 upgrade.

The slipway method (model 2) may be used in a number of small currently domestically oriented locations, but an existing larger location can be found in Mumbai.

A number of locations globally will be suitable for model 3, because basically any port infrastructure or ship repair yard may meet the requirements. In Asia, the Philippines and Indonesia have already expressed their interests in this industry, also Vietnam and Thailand have previously engaged in ship recycling, and it should be emphasized that the ports of Karachi in Pakistan and Chittagong in Bangladesh are both close to the existing ship recycling communities and can offer the basic port infrastructure needed.

The key stakeholders needed for the establishment of a model shipbreaking facility comprise a number of parties both national and international and will depend on the actual location. It is however of value to ensure the active participation of both authorities and local trade unions and industry associations.

The key barriers for moving towards a greener ship recycling industry include a lack of political will to legislate and enforce regulations, fear of job losses, lack of embedded requirements from shipowners or lenders in the secondhand trade or scrap trade, and the difficulties associated with the selection of verified ship recycling yards.

The entry into force of HKC and the increasing awareness of CSR issues may encourage shipowners to seek alternatives to beaching and create business opportunities for the establishment of BC/HKC compliant facilities for the recycling of ships as outlined in this study.

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Appendix A – Description of ESM standards associated with removal of certain HMs

Asbestos and materials containing asbestos

Asbestos is a natural mineral that is not harmful to the environment per se but does nonetheless represent a major health threat. When friable asbestos is disturbed it breaks up into very fine fibers that are suspended in the air for long periods and consequently are inhaled by workers and operators at the facility or by people living nearby. The fibers remain and accumulate in the lungs, and their presence leads to dramatically increased risks of lung cancer, mesothelioma[55] and asbestosis.[56]

To avoid the release of asbestos into the atmosphere and environment during the removal process, a range of protective measures should be applied:

- **Isolation:** The removal, decontamination and remediation of asbestos should be isolated from other work spaces. This can be achieved, for example, by sealing the area off with plastic sheets of sufficient strength and/or maintaining the area under negative pressure.
- **Control:** Water or an appropriate wetting agent should be applied to materials containing asbestos during the removal process, and ventilation and filter systems should be applied to filter air coming from the enclosed area.
- **Containment:** The asbestos and asbestos-containing material should be packed and sealed in plastic containers prior to being removed from the area. The containers should be properly labeled and sufficiently strong and resilient in order to minimize the possibility of accidental damage or breakage during transport.
- **Decontamination:** The area should be cleaned with a vacuum cleaner equipped with a high-efficiency particulate air (HEPA) filter. The equipment, tools and plastic sheets used for isolating should be washed/cleaned. Facilities for decontamination should be available, and work clothes should be bagged, labeled and laundered at an appropriate location at the facility or off-site.
- **Training and monitoring:** Only trained personnel wearing personal protection equipment should carry out Entry into the asbestos contamination area, and the removal process should be conducted under the monitoring and management of a competent person.

PCBs and materials containing PCBs

PCB has shown to cause a number of adverse health effects. They are chronically toxic to the environment because they bioaccumulate and are very persistent. The most carcinogenic PCB tend to accumulate in top predators, including humans. When PCB is heated, chemicals[57] are produced that are known to be even more detrimental than are PCB themselves.

[55] A cancer of the chest and abdominal linings.
[56] Irreversible lung scarring that can be fatal.
[57] Polychlorinated dibenzofurans and polychlorinated dibenzo-p-dioxins.

Procedures to avoid spills, scattering and volatilization of liquids and materials containing PCB should be applied during the removal process, including the use of closed drainage equipment. For liquids, spill prevention measures include booms, drip pans, liners and/or absorbent materials. For solid materials where manual, chemical or mechanical means, such as blasting, scraping, cutting, stripping or gouging, are used, methods to avoid scattering should be applied.

After the removal process is finished, the equipment used to remove materials containing PCB should be decontaminated. The decontamination liquid should be collected and stored. Only trained personnel should conduct handling of PCB.

Oil and fuel residues

Measures to contain and control leakage and overflow of oils and fuels into soil/sediment and water during the removal process and transfer to land should be applied. This includes placing drip pans, liners, and/or absorbent materials and booms around the ship if it is still in the water and using available port reception facilities.

Cleaning of tanks, containers and piping systems should be conducted after the removal process. The wastewater and any used solvents from the cleaning process must be contained and properly treated.

Equipment and instruments

Equipment and other instruments typically contain heavy metals, ODS and radioactive substances. Equipment and instruments containing HMs should be removed in a manner that avoids leakage and spills.

Paints and coatings that contain heavy metals

Paint may contain a range of different hazardous compounds, such as heavy metals (e.g., lead, barium, cadmium, chromium, zinc), PCB, pesticides (e.g., TBT), organo-mercury compounds, copper oxides, arsenic and solvents. Hazardous paint fumes may arise during metal cutting. The fumes are of primary concern for occupational health; however, they may disperse through the air and deposit far away from their source and potentially contaminate the environment.

Due to the potential toxicity and environmental hazard arising from paint fumes, the flammability and toxicity of paints or coatings on cutting surfaces should be checked prior to hot cutting. In cases where toxic or flammable paints are identified, a sufficiently wide band of paint along the cutting line (for hot cutting) should be mechanically or chemically removed, or hot methods of removal should be avoided altogether and removal should be completed by using hydraulic shears to cut the metal plates.

Thus, paint and antifouling paints/compounds may be scattered as a result of blasting, chemical stripping or mechanical removal, or as result of other efforts such as dragging, and attention should be given to collect and contain these flakes of paint waste in order to avoid their spread to the terrestrial and aquatic environments in the yard vicinity. Prevention and control measures to avoid the spillage and leak of paints and antifouling compounds, such as organotin paint and future (potentially hazardous) antifouling compounds into the sea or soil, should also be applied.

ODS-containing materials

ODS are typically found in HVAC systems, but residues can also be found in insulation foam, where they have been used as blowing agents. The liquids in cooling systems evaporate quickly from open containers and thus must be drained and stored in airtight cylinders. Special considerations should be given to the removal of insulation foam to avoid release into the atmosphere. This includes airtight packing.

Ship-generated waste and stores (IHM Parts II and III)

This section addresses operational waste generated on board the ship, which comprise both liquids and non-liquids (apart from oils and fuel).

Liquid waste includes, among others, bilge and ballast water as well as sewage. Bilge and ballast water may contain oil residues and need to be treated with an oil-water separator to enable safe discharge. Ballast water could also contain non-indigenous invasive species and need to be disinfected prior to discharge to local waters, where survival of the species would be possible. Sewage needs to be collected for treatment. Cleaning and disinfection of bilge, ballast and sewage compartments should be done after emptying collected wastewater and remediating waste for appropriate storage.

Non-liquid operationally-generated waste includes, among others, medical/infectious waste, incinerator ash, dry cargo residues and garbage, all of which should be collected for appropriate safe storage and disposal.

Ships stores include a host of different substances, materials and chemicals – typically various solvents, chemical cleaners and paints – that need to be handled according to the type of associated hazard.[58] Some stores may represent a market value and be sold for further use.

[58] A comprehensive list can be found in Parts II and III of the HKC guideline on inventories of hazardous materials.

Appendix B – Standards and Technical Guidelines

Basel Convention Technical Guidelines

The Basel Convention Technical Guidelines for the Environmentally Sound Management of the Full and Partial Dismantling of Ships (Basel Convention, 2003) provide technical and procedural recommendations on environmental issues associated with ship dismantling. The guidelines are applicable to both existing ship dismantling facilities and new facilities; however, they do not make specific provisions on the aspects of health and safety but rather reference the guidelines developed by the International Labour Organization on these issues.

According to the guidelines, the successful establishment of an EMS, which can assist the SRF in achieving its environmental goals and demonstrate environmentally sound performance, is based on establishing an Environmental Management Plan (EMP). The EMP is an all-encompassing document covering all environmental issues on a macro scale. The initial step of the EMP is to assess the potential environmental impacts from the facility by performing an Environmental Impact Assessment (EIA). The EIA helps identify the environmental aspects and environmental goals to be set for the facility and serves as an input to the EMS. An inventory of best practices of potential preventive measures to avoid or minimize the generation of HW should be prepared.

The key components of the EMS are a waste management plan, a contingency preparedness plan (CPP) and a monitoring plan (MP). The waste management plan addresses all materials in the extraction, sorting and transport phases of the waste stream deriving from the dismantling process. The CPP includes health, safety and environmental issues. The CPP assigns duties and responsibilities among the involved actors (e.g., authorities, response team members and coordinators). The monitoring programme takes into account the facility's characteristics on releases of HMs to soil, sediments, water and air, as well as nuisance from noise/vibrations. A monitoring programme relies on knowledge of the environmental condition prior to any contamination of the area. In case a facility is already established, an undisturbed reference station with similar geological and meteorological conditions at the site of interest should be chosen as the base case. Parameters to monitor include chemical, biological and physical changes in the environment surrounding the SRF. The MP includes sampling of water and soil/sediments, measuring air and noise/vibrations, and performing a subsequent comparative analysis. It also includes implementing training programmes for key personnel who handle HMs and for the emergency and response teams.

