HANDLING OF HAZARDOUS MATERIALS IN SHIP RECYCLING

1. *Author :* Bharat Juluru
   Anglo-Eastern Maritime Academy
   Karjat, jbharat96@gmail.com
2. *Author:* Vidyasai Vempaty
   Anglo-Eastern Maritime Academy
   Karjat, vidyasai1995@gmail.com

ABSTRACT--- In a basic life-cycle of a ship, after designing, manufacturing and operating stages recycling is also important aspect. Brief introduction about recycling of ships is discussed. Under the stages of recycling, disposing of hazardous materials which can effects environment drastically and is listed as a one of the major problem facing in the maritime industry. Disposal of hazardous materials based on the regulations made by Hong Kong convention is discussed. Mandatory Maintenance of inventory for hazardous material is discussed. Brief description on hazardous materials found on ships are mentioned along with sampling tests of the particular hazardous materials.

KEYWORDS: Hazardous Materials, Hong Kong convention, Inventory, Testing Methods.

I. INTRODUCTION

Over the past two decades, the importance of proper identification and disposal of hazardous material for the recycling of ships has been increasing. The hazardous materials if not properly handled can have adverse effects on the environment, worker safety and pollution levels.

The study aims at identification of hazardous material, maintenance of inventory and proper updating of it which would be later useful in proper handling at the time of recycling of ships.

Currently, the maritime world is facing many environmental problems related to Emissions of ships, Ballast water management, Life cycle management and Recycling. Many regulations are being enforced made to reduce these effects on environment.

The Hong Kong convention plays an important role in the safety measures to be taken for the environment well-being and ISO 14000 series certification is contributing in making ships more environment-friendly.

Life Cycle Analysis (LCA) is a powerful tool for economic viability, maintenance and environmental protection for the ship construction, operation and recycling.

RECYCLING:

Ship recycling is a major issue like global warming or ozone depletion which is yet to be addressed along with sustainable development. Design for ship recycling activities should be given more importance to reduce the hazardous materials used on board the ship, minimizing the operationally generated waste, controlling the emissions and the marine pollution due to products of corrosion etc.

Aged ships are one of the main sources of marine pollution and threat comes from various on-board materials and systems such as pollutant cargo residues, heat insulation materials like asbestos and other materials like PCB (Poly Chlorinated Biphenyls), TBT (Triutyltins) etc. Ship owners are now more aware of the potential threat from unscientific ship recycling and honest efforts are made by international maritime regulatory authorities to bring ecological awareness among the stakeholders in the global shipping sector. Definite necessity is felt for classification of ocean-going vessels based on four major features such as “green” product characteristics, energy efficient systems on board, application of emerging engineering concepts and complement-friendly on-board working environment.

The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 (the Hong Kong Convention), was adopted at diplomatic conference held in Hong Kong, China, from 11 to 15 May 2009, which was attended by delegates from 63 countries.

The Convention was 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 to the environment.

Upon entry into force of the Hong Kong Convention, ships to be sent for recycling will be required to carry an inventory of hazardous materials, which will be specific to each ship. An appendix to the convention provides a list of hazardous materials, the installation or use of which is prohibited or restricted in shipyards, ship repair yards, and ships. Ships will be required to have an initial survey to verify the inventory of hazardous materials, additional surveys during the life of the ship, and a final survey prior to recycling.

II. SCOPE OF INVENTORY

Inventory mainly consists of three parts

Part 1: Materials contained in the ship structure and equipment

- Paints and coating materials containing hazardous materials
- Equipment and Machinery containing hazardous materials
- Structure and Hull containing hazardous materials.

Part 2: Operationally generated wastes

Part 3: Stores

- Liquids sealed in the ship machinery and equipment
- Gases sealed in Ship machinery and equipment
- Regular consumable goods containing hazardous materials.

MATERIALS TO BE LISTED IN THE INVENTORY:

"Items to be listed in the inventory of hazardous materials" provides the information on the hazardous materials found on board ships. Each material which is present in the inventory is classified under Table A, Table B, Table C and Table D based on its properties.