In short, the EMP comprises:

- The assessment of potential impacts (EIA)
- The formulation of potential preventive measures (inventory of best practices)
- An EMS
    - Waste management plan
    - Contingency preparedness plan

- Monitoring plan

Hong Kong Convention Technical Guidelines

The 2012 Guidelines for Safe and Environmentally Sound Ship Recycling of the Hong Kong Convention (MEPC.210(63), 2012) make specific reference to environmentally sound management of hazardous materials. The guidelines are intended to be used by stakeholders, particularly ship recycling facilities, and lay out the provision of sound management in the form of a ship recycling facility plan (SRFP).[59]

The SRFP is the main document that the competent authority or organization recognized by it will rely on in authorizing a ship recycling facility. Site inspections are to be utilized to verify that facility operations conform to the description in the SRFP.

The SRFP should fully describe the operations and procedures that are in place at the ship recycling facility to ensure compliance with the HKC and demonstrate knowledge and understanding of all applicable statutory and regulatory requirements. It should include descriptions of the operational processes and procedures at the ship recycling facility and demonstrate how the requirements of the HKC will be met.

The SRFP should provide a description of plans and procedures for protecting the environment, human health and worker safety, demonstrating that the ship recycling facility understands the risks associated with ship recycling and implements the environmental requirements imposed by applicable international and national laws and regulations; is capable of managing and disposing of all the materials in the ship in an environmentally sound manner; and is implementing controls to protect the environment with respect to dedicated infrastructure, handling, treatment and disposal of HMs in line with national laws and regulations. It should address the roles and responsibilities of personnel, emergency preparedness teams and response teams. The SRFP should also address systems for monitoring, reporting, record keeping and training programmes.

International Labour Organization Guidelines

The Safety and Health in Shipbreaking: Guidelines for Asian Countries and Turkey in 2004.[60] are designed to assist ship breakers and competent authorities to implement the relevant provisions of ILO standards, codes of practice and other guidelines on occupational safety and health and working conditions. With the guidelines the ILO aims to aid progressive improvement; provide guidance to those engaged in the framing of relevant provisions; and help the establishment of effective national systems, procedures and enterprise regulations. The guidelines are not legally binding and are not intended to replace national laws, regulations or accepted standards.

ISO 30000/30004

The International Organization for Standardization (ISO) develops international common standards that give specifications for products, services and practices. The ISO 30004 (2012) is the Guideline for implementation of the ISO 30000 standard, which specifies the requirements of the management system used by a ship recycling

[59] http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf
[60] http://www.ilo.org/public/english/standards/relm/gb/docs/gb289/pdf/meshs-1.pdf

facility that intends to be an ISO-certified environmentally sound ship recycling facility. The scope of the standard enables a ship recycling facility to develop and implement procedures, policies and objectives in order to be able to undertake safe and environmentally sound ship recycling operations in accordance with national and international standards. The standard comprises health, safety and environmental issues and applies to the entire recycling process with regard to elements of environmental concern.

The ISO 30000 is a management standard by which to conduct quality assurance, although it does not address specific environmentally sound methods of recycling. It covers documentation prior to dismantling, as well as procedures for identification, handling, disposal and treatment of hazardous materials.

Appendix C – Components of environmentally sound management

Number of components for the respective upgrades with respect to 25,000 LDT, 50,000 LDT and 100,000 LDT.

Basic pier – upgrade to Model pier breaking facility

Table 1 - Documentation/identification

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Documentation	Correlate HMs against IHM	Document all hazardous materials on board against supplied Inventory of Hazardous Materials / Green passport	Work hours	-		-
	Approved Ship specific Recycling Plan	Approved Ship specific Recycling Plan	Work hours	-		-
Identification	Visual inspection	Visual inspection	Work hours	-		-
	Sampling and analysis of HM and PCHM	Sampling and analysis of HM and PCHM	Sampling analysis	3	5	10

Table 2 Equipment for dismantling activities - pre cutting phase

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Asbestos	Area isolation items	Heavy curtains to confine asbestos contaminated area	Wall curtains	1	2	4
	Ventilation and filter systems	To filter the air from enclosed chambers where asbestos is present	Ventilation fan and filter	1	2	2
	Air monitoring equipment	To monitor airborne asbestos	Pump kit	1	2	2
	Vacuum cleaners	To clean for asbestos fibers (equipped with HEPA filter)	Vacuum cleaner	1	2	2
	Bags for asbestos	To secure isolation of asbestos	75 pieces	13	25	50
	Decontamination facility	Decontamination of workers when leaving area for asbestos	Shower cabin	1	2	4
PCB	Airtight drums for PCB	To minimize contamination of environment	Drum	3	5	10
Oils and fuels	Pumping and draining equipment	To empty tank/compartments of oil and fuels	Pump	1	1	2
	Drums for oil	For intermediate storage	Drum	6	12	24
	Oil booms	Part of emergency kit in case of oil spill.	Oil boom	1	2	4
	Oil dispersant	Part of emergency kit in case of oil spill.	Oil Dispersant	1	2	4
	Oil skimmers	For removing oil from the surface of water.	Oil skimmer	1	1	1
	Cleaning solvents	For cleaning compartments after emptying	Drum	3	5	10
Paint	Abrasive blasting equipment	High pressure equipment used on paints containing HMs such as PCB, Heavy metals and antifouling	Air compressor and abrasive blaster	1	1	1
	Chemical for stripping of paint	In order to obtain clean metal for hot-cutting	Solvent	1	1	2
	Power tools	For mechanical removal of paint In order to obtain clean metal for hot-cutting	Angle grinder	2	4	8
ODS containing materials	Airtight drums for ODS materials	Airtight packing for insulation where ODS has been used as propellant	Drum	3	5	10
Ship generated wastes and stores	Pumping equipment	To empty tank/compartments sewage, bilge and ballast water	Pumps	1	1	2
	Oil-water separation	To separate oil from water	Oil-water	1	1	1

	equipment		separator			
	Disinfectants for ballast water	To disinfect ballast water prior to discharge	Canister	26	52	104
	Cleaning solvents	For remediation of spill on board	Drum	1	1	2

Table 3 Equipment for dismantling activities - Cutting phase

Element	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Miscellaneous	Hydraulic shears	To cut metal	Pair of shears	0	0	1
	Mechanical movers	Either tracked or all terrain vehicles that support hydraulic arms to operate the hydraulic shears.	Mechanical movers	1	1	2
	Forklift	To transport dismantled parts from the ship to their designated storage area.	Forklifts	1	1	2
	Dumper trucks	To transport dismantled parts from the ship to their designated storage area.	Dumper trucks	1	2	4
	Gas detectors and oxygen meters	To ensure the atmosphere within a space does not contain elevated levels of dangerous gases.	Gas detectors and oxygen meters	3	3	8
	Fixed/mobile cranes	To lift the sections of dismantled ship onto the ground or clear of the ship.	Cranes	2	3	4
	Spider grabs/magnetic lifts	Suspended from the cranes to lift the steel sections to the storage area.	Grabs/Lifts	1	1	2
	Lifting gear	Slings, winches, chain blocks and ropes to remove machinery from the vessel.	Set of lifting gear	1	2	4
	Transformers	To provide 110V supply from 240v or 415v main.	Transformers	1	2	4
	Gas burning equipment	To cut metal	Gas burners	20	40	80
	Hand lamps	Lighting for safe passage around a ship once power has been shut down.	Lamps	75	150	300
	Hand tools and communication equipment	Hammers, hacksaws, punchers and spanners to dismantle items and radios for communication.	Set of hand tools	10	20	40
	Sounding tape	To sound the oil cargo and ballast tanks (measure depth of liquid).	Sounding tape	1	2	4
	Portable air fans and trunking	To supply air to confined spaces or during localised burning extract fumes.	Air fans	4	8	16
	Temporary lighting	Lighting for safe passage around a ship once power has been shut down.	Projectors	10	20	40
	First aid kits	For emergency use for workers.	First Aid Kits	2	4	8
	Protective clothing and equipment	Personal protective equipment for staff conducting specific tasks (helmets, hard toed shoes, gloves, PPE for eyes, face and skin)	Sets of personal protective equipment	100	200	400
	Breathing apparatus sets	Respiratory equipment for entering contaminated spaces in emergency.	Respirators	5	10	20

Table 4 Yard facilities and hazardous waste handling

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Dismantling area	Impermeable floors for handling areas and designated areas for segregation of HMs	Area for dismantling, sorting and finishing processes with impermeable floor to prevent leakage of contaminants to soil and water	m^2 pavement	12,500	25,000	50,000
	Building for segregation of asbestos with limited access	Closed area where asbestos is separated from other materials	m^2 building	50	100	200
	Gullies	Cement gully to segregate areas where HMs is extracted from the surroundings	m^2	125	250	500
	Roads for heavy transport	For transport of materials inside the yard area	m^2 pavement	-	-	Part of 50,000 m^2
Storage area	Impermeable floors in storage area	Total paved storage area	m^2 pavement	5,000	10,000	20,000

Asbestos	Roofing of HM storage	Sheltered area for storage of asbestos with impermeable floor	m^2 shed	25	50	100
Paints and coatings	Roofing of HM storage	sheltered area with facilities for storage of paints (liquid and solid). Plates with organotins (in paint) under roof and with drain.	m^2 shed	250	500	1,000
Oils and fuels	Roofing of HM storage	Sheltered containment area with impermeable floor and curbing	m^2 shed	25	50	100
	Tanks for oil and fuel	Tanks with leakage detection, overfill monitoring and corrosion protection	Tanks	1	1	2
PCB	Roofing of HM storage	Sheltered storage facility with impermeable floor and curbing	m^2 shed	25	50	100
ODS	Roofing of HM storage	Sheltered storage facility with impermeable floor and curbing	m^2 shed	25	50	100
	Tanks for ODS	453 L refrigerant cylinder	Tank	1	1	1
Ship generated wastes and stores	Roofing of HM storage	Sheltered containment area with impermeable floor and curbing	m^2 shed	250	500	1000
	Tanks for sludge and bilge water	Tanks equipped with overfill detection to reduce risk of spills (maximum vessel-tank volume).	Tanks	2	4	8
Equipment	Roofing of area for equipment for reuse/recycling	Sheltered area for materials and equipment with impermeable floor. If possible protected from rain. Including workshop area.	m^2 shed	1,250	2,500	5,000
Miscellaneous	Spill response equipment	for spills up to 360L	Kit	5	10	20
	Storm water discharge facility	To minimize contaminated run off water entering soil and water	Drainage system	1	2	4
	Fire Fighting Equipment	For emergency use for workers.	Set of fire extinguisher, fire blanket etc.	2	4	8
	Containers for cables etc.	Containers for wires etc.	Containers	1	2	4
	Containers for metal	Metals stored in separate containers (mercury in sealed container)	Containers	1	2	4
	Warning signs	Signs identifying key safety hazards	Signs	3	5	10
	Pumping equipment	Pumping equipment linked to impermeable areas for storage tanks /catch pits.	Pump	1	2	4
	Magnet	To check ferrous or non-ferrous metal.	Magnets	1	2	4
Administration area (on site)	Domestic building incl. Emergency response facilities	Building with facilities for catering, changing rooms and treatment of first aid	m^2 building	125	250	500
	Office buildings	Administration block for project leading etc.	m^2building	100	200	400

Table 5 Operational Measures

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Environmental Management plan (Basel convention)	Assessment of potential impacts (EIA)	Chapter 6, BC technical guideline	Procedure development	1	1	1
	Inventory of Best Practices	Chapter 6, BC technical guideline	Procedure development	1	1	1
	Environmental management system	Chapter 6, BC technical guideline Waste management plan (WMP)	Procedure development	1	1	1
		Chapter 6, BC technical guideline Contingency preparedness plan (CPP)	Procedure development	1	1	1
		Chapter 6, BC technical guideline Monitoring plan (MP)	Procedure development	1	1	1
Ship recycling facility plan (Hong Kong Convention)	Ship facility management plan	Facility management	Procedure development	1	1	1
		Facility operation (hereunder Ship-specific Ship Recycling Plan)	Procedure development	1	1	1
		Worker safety and health compliance approach (hereunder ILO Asbestos management)	Procedure development	1	1	1

		Environmental compliance approach	Procedure developme nt	1	1	1
ISO certification (14001, 9001, 30001) or national equivalent	Procedures (Internal cost)	Developing and implementing procedures as laid out in the standards http://www.iso.org/iso/home/standards/management-standards/iso_9000.htm http://www.iso.org/iso/home/standards/management-standards/iso14000.htm http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=51244	Procedure developme nt	1	1	1
	Auditing and certification (External cost)	External auditing and certification of the developed procedures by responsible authorities. E.g: http://www.iaf.nu//articles/IAF_MEMBERS_SIGNATORIES/4	Auditing and certification	1	1	1

Table 6 Train the trainers - leading staff -

Process	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Off shore	Ship Recycling Plan incl. Safety and Health Plan, Environmental Compliance Plan and Operational Plan (IMO guidelines)	Facility guidelines chapter 3.24 and 3.3 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course	-	-	-
Dismantling	Safety and Health Management System	http://www.ilo.org/global/publications/ilo-bookstore/order-online/books/WCMS_PUBL_9221116344_EN/lang--en/index.htm	Course	-	-	-
Transport	Package and transport of asbestos, PCB, organotin waste and special oils, Freon and CFC-gasses according to UNECE recommendations	United Nations Economic Commission for Europe, UNECE (2004): UN Model Regulations on the Transport of Dangerous Goods, 14th edition	Course	-	-	-
Plans and programmes	Contingency and response plan	Facility guidelines, chapter 3.3.5 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course	-	-	-
	Environmental contingency plan (UNEP/OCHA guidelines)	https://ochanet.unocha.org/p/Documents/DWG%20Annex%20XII.Disaster%20waste%20management%20contingency%20planning.pdf	Course	-	-	-
	Spill cleaning procedure incl. safe handling operations, appropriate protective clothing (Basel guideline)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf http://www.ilo.org/safework/info/standards-and-instruments/codes/lang--en/index.htm	Course	-	-	-
	Monitoring programme (sampling and analysis)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf	Course	-	-	-
	Discharge monitoring system (waste water monitoring)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf	Course	-	-	-
	Environmental monitoring programme (noise, air, soil and water)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf	Course	-	-	-
TOTAL	**Capacity building leading staff**			**3**	**6**	**12**

Table 7 Training of working staff

Training of staff	Requirement	Reference	Unit	Number	Number	Numbe

				25,000 LDT	50,000 LDT	r 100,000 LDT
Asbestos	Removal (ILO 1984), package and storage of asbestos (UNECE recommendations)	http://www.ilo.org/wcmsp5/groups/public/@ed_protect/@protrav/@safework/documents/normativeinstrument/wcms_107843.pdf	Course			
PCE	Removal, package and storage of PCE (UNECE recommendations)	http://www.unece.org/trans/danger/publi/dg_publications.html	Course			
HM	Removal, transport and storage of hazardous waste	http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/normativeinstrument/wcms_107689.pdf	Course			
Freon	Removal of Freon (to closed cylinders)	http://www.ilo.org/legacy/english/protection/safework/cis/products/safetytm/toc.htm	Course			
Ready for entry	"Gas-free for hot work" and "Enclosed Space Entry Permit"	Facility guidelines Chapter 3.3.4.1 and 3.3.4.2 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course			
-	Good housekeeping	Facility guidelines Chapter 3.3.4.7 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course			
Emergency	Emergency preparedness and response arrangements (training and exercises according to ILO guidelines)	http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/normativeinstrument/wcms_107689.pdf http://www.ilo.org/public/english/region/afpro/cairo/downloads/wcms_107727.pdf	Course			
TOTAL	**Training of working staff**			**109**	**217**	**434**

Basic harbor area – upgrade to Model slipway facility

Table 1 Documentation/identification

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Documentation	Correlate HMs against IHM	Document all hazardous materials on board against supplied Inventory of Hazardous Materials / Green passport	Work hours			-
	Approved Ship specific Recycling Plan	Approved Ship specific Recycling Plan	Work hours			-
Identification	Visual inspection	Visual inspection	Work hours			-
	Sampling and analysis of HM and PCHM	Sampling and analysis of HM and PCHM	Sampling / analysis	3	5	10

Table 2 Equipment for dismantling activities - pre cutting phase

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Asbestos	Area isolation items	Heavy curtains to confine asbestos contaminated area	Wall curtains	1	2	4
	Ventilation and filter systems	To filter the air from enclosed chambers where asbestos is present	Ventilation fan and filter	1	2	2
	Air monitoring equipment	To monitor airborne asbestos	Pump kit	1	2	2
	Vacuum cleaners	To clean for asbestos fibers (equipped with HEPA filter)	Vacuum cleaner	1	2	2
	Bags for asbestos	To secure isolation of asbestos	75 pieces	13	25	50
	Decontamination facility	Decontamination of workers when leaving area for asbestos	Shower cabin	1	2	4
PCB	Airtight Drums for PCB	To minimize contamination of environment	Drum	3	5	10
Oils and fuels	Pumping and draining equipment	To empty tank/compartments of oil and fuels	Pump	1	1	2
	Drums for oil	For intermediate storage	Drum	6	12	24
	Oil booms	Part of emergency kit in case of oil spill.	Oil boom	1	2	4
	Oil dispersant	Part of emergency kit in case of oil spill.	Oil Dispersant	1	2	4
	Oil skimmers	For removing oil from the surface of water.	Oil skimmer	1	1	1
	Cleaning solvents	For cleaning compartments after emptying	Drum	3	5	10
Paint	Abrasive blasting equipment	High pressure equipment used on paints containing HMs such as PCB, Heavy metals and antifouling	Air compressor and abrasive blaster	1	1	1
	Chemical for stripping of paint	In order to obtain clean metal for hot-cutting	Solvent	1	1	2
	Power tools	For mechanical removal of paint In order to obtain clean metal for hot-cutting	Angle grinder	2	4	8
ODS containing materials	Airtight drums for ODS materials	Airtight packing for insulation where ODS has been used as propellant	Drum	3	5	10
Ship generated wastes and stores	Pumping equipment	To empty tank/compartments sewage, bilge and ballast water	Pumps	1	1	2
	Oil-water separation equipment	To separate oil from water	Oil-water separator	1	1	1
	Disinfectants for ballast water	To disinfect ballast water prior to discharge	Canister	26	52	104
	Cleaning solvents	For remediation of spill on board	Drum	1	1	2