1- Table A comprises the materials listed in appendix 1 of the Convention.

2- Table B comprises the materials listed in appendix 2 of the Convention.

3- Table C (Potentially hazardous items) comprises items which are potentially hazardous to the environment and human health at ship recycling facilities.

4- Table D (Regular consumable goods potentially containing hazardous materials) comprises goods which are not integral to a ship and are unlikely to be dismantled or treated at a ship recycling facility.

Tables A and B correspond to part 1 of the Inventory. Table C corresponds to parts 2 and 3 and table D corresponds to part 3. For loosely fitted equipment, there is no need to list this in part 1 of the Inventory. Such equipment which remains on board when the ship is recycled should be listed in part 3. Batteries containing lead acid or other hazardous materials that are fixed in place should be listed in part 1 of the Inventory. Batteries that are loosely fitted, which includes consumer batteries and batteries in stores, should be listed in part 3 of the Inventory. Similar materials or items that contain hazardous materials that potentially exceed the threshold value can be listed together (not individually) on the Inventory of Hazardous Materials (IHM) with their general location and approximate amount specified there.

Inventory tables listed in Appendix 1 and 2 of the Annex to the convention are as follows.

Table A – Materials listed in appendix 1 of the Annex to the Convention

No.	Materials		Inventory			Threshold value
			Part I	Part II	Part III	
A-1	Asbestos		x			0.1%[4]
A-2	Polychlorinated biphenyls (PCBs)		x			50 mg/kg[5]
A-3	Ozone depleting substances	CFCs	x			no threshold value[6]
		Halons	x			
		Other fully halogenated CFCs	x			
		Carbon tetrachloride	x			
		1,1,1-Trichloroethane (Methyl chloroform)	x			
		Hydrochlorofluorocarbons	x			
		Hydrobromofluorocarbons	x			
		Methyl bromide	x			
		Bromochloromethane	x			
A-4	Anti-fouling systems containing organotin compounds as a biocide		x			2,500 mg total tin/kg[7]

Table B – Materials listed in appendix 2 of the Annex to the Convention

No.	Materials	Inventory			Threshold value
		Part I	Part II	Part III	
B-1	Cadmium and cadmium compounds	x			100 mg/kg[8]
B-2	Hexavalent chromium and hexavalent chromium compounds	x			1,000 mg/kg[8]
B-3	Lead and lead compounds	x			1,000 mg/kg[8]
B-4	Mercury and mercury compounds	x			1,000 mg/kg[8]
B-5	Polybrominated biphenyl (PBBs)	x			50 mg/kg[9]
B-6	Polybrominated diphenyl ethers (PBDEs)	x			1,000 mg/kg[8]
B-7	Polychlorinated naphthalenes (more than 3 chlorine atoms)	x			50mg/kg[10]
B-8	Radioactive substances	x			no threshold value[11]
B-9	Certain shortchain chlorinated paraffins (Alkanes, C10-C13, chloro)	x			1%[12]

Table C – Potentially hazardous items

No.	Properties		Goods	Inventory		
				Part I	Part II	Part III
C-1	Liquid	Oiliness	Kerosene			x
C-2			White spirit			x
C-3			Lubricating oil			x
C-4			Hydraulic oil			x
C-5			Anti-seize compounds			x
C-6			Fuel additive			x
C-7			Engine coolant additives			x
C-8			Antifreeze fluids			x
C-9			Boiler and feed water treatment and test re-agents			x
C-10			De-ioniser regenerating chemicals			x
C-11			Evaporator dosing and descaling acids			x
C-12			Paint stabilizers/rust stabilizers			x
C-13			Solvents/thinners			x
C-14			Paints			x
C-15			Chemical refrigerants			x
C-16			Battery electrolyte			x
C-17			Alcohol, methylated spirits			x
C-18	Gas	Explosives/ inflammables	Acetylene			x
C-19			Propane			x
C-20			Butane			x
C-21			Oxygen			x
C-22		Green House Gases	CO_2			x
C-23			Perfluorocarbons (PFCs)			x
C-24			Methane			x
C-25			Hydrofluorocarbon (HFCs)			x
C-27			Nitrous oxide (N_2O)			x
C-28			Sulfur hexafluoride (SF_6)			x
C-29	Liquid	Oiliness	Bunkers: fuel oil			x
C-30			Grease			x
C-31			Waste oil (sludge)		x	
C-32			Bilge and/or waste water generated by the after-treatment systems fitted on machineries		x	
C-33			Oily liquid cargo tank residues		x	
C-34			Ballast water		x	
C-35			Raw sewage		x	
C-36			Treated sewage		x	
C-37			Non-oily liquid cargo residues		x	
C-38	Gas	Explosibility/ inflammability	Fuel gas			x