Table 3 Equipment for dismantling activities - Cutting phase

Element	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Miscellaneous	Piers off shore/barges for cranes	Pier for dismantling of ship along side	m^2	500	1,000	2,000
	Hydraulic shears	To cut metal	Pair of shears	0	0	0
	Mechanical movers	Either tracked or all terrain vehicles that support hydraulic arms to operate the hydraulic shears.	Mechanical movers	1	1	2
	Forklift	To transport dismantled parts from the ship to their designated storage area.	Forklifts	1	1	2
	Dumper trucks	To transport dismantled parts from the ship to their designated storage area.	Dumper trucks	1	2	4
	Gas detectors and oxygen meters	To ensure the atmosphere within a space does not contain elevated levels of dangerous gases.	Gas detectors and oxygen meters	2	3	4
	Fixed/mobile cranes	To lift the sections of dismantled ship onto the ground or clear of the ship.	Cranes	2	3	4
	Spider grabs/magnetic lifts	Suspended from the cranes to lift the steel sections to the storage area.	Grabs/Lifts	1	1	2
	Lifting gear	Slings, winches, chain blocks and ropes to remove machinery from the vessel.	Set of lifting gear	1	2	4
	Transformers	To provide 110V supply from 240v or 415v main.	Transformers	1	2	4
	Gas burning equipment	To cut metal	Gas burners	20	40	80
	Hand lamps	Lighting for safe passage around a ship once power has been shut down.	Lamps	75	150	300
	Hand tools and communication equipment	Hammers, hacksaws, punchers and spanners to dismantle items and radios for communication.	Set of hand tools	10	20	40
	Sounding tape	To sound the oil cargo and ballast tanks (measure depth of liquid).	Sounding tape	1	2	4
	Portable air fans and trunking	To supply air to confined spaces or during localised burning extract fumes.	Air fans	4	8	16
	Temporary lighting	Lighting for safe passage around a ship once power has been shut down.	Projectors	10	20	40
	First aid kits	For emergency use for workers.	First Aid Kits	2	4	8
	Protective clothing and equipment	Personal protective equipment for staff conducting specific tasks (helmets, hard toed shoes, gloves, PPE for eyes, face and skin)	Sets of personal protective equipment	100	200	400
	Breathing apparatus sets	Respiratory equipment for entering contaminated spaces in emergency.	Respirators	5	10	20

Table 4 Yard facilities and hazardous waste handling

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Dismantling area	Impermeable floors for handling areas and designated areas for segregation of HMs	Area for dismantling, sorting and finishing processes with impermeable floor to prevent leakage of contaminants to soil and water	m^2 pavement	12,500	25,000	50,000
	Building for segregation of asbestos with limited access	Closed area where asbestos is separated from other materials	m^2 building	50	100	200
	Gullies	Cement gully to segregate areas where HMs is extracted from the surroundings	m^2	125	250	500
	Roads for heavy transport	For transport of materials inside the yard area	m^2 pavement			Part of 50,000 m^2
Storage area	Impermeable floors in storage area	Total paves storage area	m^2 pavement	5,000	10,000	20,00

						0
Asbestos	Roofing of HM storage	Sheltered area for storage of asbestos with impermeable floor	m^2 shed	25	50	100
Paints and coatings	Roofing of HM storage	Sheltered area with facilities for storage of paints (liquid and solid). Plates with organotins (in paint) under roof and with drain.	m^2 shed	250	500	1,000
Oils and fuels	Roofing of HM storage	Sheltered containment area with impermeable floor and curbing	m^2 shed	25	50	100
	Tanks for oil and fuel	Tanks with leakage detection, overfill monitoring and corrosion protection	Tanks	1	1	2
PCB	Roofing of HM storage	Sheltered storage facility with impermeable floor and curbing	m^2 shed	25	50	100
ODS	Roofing of HM storage	Sheltered storage facility with impermeable floor and curbing	m^2 shed	25	50	100
	Tanks for ODS	453 L refrigerant cylinder	Tank	1	1	1
Ship generated wastes and stores	Roofing of HM storage	Sheltered containment area with impermeable floor and curbing	m^2 shed	250	500	1000
	Tanks for sludge and bilge water	Tanks equipped with overfill detection to reduce risk of spills (maximum vessel-tank volume).	Tanks	2	4	8
Equipment	Roofing of area for equipment for reuse/recycling	Sheltered area for materials and equipment with impermeable floor. If possible protected from rain. Including workshop area.	m^2 shed	1,250	2,500	5,000
Miscellaneous	Spill response equipment	for spills up to 360L	Kit	5	10	20
	Storm water discharge facility	To minimize contaminated run off water entering soil and water	Drainage system	1	2	4
	Fire fighting equipment	For emergency use for workers.	Set of fire extinguisher, fire blanket etc.	2	4	8
	Containers for cables etc.	Containers for wires etc.	Containers	1	2	4
	Containers for metal	Metals stored in separate containers (mercury in sealed container)	Containers	1	2	4
	Warning signs	Signs identifying key safety hazards	Signs	3	5	10
	Winch	Including cable. Used only when applying the slipway method	Winch	1	2	3
	Strain gauge and alarm	To monitor for potential breakage of cable	Monitor device	2	4	6
	Pumping equipment	Pumping equipment linked to impermeable areas for storage tanks /catch pits.	Pump	1	2	4
	Magnet	To check ferrous or non-ferrous metal.	Magnets	1	2	4
Administration area (on site)	Domestic building incl. emergency response facilities	Building with facilities for catering, changing rooms and treatment of first aid	m_2 building	125	250	500
	Office buildings	Administration block for project leading etc.	m^2 building	100	200	400

Table 5 Operational Measures

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Environmental Management plan (Basel convention)	Assessment of potential impacts (EIA)	Chapter 6, BC technical guideline	Procedure development	1	1	1
	Inventory of best practices	Chapter 6, BC technical guideline	Procedure development	1	1	1
	Environmental management system	Chapter 6, BC technical guideline Waste management plan (WMP)	Procedure development	1	1	1
		Chapter 6, BC technical guideline Contingency preparedness plan (CPP)	Procedure development	1	1	1
		Chapter 6, BC technical guideline Monitoring plan (MP)	Procedure development	1	1	1
Ship recycling facility plan (Hong Kong Convention)	Ship facility management plan	Facility management	Procedure development	1	1	1
		Facility operation (hereunder Ship-	Procedure	1	1	1

		specific Ship Recycling Plan)	developme nt			
		Worker safety and health compliance approach (hereunder ILO Asbestos management)	Procedure developme nt	1	1	1
		Environmental compliance approach	Procedure developme nt	1	1	1
ISO certification (14001, 9001, 30001) or national equivalent	Procedures (Internal cost)	Developing and implementing procedures as laid out in the standards http://www.iso.org/iso/home/standards/management-standards/iso_9000.htm http://www.iso.org/iso/home/standards/management-standards/iso14000.htm http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=51244	Procedure developme nt	1	1	1
	Auditing and certification (External cost)	External auditing and certification of the developed procedures by responsible authorities. E.g: http://www.iaf.nu//articles/IAF_MEMBERS_SIGNATORIES/4	Auditing and certificatio n	1	1	1

Table 6 Train the trainer - leading staff

Process	**Requirement**	**Description**	**Unit**	**Number 25,000 LDT**	**Number 50,000 LDT**	**Number 100,000 LDT**
Off shore	Ship Recycling Plan incl. Safety and Health Plan, Environmental Compliance Plan and Operational Plan (IMO guidelines)	Facility guidelines chapter 3.24 and 3.3 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course	-	-	-
Dismantling	Safety and Health Management System	http://www.ilo.org/global/publications/ilo-bookstore/order-online/books/WCMS_PUBL_9221116344_EN/lang--en/index.htm	Course	-	-	-
Transport	Package and transport of asbestos, PCB, organotin waste and special oils, Freon and CFC-gasses according to UNECE recommendations	United Nations Economic Commission for Europe, UNECE (2004): UN Model Regulations on the Transport of Dangerous Goods, 14th edition	Course	-	-	-
Plans and programmes	Contingency and response plan	Facility guidelines, chapter 3.3.5 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course	-	-	-
	Environmental contingency plan (UNEP/OCHA guidelines)	https://ochanet.unocha.org/p/Documents/DWG%20Annex%20XII.Disaster%20waste%20management%20contingency%20planning.pdf	Course	-	-	-
	Spill cleaning procedure incl. safe handling operations, appropriate protective clothing (Basel guideline)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf http://www.ilo.org/safework/info/standards-and-instruments/codes/lang--en/index.htm	Course	-	-	-
	Monitoring programme (sampling and analysis)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf	Course	-	-	-
	Discharge monitoring system (waste water monitoring)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf	Course	-	-	-
	Environmental monitoring programme (noise, air, soil and water)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf	Course	-	-	-
TOTAL	Capacity building leading staff			**3**	**6**	**12**

Table 7 Training of working staff

Training of staff	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Asbestos	Removal (ILO 1984), package and storage of asbestos (UNECE recommendations)	http://www.ilo.org/wcmsp5/groups/public/@ed_protect/@protrav/@safework/documents/normativeinstrument/wcms_107843.pdf	Course			
PCE	Removal (UNEP Removal, package and storage of PCE (UNECE recommendations)	http://www.unece.org/trans/danger/publi/dg_publications.html	Course			
HM	Removal, transport and storage of hazardous waste	http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/normativeinstrument/wcms_107689.pdf	Course			
Freon	Removal of Freon (to closed cylinders)	http://www.ilo.org/legacy/english/protection/safework/cis/products/safetytm/toc.htm	Course			
Ready for entry	"Gas-free for hot work" and "Enclosed Space Entry Permit"	Facility guidelines Chapter 3.3.4.1 and 3.3.4.2 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course			
-	Good housekeeping	Facility guidelines Chapter 3.3.4.7 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course			
Emergency	Emergency preparedness and response arrangements (training and exercises according to ILO guidelines)	http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/normativeinstrument/wcms_107689.pdf http://www.ilo.org/public/english/region/afpro/cairo/downloads/wcms_107727.pdf	Course			
TOTAL	**Training of working staff**			**109**	**217**	**434**

Existing pier breaking facility – upgrade to model pier breaking facility

Table 1 Documentation and identification - Pre cutting phase

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Documentation	Correlate HMs against IHM	Document all hazardous materials on board against supplied Inventory of Hazardous Materials / Green passport	Work hours			-
	Approved Ship specific Recycling Plan	Approved Ship specific Recycling Plan	Work hours			-
Identification	Visual inspection	Visual inspection	Work hours			-
	Sampling and analysis of HM and PCHM	Sampling and analysis of HM and PCHM	Sampling/analysis	3	5	10

Table 2 Equipment for dismantling activities - pre cutting phase

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Asbestos	Area isolation items	Heavy curtains to confine asbestos contaminated area	Wall curtains	1	2	4
	Ventilation and filter systems	To establish negative air pressure in the confined asbestos contaminated area, which can filter for asbestos.	Ventilation fan and filter	1	2	2
	Air monitoring equipment	To monitor airborne asbestos	Pump kit	1	2	2
	Vacuum cleaners	To clean for asbestos fibers (equipped with HEPA filter)	Vacuum cleaner	1	2	2
	Bags for asbestos	To secure isolation of asbestos	75 pieces	13	25	50
	Decontamination facility	Decontamination of workers when leaving isolated asbestos area	Shower cabin	1	2	4
PCB	Airtight drums for PCB	To minimize contamination of environment	Drum	3	5	10
Oils and fuels	Pumping and draining equipment	To empty tank/compartments of oil and fuels	Pumps	1	1	2
	Drums for oil	For intermediate storage	Drums	6	12	24
	Oil booms	Part of emergency kit in case of oil spill.	Oil booms	1	2	4
	Oil dispersant	Part of emergency kit in case of oil spill.	Oil dispersant	1	2	4
	Oil skimmers	For removing oil from the surface of water.	Oil skimmer	1	1	1
	Cleaning solvents	For cleaning compartments after emptying	Drum	3	5	10
Paint	Abrasive blasting equipment	High pressure equipment used on paints containing HMs such as PCB, Heavy metals and antifouling	Air compressor and abrasive blaster	1	1	1
	Chemicals for stripping of paint	In order to obtain clean metal for hot-cutting	Solvents	1	1	2
	Power tools	For mechanical removal of paint In order to obtain clean metal for hot-cutting	Angle grinder	2	4	8
ODS containing materials	Airtight Drums for ODS materials	Airtight packing for insulation where ODS has been used as propellant	Drum	3	5	10
Ship generated wastes and stores	Pumping equipment	To empty tank/compartments sewage, bilge and ballast water	Pump	1	1	2
	Oil-water separation equipment	To separate oil from water	Oil-water separator	1	1	1
	Disinfectants for ballast water	To disinfect ballast water prior to discharge	Bags	26	52	104
	Cleaning solvents	For remediation of spill on board	L	1	1	2

Table 3 Equipment for dismantling activities - Cutting phase

Element	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT

Miscellaneous	Hydraulic shears	To cut metal without heat	Pair of shears	1	1	1
	Mechanical movers	Either tracked or all terrain vehicles that support hydraulic arms to operate the hydraulic shears.	Mechanical movers	0	1	2
	Forklift	To ensure that transport dismantled parts from the ship to their designated storage area do not abrade and scatter paint from dragging	Forklifts	0	1	2
	Dumper trucks	To ensure that transport dismantled parts from the ship to their designated storage area do not abrade and scatter paint from dragging	Dumper trucks	1	2	4
	Gas detectors and oxygen meters	To ensure the atmosphere within a space does not contain elevated levels of dangerous gases.	Gas detectors	2	3	4
	Fixed/mobile Cranes	To enable top-down dismantling and lift the sections of dismantled ship onto the ground or clear of the ship.	Cranes	0	1	1
	Spider grabs/magnetic lifts	Suspended from the cranes to lift the steel sections to the storage area.	Grabs/lifts	1	1	2
	Lifting gear	Slings, winches, chain blocks and ropes to remove machinery from the vessel.	Set of lifting gear	1	2	4
	Transformers	To provide 110V supply from 240v or 415v main.	Transformers	1	2	4
	Gas burning equipment	To cut metal	Gas burners	12	24	48
	Hand lamps	Lighting for safe passage around a ship once power has been shut down.	Lamps	10	20	40
	Hand tools and communication equipment	Hammers, hacksaws, punchers and spanners to dismantle items and radios for communication.	Set of hand tools	10	20	40
	Sounding tape	To sound the oil cargo and ballast tanks (measure depth of liquid).	Sounding tape	1	2	4
	Portable air fans and trunking	To supply air to confined spaces or during localised burning extract fumes.	Air fans	1	2	4
	Temporary lighting	Lighting for safe passage around a ship once power has been shut down.	Projectors	3	5	10
	First aid kits	For emergency use for workers.	First Aid Kits	2	4	8
	Protective clothing and equipment	Personal protective equipment for staff conducting specific tasks (helmets, hard toed shoes, gloves, PPE for eyes, face and skin)	Sets of personal protective equipment	20	40	80
	Breathing apparatus sets	Respiratory equipment for entering contaminated spaces in emergency.	Respirators	5	10	20

Table 4 **Yard facilities and hazardous waste handling**

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Dismantling area	Impermeable floors for handling areas and designated areas for segregation of HMs	Area for dismantling, sorting and finishing processes with impermeable floor to prevent leakage of contaminants to soil and water	m^2 pavement	1,250	2,500	5,000
	Building for segregation of asbestos with limited access	Closed area where asbestos is separated from other materials	m^2 building	50	100	200
	Gullies	Cement gully to segregate areas where HMs is extracted from the surroundings	m^2	125	250	500
	Roads for heavy transport	For transport of materials inside the yard area	m^2 pavement			Part of 50,000 m^2
Storage area	Impermeable floors in storage and segregation area	Total paves storage area	m^2 pavement	5,000	10,000	20,000
Asbestos	Roofing of HM storage	Sheltered area for storage of asbestos with impermeable floor	m^2 shed	25	50	100
Paints and coatings	Roofing of HM storage	Storage area with facilities for storage of paints (liquid and solid). Plates with organotins (in paint) under roof and with drain.	m^2 shed	250	500	1,000
Oils and fuels	Roofing of HM storage	Sheltered containment area with impermeable floor and curbing	m^2 shed	25	50	100
	Tanks for oil and fuel	Tanks with leakage detection, overfill monitoring and corrosion protection	Tanks	1	1	2
PCB	Roofing of HM	Sheltered storage facility with	m^2 shed	25	50	100

	storage	impermeable floor and curbing				
ODS	Roofing of HM storage	Sheltered storage facility with impermeable floor and curbing	m^2 shed	25	50	100
	Tanks for ODS	453 L refrigerant cylinder	Tank	1	1	1
Ship generated wastes and stores	Roofing of HM storage	Sheltered containment area with impermeable floor and curbing	m^2 shed	250	500	1000
	Tanks for sludge and bilge water	Tanks equipped with overfill detection to reduce risk of spills (maximum vessel-tank volume).	Tanks	2	4	8
Equipment	Roofing of area for equipment for reuse/recycling	Sheltered area for materials and equipment with impermeable floor. If possible protected from rain. Including workshop area.	m^2 shed	250	500	1,000
Miscellaneous	Spill response equipment	For oil and chemical spills 100-1000L	Kit	2	3	5
	Storm water discharge facility	To minimize contaminated run off water entering soil and water	Drainage system	1	2	4
	Fire fighting equipment	For emergency use for workers.	Set of fire extinguisher, fire blanket etc.	2	4	8
	Containers for cables etc.	Containers for wires etc.	Containers	1	2	4
	Containers for metal	Metals stored in separate containers (mercury in sealed container)	Containers	1	2	4
	Warning signs	Signs identifying key safety hazards	Signs	3	5	10
	Winch	Including cable. Used only when applying the slipway method	Winch	1	1	1
	Strain gauge and alarm	To monitor for potential breakage of cable	Monitor device	1	1	2
	Pumping equipment	Pumping equipment linked to impermeable areas for storage tanks /catch pits.	Pump	1	2	4
	Magnet	To check ferrous or non-ferrous metal.	Magnets	1	2	4
Administration area (on site)	Domestic building incl. Emergency response facilities	Building with facilities for catering, changing rooms and treatment of first aid	m^2 building	125	250	500
	Office buildings	Administration block for project leading etc.	m^2 building	100	200	400