No.	Properties	Goods	Inventory		
			Part I	Part II	Part III
C-39	Solid	Dry cargo residues		x	
C-40		Medical waste/infectious waste		x	
C-41		Incinerator ash[13]		x	
C-42		Garbage		x	
C-43		Fuel tank residues		x	
C-44		Oily solid cargo tank residues		x	
C-45		Oily or chemical contaminated rags		x	
C-46		Batteries (incl. lead acid batteries)			x
C-47		Pesticides/insecticide sprays			x
C-48		Extinguishers			x
C-49		Chemical cleaner (incl. electrical equipment cleaner, carbon remover)			x
C-50		Detergent/bleacher (could be a liquid)			x
C-51		Miscellaneous medicines			x
C-52		Fire fighting clothing and Personal protective equipment			x
C-53		Dry tank residues		x	
C-54		Cargo residues		x	
C-55		Spare parts which contain materials listed in Table A or Table B			x

Some of the major hazardous materials include

- Asbestos
- Polychlorinated Biphenyls
- Ozone depleting substances
- Organotin Compounds (found in paint)

Table D – Regular consumable goods potentially containing hazardous materials[14]

No.	Properties	Example	Inventory		
			Part I	Part II	Part III
D-1	Electrical and electronic equipment	Computers, refrigerators, printers, scanners, television sets, radio sets, video cameras, video recorders, telephones, consumer batteries, fluorescent lamps, filament bulbs, lamps			x
D-2	Lighting equipment	Fluorescent lamps, filament bulbs, lamps			x
D-3	Non ship-specific furniture, interior and similar equipment	Chairs, sofas, tables, beds, curtains, carpets, garbage bins, bed-linen, pillows, towels, mattresses, storage racks, decoration, bathroom installations, toys, not structurally relevant or integrated artwork			x

Asbestos

Asbestos is a material which is banned and prohibited to be used on board ships because of the several health hazards that it poses. However, there are some exceptions wherein it can be used on board ships and they are defined in SOLAS Chapter II-1 Regulation 3-5.

Specific tests method to test asbestos

Types to test for: as per resolution MEPC.179(59); Actinolite CAS 77536-66-4 Amosite (Grunerite) CAS 12172-73-5 Anthophyllite CAS 77536-67-5 Chrysotile CAS 12001-29-5 Crocidolite CAS 12001-28-4 Asbestos Tremolite CAS 77536-68-6.

Specific testing techniques: Polarized Light Microscopy (PLM), electron microscope techniques and/or X-Ray Diffraction (XRD) as applicable.

Specific reporting information: The presence/no presence of asbestos, indicate the concentration range, and state the type when necessary.

Notes:

1 The suggested three kinds of testing techniques are most commonly used methods when analysing asbestos and each of them has its limitation. Laboratories should choose the most suitable methods to determine, and in most cases, two or more techniques should be utilized together.

2 The quantification of asbestos is difficult at this stage, although the XRD technique is applicable. Only a few laboratories conduct the quantification rather than the qualification, especially when a precise number is required. Considering the demand from the operators and ship recycling parties, the precise concentration is not strictly required.

The following are the places and applications where Asbestos can be used on ships.

1) It is used in vanes of rotary vane air compressor and rotary vane vacuum pumps.
2) It is also used for insulation and water tight joints which are used for circulation of fluids and where the temperature is in excess of 350 deg C and pressure in excess of 70 bar. It is also used in places where there is risk of fire, corrosion or toxicity.
3) Supple and flexible thermal insulation used for temperatures above 1000 deg C.