Table 5 Operational Measures

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Environmental Management plan (Basel convention)	Assessment of potential impacts (EIA)	Chapter 6, BC technical guideline	Procedure development	1	1	1
	Inventory of best practices	Chapter 6, BC technical guideline	Procedure development	1	1	1
	Environmental management system	Chapter 6, BC technical guideline Waste management plan (WMP)	Procedure development	1	1	1
		Chapter 6, BC technical guideline Contingency preparedness plan (CPP)	Procedure development	1	1	1
		Chapter 6, BC technical guideline Monitoring plan (MP)	Procedure development	1	1	1
Ship recycling facility plan (Hong Kong Convention)	Ship facility management plan	Facility management	Procedure development	1	1	1
		Facility operation (hereunder Ship-specific Ship Recycling Plan)	Procedure development	1	1	1
		Worker safety and health compliance approach (hereunder ILO Asbestos management)	Procedure development	1	1	1
		Environmental compliance approach	Procedure development	1	1	1
ISO certification (14001, 9001, 30001) or national equivalent	Procedures (Internal cost)	Developing and implementing procedures as laid out in the standards http://www.iso.org/iso/home/standards/management-standards/iso_9000.htm http://www.iso.org/iso/home/standards/management-standards/iso14000.htm	Procedure development	1	1	1

		http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=51244				
	Auditing and certification (External cost)	External auditing and certification of the developed procedures by responsible authorities. E.g: http://www.iaf.nu//articles/IAF_MEMBERS_SIGNATORIES/4	Auditing and certification	1	1	1

Table 6 Train the trainer - leading staff

Process	Requirement	Reference	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Off shore	Ship recycling plan incl. safety and health plan, environmental compliance Plan and operational plan (IMO guidelines)	Facility guidelines chapter 3.24 and 3.3 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course	-	-	-
Dismantling	Safety and health management system	http://www.ilo.org/global/publications/ilo-bookstore/order-online/books/WCMS_PUBL_9221116344_EN/lang--en/index.htm	Course	-	-	-
Transport	Package and transport of asbestos, PCB, organotin waste and special oils, Freon and CFC-gasses according to UNECE recommendations	United Nations Economic Commission for Europe, UNECE (2004): UN Model Regulations on the Transport of Dangerous Goods, 14th edition	Course	-	-	-
Plans and programmes	Contingency and response plan	Facility guidelines, chapter 3.3.5 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course	-	-	-
	Environmental contingency plan (UNEP/OCHA guidelines)	https://ochanet.unocha.org/p/Documents/DWG%20Annex%20XII.Disaster%20waste%20management%20contingency%20planning.pdf	Course	-	-	-
	Spill cleaning procedure incl. safe handling operations, appropriate protective clothing (Basel technical guideline)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf http://www.ilo.org/safework/info/standards-and-instruments/codes/lang--en/index.htm	Course	-	-	-
	Monitoring programme (sampling and analysis)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf	Course	-	-	-
	Discharge monitoring system (waste water monitoring)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf	Course	-	-	-
	Environmental monitoring programme (noise, air, soil and water)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf	Course	-	-	-
TOTAL	**Capacity building leading staff**			**3**	**6**	**12**

Table 7 Training of working staff

Training of staff	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Asbestos	Safety in use of asbestos (ILO 1984), removal, package and storage of asbestos	http://www.ilo.org/wcmsp5/groups/public/@ed_protect/@protrav/@safework/documents/normativeinstrument/wcms_107843.pdf	Course			
PCE	Removal, package and storage of PCE (UNECE recommendations)	http://www.unece.org/trans/danger/publi/dg_publications.html	Course			
HM	Removal, transport	http://www.ilo.org/wcmsp5/groups/pu	Course			

	and storage of hazardous waste	blic/---ed_protect/---protrav/---safework/documents/normativeinstrument/wcms_107689.pdf				
Freon	Removal of Freon (to closed cylinders)	http://www.ilo.org/legacy/english/protection/safework/cis/products/safetytm/toc.htm	Course			
Ready for entry	"Gas-free for hot work" and "Enclosed Space Entry Permit"	Facility guidelines Chapter 3.3.4.1 and 3.3.4.2 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course			
-	Good housekeeping	Facility guidelines Chapter 3.3.4.7 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course			
Emergency	Emergency preparedness and response arrangements (training and exercises according to ILO guidelines)	http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/normativeinstrument/wcms_107689.pdf http://www.ilo.org/public/english/region/afpro/cairo/downloads/wcms_107727.pdf	Course			
TOTAL	**Total training of working staff**			**15**	**30**	**59**

Existing slipway facility – upgrade to model slip way facility

Table 1 Documentation and identification - Pre cutting phase

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Documentation	Correlate HMs against IHM	Document all hazardous materials on board supplied Inventory of Hazardous Materials / Green passport	Work hours			-
	Approved Ship specific Recycling Plan	Approved Ship specific Recycling Plan	Work hours			-
Identification	Visual inspection	Visual inspection	Work hours			-
	Sampling and analysis of HM and PCHM	Sampling and analysis of HM and PCHM	Sampling /analysis	3	5	10

Table 2 Equipment for dismantling activities - pre cutting phase

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Asbestos	Area isolation items	Heavy curtains to confine asbestos contaminated area	Wall curtains	1	2	4
	Ventilation and filter systems	To filter the air from enclosed chambers where asbestos is present	Ventilation fan and filter	1	2	2
	Air monitoring equipment	To monitor airborne asbestos	Pump kit	1	2	2
	Vacuum cleaners	To clean for asbestos fibers (equipped with HEPA filter)	Vacuum cleaner	1	2	2
	Bags for asbestos	To secure isolation of asbestos	75 pieces	3	5	10
	Decontamination facility	Decontamination of workers when leaving area for asbestos	Shower cabin	1	2	4
PCB	Airtight drums for PCB	To minimize contamination of environment	Drum	13	25	50
Oils and fuels	Pumping and draining equipment	To empty tank/compartments of oil and fuels	Pumps	1	1	2
	Drums for oil	For intermediate storage	Drums	6	12	24
	Oil booms	Part of emergency kit in case of oil spill.	Oil booms	1	2	4
	Oil dispersant	Part of emergency kit in case of oil spill.	Oil Dispersant	1	2	4
	Oil skimmers	For removing oil from the surface of water.	Oil skimmer	1	1	1
	Cleaning solvents	For cleaning compartments after emptying	Drum	3	5	10
Paint	Abrasive blasting equipment	High pressure equipment used on paints containing HMs such as PCB, Heavy metals and antifouling	Air compressor and abrasive blaster	1	1	1
	Chemical for stripping of paint	In order to obtain clean metal for hot-cutting	Solvents	1	1	2
	Power tools	For mechanical removal of paint In order to obtain clean metal for hot-cutting	Angle grinder	2	4	8
ODS containing materials	Airtight drums for ODS materials	Airtight packing for insulation where ODS has been used as propellant	Drum	3	5	10
Ship generated wastes and stores	Pumping equipment	To empty tank/compartments sewage, bilge and ballast water	Pumps	1	1	2
	Oil-water separation equipment	To separate oil from water	Oil-water separator	1	1	1
	Disinfectants for ballast water	To disinfect ballast water prior to discharge	Bags	26	52	104
	Cleaning solvents	For remediation of spill on board	L	1	1	2

Table 3 Equipment for dismantling activities - Cutting phase

Element	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Miscellaneous	Piers off shore/barges for cranes	Pier for dismantling of ship along side	m^2	500	1,000	2,000
	Hydraulic shears	To cut metal	Pair of shears	0	1	1
	Mechanical movers	Either tracked or all terrain vehicles that support hydraulic arms to operate the hydraulic shears.	Mechanical movers	0	1	2
	Forklift	To transport dismantled parts from the ship to their designated storage area.	Forklifts	0	1	2
	Dumper trucks	To transport dismantled parts from the ship to their designated storage area.	Dumper trucks	1	2	4
	Gas detectors and oxygen meters	To ensure the atmosphere within a space does not contain elevated levels of dangerous gases.	Gas detectors	3	3	4
	Fixed/mobile cranes	To lift the sections of dismantled ship onto the ground or clear of the ship.	Cranes	1	2	2
	Spider grabs/magnetic lifts	Suspended from the cranes to lift the steel sections to the storage area.	Grabs/Lifts	1	1	2
	Lifting gear	Slings, winches, chain blocks and ropes to remove machinery from the vessel.	Set of lifting gear	1	2	4
	Transformers	To provide 110V supply from 240v or 415v main.	Transformers	1	2	4
	Gas burning equipment	To cut metal	Gas burners	12	24	48
	Hand lamps	Lighting for safe passage around a ship once power has been shut down.	Lamps	10	20	40
	Hand tools and communication equipment	Hammers, hacksaws, punchers and spanners to dismantle items and radios for communication.	Set of hand tools	10	20	40
	Sounding tape	To sound the oil cargo and ballast tanks (measure depth of liquid).	Sounding tape	1	2	4
	Portable air fans and trunking	To supply air to confined spaces or during localised burning extract fumes.	Air fans	1	2	4
	Temporary lighting	Lighting for safe passage around a ship once power has been shut down.	Projectors	3	5	10
	First aid kits	For emergency use for workers.	First Aid Kits	2	4	8
	Protective clothing and equipment	Personal protective equipment for staff conducting specific tasks (helmets, hard toed shoes, gloves, PPE for eyes, face and skin)	Sets of personal protective equipment	20	40	80
	Breathing apparatus sets	Respiratory equipment for entering contaminated spaces in emergency.	Respirators	5	10	20

Table 4 Yard facilities and hazardous waste handling

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Dismantling area	Impermeable floors for handling areas and designated areas for segregation of HMs	Area for dismantling, sorting and finishing processes with impermeable floor to prevent leakage of contaminants to soil and water	m^2 pavement	12,500	25,000	50,000
	Building for segregation of asbestos with limited access	Closed area where asbestos is separated from other materials	m^2building	50	100	200
	Gullies	Cement gully to segregate areas where HMs is extracted from the surroundings	m^2	125	250	500
	Roads for heavy transport	For transport of materials inside the yard area	m^2pavement			Part of 50,000 m^2
Storage area	Impermeable floors in storage and segregation area	Paved storage area	m^2 pavement	5,000	10,000	20,000
Asbestos	Roofing of HM storage	Sheltered area for storage of asbestos with impermeable floor	m^2 shed	25	50	100

Paints and coatings	Roofing of HM storage	Storage area with facilities for storage of paints (liquid and solid). Plates with organotins (in paint) under roof and with drain.	m^2 shed	250	500	1,000
Oils and fuels	Roofing of HM storage	Sheltered containment area with impermeable floor and curbing	m^2 shed	25	50	100
	Tanks for oil and fuel	Tanks with leakage detection, overfill monitoring and corrosion protection	Tanks	1	1	2
PCB	Roofing of HM storage	Sheltered storage facility with impermeable floor and curbing	m^2 shed	25	50	100
ODS	Roofing of HM storage	Sheltered storage facility with impermeable floor and curbing	m^2 shed	25	50	100
	Tanks for ODS	453 L refrigerant cylinder	Tank	1	1	1
Ship generated wastes and stores	Roofing of HM storage	Sheltered containment area with impermeable floor and curbing	m^2 shed	250	500	1000
	Tanks for sludge and bilge water	Tanks equipped with overfill detection to reduce risk of spills (maximum vessel-tank volume).	Tanks	2	4	8
Equipment	Roofing of area for equipment for reuse/recycling	Sheltered area for materials and equipment with impermeable floor. If possible protected from rain. Including workshop area.	m^2 shed	1,250	2,500	5,000
Miscellaneous	Spill response equipment	For spills up to 360L	Kit	5	10	20
	Storm water discharge facility	To minimize contaminated run off water entering soil and water	Drainage system	1	2	4
	Fire fighting equipment	For emergency use for workers.	Set of fire extinguisher, fire blanket etc.	2	4	8
	Containers for cables etc.	Containers for wires etc.	Containers	1	2	4
	Containers for metal	Metals stored in separate containers (mercury in sealed container)	Containers	1	2	4
	Warning signs	Signs identifying key safety hazards	Signs	3	5	10
	Winch	Including cable. Used only when applying the slipway method	Winch	1	1	2
	Strain gauge and alarm	To monitor for potential breakage of cable	Monitor device	1	2	4
	Pumping equipment	Pumping equipment linked to impermeable areas for storage tanks /catch pits.	Pump	1	2	4
	Magnet	To check ferrous or non-ferrous metal.	Magnets	1	2	4
Administration area (on site)	Domestic building incl. emergency response facilities	Building with facilities for catering, changing rooms and treatment of first aid	m^2 building	125	250	500
	Office buildings	Administration block for project leading etc.	m^2 building	100	200	400

Table 5 Operational Measures

Area/function	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Environmental Management plan (Basel convention)	Assessment of potential impacts (EIA)	Chapter 6, BC technical guideline	Procedure development	1	1	1
	Inventory of best practices	Chapter 6, BC technical guideline	Procedure development	1	1	1
	Environmental management system	Chapter 6, BC technical guideline Waste management plan (WMP)	Procedure development	1	1	1
		Chapter 6, BC technical guideline Contingency preparedness plan (CPP)	Procedure development	1	1	1
		Chapter 6, BC technical guideline Monitoring plan (MP)	Procedure development	1	1	1
Ship recycling facility plan (Hong Kong Convention)	Ship facility management plan	Facility management	Procedure development	1	1	1
		Facility operation (hereunder Ship-specific Ship Recycling Plan)	Procedure development	1	1	1
		Worker safety and health compliance approach (hereunder ILO Asbestos management)	Procedure development	1	1	1

		Environmental compliance approach	Procedure development	1	1	1
ISO certification (14001, 9001, 30001) or national equivalent	Procedures (Internal cost)	Developing and implementing procedures as laid out in the standards http://www.iso.org/iso/home/standards/management-standards/iso_9000.htm http://www.iso.org/iso/home/standards/management-standards/iso14000.htm http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=51244	Procedure development	1	1	1
	Auditing and certification (External cost)	External auditing and certification of the developed procedures by responsible authorities. E.g: http://www.iaf.nu//articles/IAF_MEMBERS_SIGNATORIES/4	Auditing and certification	1	1	1

Table 6 Train the trainer - leading staff

Process	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Off shore	Ship Recycling Plan incl. Safety and Health Plan, Environmental Compliance Plan and Operational Plan (IMO guidelines)	Facility guidelines chapter 3.24 and 3.3 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course	-	-	-
Dismantling	Safety and Health Management System	http://www.ilo.org/global/publications/ilo-bookstore/order-online/books/WCMS_PUBL_9221116344_EN/lang--en/index.htm	Course	-	-	-
Transport	Package and transport of asbestos, PCB, organotin waste and special oils, Freon and CFC-gasses according to UNECE recommendations	United Nations Economic Commission for Europe, UNECE (2004): UN Model Regulations on the Transport of Dangerous Goods, 14th edition	Course	-	-	-
Plans and programmes	Contingency and response plan	Facility guidelines, chapter 3.3.5 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course	-	-	-
	Environmental contingency plan (UNEP/OCHA guidelines)	https://ochanet.unocha.org/p/Documents/DWG%20Annex%20XII.Disaster%20waste%20management%20contingency%20planning.pdf	Course	-	-	-
	Spill cleaning procedure incl. safe handling operations, appropriate protective clothing (Basel guideline)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf http://www.ilo.org/safework/info/standards-and-instruments/codes/lang--en/index.htm	Course	-	-	-
	Monitoring programme (sampling and analysis)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf	Course	-	-	-
	Discharge monitoring system (waste water monitoring)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf	Course	-	-	-
	Environmental monitoring programme (noise, air, soil and water)	http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/techgships-e.pdf	Course	-	-	-
TOTAL	**Capacity building leading staff**			**3**	**6**	**12**

Table 7 Training of working staff

Training of staff	Requirement	Description	Unit	Number 25,000 LDT	Number 50,000 LDT	Number 100,000 LDT
Asbestos	Removal (ILO 1984), package and storage of asbestos (UNECE recommendations)	http://www.ilo.org/wcmsp5/groups/public/@ed_protect/@protrav/@safework/documents/normativeinstrument/wcms_107843.pdf	Course			
PCE	Removal, package and storage of PCE (UNECE recommendations)	http://www.unece.org/trans/danger/publi/dg_publications.html	Course			
HM	Removal, transport and storage of hazardous waste	http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/normativeinstrument/wcms_107689.pdf	Course			
Freon	Removal of Freon (to closed cylinders)	http://www.ilo.org/legacy/english/protection/safework/cis/products/safetytm/toc.htm	Course			
Ready for entry	"Gas-free for hot work" and "Enclosed Space Entry Permit"	Facility guidelines Chapter 3.3.4.1 and 3.3.4.2 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course			
-	Good housekeeping	Facility guidelines Chapter 3.3.4.7 http://www.imo.org/OurWork/Environment/ShipRecycling/Documents/210(63).pdf	Course			
Emergency	Emergency preparedness and response arrangements (training and exercises according to ILO guidelines)	http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/normativeinstrument/wcms_107689.pdf http://www.ilo.org/public/english/region/afpro/cairo/downloads/wcms_107727.pdf	Course			
TOTAL	**Training of working staff**			**30**	**59**	**117**

Appendix D - Training and Capacity Courses

Train the trainer courses leading staff

Ship Recycling Plan incl. Safety and Health Plan, Environmental Compliance Plan and Operational Plan (IMO guidelines)
Safety and Health Management System
Package and transport of asbestos, PCB, organotin waste and special oils, Freon and CFC-gasses according to UNECE recommendations
Contingency and response plan
Environmental contingency plan (UNEP/OCHA guidelines)
Spill cleaning procedure incl. safe handling operations, appropriate protective clothing (Basel guideline)
Monitoring programme (sampling and analysis)
Discharge monitoring system (waste water monitoring)
Environmental monitoring programme (noise, air, soil and water)

Training Courses - labourers

Removal (ILO 1984), package and storage of asbestos (UNECE recommendations)
Removal (UNEP 1999), package and storage of PCE (UNECE recommendations)
Removal, transport and storage of hazardous waste
Removal of Freon (to closed cylinders)
"Gas-free for hot work" and "Enclosed Space Entry Permit"
Good housekeeping
Storage according to guidelines (asbestos, PCB)
Emergency preparedness and response arrangements (training and exercises according to ILO guidelines)

Training and capacity building courses - highly mechanized facility

Grade	Staff type	Capacity building leading staff	Training of working staff
Management	Project Manager		
	Health, Safety and Environmental Manager	1	
	Quality Assurance Manager	1	
	Human Resource Manager	1	
	Competent Waste Manager	1	
Technical specialists	Professionel Engineers	4	
	Demolition Engineer	2	
Supervisory	Project foremen	2	
	Store Person		2
Tech and support	Clerical Staff		
	Welders and Gas Cutter Operators (double as Fire Watchers)		48
	Mechanics		4
	Electricians		4

	Plant Operators (4 plants)		4
	Crane Operators (4 cranes)		
	Forklift Operators		6
	Support Store Person		4
	Security Staff		8
	Labourer Staff		37
TOTAL	**Participants**	**12**	**117**

Training and capacity building courses - labour intensive facility

Grade	Staff type	Capacity building leading staff	Training of working staff
Management	Project Manager		
	Health, Safety and Environmental Manager	1	
	Quality Assurance Manager	1	
	Human Resource Manager	1	
	Competent Waste Manager	1	
Technical specialists	Professionel Engineers	4	
	Demolition Engineer	2	
Supervisory	Project foremen	2	
	Store Person		2
Tech and support	Clerical Staff		
	Welders and Gas Cutter Operators (double as Fire Watchers)		80
	Mechanics		4
	Electricians		4
	Plant Operators (4 plants)		4
	Crane Operators (4 cranes)		
	Forklift Operators		6
	Support Store Person		4
	Security Staff		30
	Labourer Staff		300
TOTAL	Participants	12	434

Appendix E – Correlation with Case Study Table 7

Following table shows how the phases used to identify cost in the Feasibility study correlates to the action structure applied in 7.1a and 7.1b of the case study.