Polychlorinated Biphenyls:

Polychlorinated biphenyls are widely deployed as dielectric and coolant fluids in electrical apparatus and in heat transfer fluids. Because of their longevity, PCBs are still widely used, even though their manufacture has declined drastically since the 1960s, when a host of problems were identified and due to environmental toxicity, it was classified as persistent organic pollutant.

Specific tests method to test Polychlorinated Biphenyls:

There are 209 different congeners (forms) of PCB, it is impracticable to test for all. Various organizations have developed lists of PCBs to test for as indicators. In this instance two alternative approaches are recommended. Method 1 identifies the seven congeners used by the International Council for the Exploration of the Sea (ICES). Method 2 identifies 19 congeners and seven types of aroclor (PCB mixtures commonly found in solid shipboard materials containing PCBs). Laboratories should be familiar with the requirements and consequences for each of these lists.

Types to test for: Method 1: ICES7 congeners (28, 52, 101, 118, 138, 153, 180). Method 2: 19 congeners and seven types of aroclor, using the US EPA 8082a test. MEPC 68/21/Add.1 Annex 17, page 54

Specific testing technique: GC-MS (congener specific) or GC-ECD or GC-ELCD for applicable mixtures such as aroclors. Note: standard samples must be used for each type.

Specific reporting information: PCB congener, ppm per congener in sample, and for Method 2, ppm per aroclor in sample should also be reported.

Notes:

1 Certain field or indicator tests are suitable for detecting PCBs in liquids or surfaces. However, there are currently no such tests that can accurately identify PCBs in solid shipboard materials. It is also noted that many of these tests rely on the identification of free chlorine ions and are thus highly susceptible to chlorine contamination and false readings in a marine environment where all surfaces are highly contaminated with chlorine ions from the sea water and atmosphere.

2 Several congeners are tested for as "indicator" congeners. They are used because their presence often indicates the likelihood of other congeners in greater quantities (many PCBs are mixes, many mixes use a limited number of PCBs in small quantities, therefore the presence of these small quantities indicates the potential for a mix containing far higher quantities of other PCBs).

3 Many reports refer to "total PCB", which is often a scaled figure to represent likely total amount of PCBs based on the sample and the common ratios of PCB mixes. Where this is done, the exact scaling technique must be stated, and is for information only and does not form part of the specific technique.

Ozone depleting substances:

Types to test for: as per Appendix 8 of these guidelines all the listed CFCs, Halons, HCFCs and other listed substance as required by Montreal Protocol.

Specific testing technique: Gas Chromatography-Mass Spectrometry (GC-MS), coupled Electron Capture Detectors (GC-ECD) and Electrolytic Conductivity Detectors (GC-ELCD).

Specific reporting information: Type and concentration of ODS.

Anti-fouling systems containing organotin compounds as a biocide:

Types to test for: Anti-fouling compounds and systems regulated under annex I to the International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001 (AFS Convention), including: tributyltins (TBT), triphenyl tins (TPT) and tributyl tin oxide (TBTO).

Specific testing technique: As per resolution MEPC.104 (49) (*Guidelines for Brief Sampling of Anti-Fouling Systems on Ships*), adopted 18 July 2003, using ICPOES, ICP, AAS, XRF, GC-MS as applicable.

Specific reporting information: Type and concentration of organotin compound.

Note: For "field" or "indicative" testing it may be acceptable to simply identify presence of tin, due to the expected good documentation on anti-fouling systems.

CONCLUSION

The proper handling and disposal of hazardous material is of great importance as it can effect the environment, worker safety and pollution which may cause the material to rise up the food chain to human beings. Replacement of some of the hazardous materials should be considered, some of replacements of asbestos include amorphous silica fabrics, cellulose fibre, polyurethane foam etc. Inventory management should be as per the conventions. Awareness of these hazardous materials and their safe handling cannot be overlooked.

REFERENCES

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