(TABLE 7.1a - ACTIONS FOR SHIP RECYCLING FACILITIES - THE SHIP)

SHORT TERM WITHIN ONE YEAR	**Phase in Feasibility Study**	**MEDIUM TERM ONE TO THREE YEARS**	**Phase in Feasibility Study**	**LONG TERM THREE TO EIGHT YEARS**	**Phase in Feasibility Study**
Minimal Equipment /Cost	*Simple/low cost techniques*	*Improved infrastructure and equipment*	-	-	-
Carry out visual inspection, identification and labeling of hazardous materials on board prior to beaching.	*Identification*	Test suspect hazardous materials in situ, sample for confirmatory testing	*Identification*	Document all hazardous materials on board against supplied Inventory of Hazardous Materials	*Operational measure*
Determine pollutant Concentrations prior to removal of bilge and ballast water.	*Identification*	Apply simple tests for key parameters: oil, selected metals	*Identification*	Apply full monitoring protocol for key parameters: oils, PCB, metals (mercury, cadmium)	*Operational measure*
Make and record visual inspection of pollutants in waters around ship.	*Operational measure*	Deploy spill containment boom with spill clean-up equipment on standby	*Equipment for dismantling activities - pre cutting phase*	-	-
Pump out heavy oils and sludges to drums before starting other work.	*Equipment for dismantling activities - pre cutting phase*	Pump out liquids to secure storage	*Operational/ Yard facilities and hazardous waste handling*	Prioritize pumping over man entry for liquid removal operations inside the tanks	*Operational measure (Ship recycling facility plan)*
Test compartments for presence of toxins, corrosives, irritants and breathable and flammable gases before entering.	*Equipment for dismantling activities - pre cutting phase*	-	-	Install gas monitoring equipment at key locations	*Equipment for dismantling activities - Cutting phase*
Ventilate spaces (compartments/ tanks) and monitor for breathable and flammable gases during work.	*Operational measure (ship specific recycling plan)*	-	-	-	-
Remove combustible and recyclable materials, including cables before hot work.	*Operational measure (ship specific recycling plan)*	-	-	-	-
Clean oil tanks and compartments before starting hot work.	*Equipment for dismantling activities - pre cutting phase*	-	-	-	-

SHORT TERM WITHIN ONE YEAR	Phase in Feasibility Study	MEDIUM TERM ONE TO THREE YEARS	Phase in Feasibility Study	LONG TERM THREE TO EIGHT YEARS	Phase in Feasibility Study
Apply "hot work" certification system.	*Operational Measure*	-	-	-	-
Identify and remove toxic or flammable paint prior to metal cutting. Collect and contain waste paints removed	*Identification /Equipment for dismantling activities - pre cutting phase*	-	-	-	-
Identify and remove to safe store presumed PCB-containing material (closed and open sources - solids and liquid). No hot work carried out on or near any PCB.	*Identification/ Yard facilities and hazardous waste handling*	-	-	-	-
Create dedicated area for asbestos removal. Apply safe removal procedures. Limit access to trained workers.	*Equipment for dismantling activities - pre cutting phase*	Seal areas on board ship where asbestos has been identified. Limit access. Filter air emissions. Securely pack all asbestos.	*Equipment for dismantling activities - pre cutting phase*	Install dedicated decontamination system.	*Equipment for dismantling activities - pre cutting phase*

(TABLE 7.1b - ACTIONS FOR SHIP RECYCLING FACILITIES – ON SHORE)

SHORT TERM WITHIN ONE YEAR	Phase in Feasibility Study	MEDIUM TERM ONE TO THREE YEARS	Phase in Feasibility Study	LONG TERM THREE TO EIGHT YEARS	Phase in Feasibility Study
Minimal Equipment /Cost	*Simple/low cost techniques*	*Improved infrastructure and equipment*	-	-	-
Set out facility plan - design major areas to indicate places for storage, cutting, roadways etc.	*Operational measure*	Provide firm compacted surfaces suitable for vehicle access.	*Yard facilities and hazardous waste handling*	Pave roadways. Employ lifting machinery and plant for heavy items, with low ground-bearing capacity or on firm services.	*Yard facilities and hazardous waste handling Equipment for dismantling activities - Cutting phase*
Create a dedicated area for segregation of hazardous materials (e.g. PCB, hazardous waste, liquids). Install clear signs to show where each type is put.	*Operational measure*	Install impermeable base for hazardous materials, paint removal and hazardous wastes handling / storage. Drain impermeable areas to tanks for later treatment and disposal.	*Yard facilities and hazardous waste handling*	Cover hazardous waste handling areas. Test, remove and dispose of PCB containing material to hazardous waste facility. (Optional) Develop communal ship decontamination facility. Utilize environmentally sound treatment/ disposal facilities	*Yard facilities and hazardous waste handling Identification Included in sensibility analysis*

				for hazardous materials.	
Install warning signs, buffer protection zone around fuel drums and tanks.	*Yard facilities and hazardous waste handling*	Protect fuel tanks (bunds) on hard standing.	*Yard facilities and hazardous waste handling*	-	-
Inspect winch cables regularly, replace damaged and frayed cable.	*Operational measure*	Test cable regularly. Install pulley and block system.	*Operational measure*	Install strain gauges and alarms.	*Yard facilities and hazardous waste handling*
Develop and implement spill clean-up and notification procedures.	*Operational measure*	Provide storm water Discharge facilities, to avoid contamination of storm water run-off.	*Yard facilities and hazardous waste handling*	Install and operate draining and pumping equipment to impermeable areas linked to storage tanks /catch pits.	*Yard facilities and hazardous waste handling*
Supply and use Personal Protective Equipment: (Hard hats, gloves, eyes/face protection, welding goggles, torches, safety shoes).	*Equipment for dismantling activities - Cutting phase*	-	-	-	-
Supply and use respiratory hazard protective equipment.	*Equipment for dismantling activities - Cutting phase*	-	-	-	-
Supply fire extinguishing equipment at risk areas.	*Yard facilities and hazardous waste handling*	-	-	Commission dedicated fire and rescue service (joint venture).	*Not included*
Implement appropriate asbestos management procedures in accordance with ILO code of practice. Asbestos work by trained personnel only. Access to asbestos identified areas to designated personnel.	*Operational measure (BC & HKC)*	Collect and contain all wastes from asbestos removal processes. Pack asbestos in approved packaging. Decontaminate workers when leaving the designated area.	*Yard facilities and hazardous waste handling* *Equipment for dismantling activities - Cutting phase*	-	-
Post notices/ pictograms of key safety hazards.	*Yard facilities and hazardous waste handling*	-	-	-	-
Provide emergency first aid post	*Yard facilities and hazardous waste handling*	Provide occupational health service.	*Operational measure*	Establish medical centre (cooperative venture)	*Not included*

(TABLE 7.2 – Specific Additional Actions For Ship Recycling Facilities In States Progressing Towards Hong Kong Convention Compliance)

SHORT TERM WITHIN ONE YEAR	**Phase in Feasibility Study**	**MEDIUM TERM ONE TO THREE YEARS**	**Phase in Feasibility Study**	**LONG TERM THREE TO EIGHT YEARS**	**Phase in Feasibility Study**
Minimal Equipment /Cost	*Simple/low cost techniques*	*Improved infrastructure and equipment*	-	-	-
Establish basic Ship Recycling facility Plan (referring to the IMO Guidelines for the Development of the Ship Recycling Plan) Employers and workers responsibilities Worker Safety policy Worker Training programme	*Operational measures*	Implement Intermediate Ship Recycling Facility Plan: Worker ESM and safety Training and information Emergency Plan Record Keeping Reporting system for discharges, incidents accidents Reporting system for accidents injuries etc.	*Operational measures*	Advanced Ship Recycling Facility Plan Performance Monitoring Plan Quality System to achieve HKC goals and continuous improvement	*Operational measures*
Basic check hazardous materials on board (refer to IMO Guidelines for the Development of the Inventory of Hazardous Materials)	*Operational measures*	Use Inventory of Hazardous Materials as main source of information	*Operational measures*	-	-
Safe and Environmentally Sound Management of Hazardous Materials 1. Identify 2. Label 3. Segregate	*All ready included in main actions*	Upgrade storage 1. Hard standing 2. Drainage Identify waste disposal facilities 1. Survey capacity	*All ready included in main actions* *Not included*	Upgrade Storage 1. Cover/protect storage areas Waste Management 1. All wastes to authorized ESM facilities	*Operational measures* *Not included*
Ship-specific Recycling Plan (Refer to IMO Guidelines for Safe and Environmentally Sound Ship Recycling)	*All ready included in main actions*	-	-	-	-