Volume XXI 2018
ISSUE no.2
MBNA Publishing House Constanta 2018

Scientific Bulletin of Naval Academy

SBNA PAPER • OPEN ACCESS

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To cite this article: Géza Károly, Kiss Leizer, Scientific Bulletin of Naval Academy, Vol. XXI 2018, pg. 104-111.

Available online at www.anmb.ro

ISSN: 2392-8956; ISSN-L: 1454-864X

doi: 10.21279/1454-864X-18-I2-011

RIVER, LAKE AND SEA TRAFFIC SAFETY ISSUES REGARDING WASTE GENERATED DURING DISASTERS

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Abstract: **This publication present questions related to river and sea traffic safety and waste management in disaster situations taking into consideration domestic and international waste management policies, river and sea transport industry recommendations, instructions, and provisions. The principal objective is to examine how applicable are the technical security solutions and regulations to enhance safe and efficient waste management to meet of today's challenges.**

Keywords: **catastrophe, waste management, safety technology, waste, water transport, dangerous merchandise**

INTRODUCTION

To investigate the most common methods of technical security of waste management practiced during river and sea disasters, from the view point of long-term fiscal sustainability and the effect on the environment.

During my previous researches I came to the conclusion that clear technical security regulations of river and sea transport related to waste rising up from river and sea disasters or emergencies are incomplete. In my publication I want like to point out that review of specialized literature, domestic and international field studies, operative legal regulations and basic standards –waste management technical security applied in prevention and disaster situation – may help to establish a more efficient and secure system of river and sea waste management, compatible with the newest expectations and challenges.

In this study I also pay attention to the opportunities of engineering ideas affecting engineering safety, furthermore, the questions and specifications related to waste management systems of river and sea transport and cargo, in addition, the problems of technical security of waste management during catastrophes. Finally, I summarize this study, and I formulate the aims of my future research.

I. INTRODUCTION OF THE PROBLEM, DETERMINATION OF THE SUBJECT OF THE RESEARCH, SHAPING THE OBJECTIVE AND THE RESEARCH HYPOTHESIS

During my previous research, I revealed many shortcomings affecting the specific technical engineering safety regulations regarding dangerous wastes and catastrophic events in the professional field of shipping.

In this article I want to emphasize the importance of the effective engineering-safety solutions in shipping, in order to find new solutions to handle dangerous waste during/after accidents and catastrophes. I also paid attention to the problems of environmental risks of the poorly managed wastes.

The primary objective of this article is to introduce how to avoid environmental harms coming from accidents and catastrophes of shipping, including all types of waterways.

The importance of my study is supported by the fact that catastrophes are part of our life. Nowadays, catastrophes' significance, size, frequency and destructive effect are so high that protection against such events became a priority.

Importance and necessity of secure waste management is coming from the huge damages of property and costs of post-rehabilitation, affecting our society and economy after accidents and catastrophes.

II. WASTE HANDLING SYSTEMS AND REGULATIONS RELATED TO RIVER AND SEA TRAFFIC AND TRANSPORTATION

Shipping-based waste handling and transportation is concentrated on ships and ports, where pretreatment of waste is considered to be secured. In order to provide further steps of effective waste handling, it is very important to establish coastal waste deposits, to maintain systems of waste forwarding, handling, recycling and neutralization, complemented with the necessary legal framework and safety arrangements.

Examining the processes of shipping it is concluded that two groups of waste can be classified. On one hand, wastes arisen from maintenance, transportation, on the other hand, wastes arisen from catastrophic events.

Maintenance wastes

Maintenance wastes are usually materials derived from ships with high oil- and lubricant content: used engine-oil, hydraulic oil, bilge water, other oily and lubricant waste like frying oil and fat, filters, textile wastes (wiping clothes), protecting and working clothes and their packaging; such materials have to be treated as dangerous wastes. In Hungary,

related Government Regulation 225/2015. (VIII.7.) came into force, encompassing the handling of dangerous waste and all connected activities on the areas of shipping [4].

The Regulation states:

- Dangerous waste has to be collected by the owner

a) in a pot,

b) in a container,

c) in a secure chamber fit to adopt such materials,

d) in a covered area with solid housing,

Depending on the physical and chemical characteristics of the waste, the chance to endanger environment and to prevent pollution, impairing risks on human health.

- Transportation of dangerous waste has to be done by a safe vehicle to exclude the chance to harm the environment, in accordance with the necessary safety regulations and methods.

Safe waste management requires additional important standards (missing from the official regulation):

- When working with dangerous waste, falling out, disperse and leak of the material should be avoided;
- Dangerous waste cannot be treated by unauthorized person;
- Leaked gasoline or other hydrocarbon waste should be diluted with water or with special substances. The resulting waste must be placed into closed metal barrels suitable for storage;
- The resulting waste should be delivered to the designated companies or public services in order to provide traceableness.

TABLE I
During river and sea transport the following types of wastes may be formed:

EWC code	Designation	Methods of secure collection and storage
20 01 35*	Scrapped electronic or electromotive devices containing dangerous waste, different from wastes with codename 20 01 21 and 20 01 23.	Selectively, in closed plastic container
13 02 08*	other engine-oils, gear oils or lubricating oils	Selectively, in closed metal container
13 04 01*	oil-contaminated bilge-water from inland navigation	Selectively, in closed metal container
13 04 03*	other, oil-contaminated bilge-water from shipping	Selectively, in closed metal container
13 04 02*	port oil, oily waste coming from oil-catchers	Selectively, in closed metal container
13 07 01*	fuel- and diesel oil	Selectively, in closed metal container
20 01 33*	batteries and accumulators, including elements with code Nr. 16 06 01, 16 06 02 and 16 06 03	Selectively, in closed metal container
15 01 10*	Packages containing dangerous waste as frazzle, or packages made from dangerous waste	Selectively, in closed plastic container
15 02 02*	Absorbents or filters contaminated with dangerous materials (including several types of oil filters), napkins, protective clothes	Selectively, in closed plastic container

For the time being, international regulations provide that maximum sulphur content of ocean-going ships' fuel, that can be 4,5% maximum. Sulphur content of fuel used by the cruise liners meets the international standards, because fuel supplies have an average 3% sulphur content. By the year of 2020 a new international standard will be enforced, as a result pollution like dust, sulphur, nitrogen-oxide coming from ships could be reduced significantly [14].

Power-type ship engines producing a significant amount of air pollution, endangering harbour areas – mainly densely populated cities – with contamination. Quantity of burnt fuel is the highest when the engine starts, which means pollution is just as significant as a long range cruise's emission.

Recently fuel consumption and parallel air pollution was reduced appreciably, thanks to the modern ship engines, operating much more economically, unlike engine types of previous generations. Growing water transport is also responsible for an increasing percentage of global air pollution. Current laws related to waste management do not cover the emitted aeriform materials.

On the ships and in the ports there are no security arrangements for the people working with fuel, lubricants and hydraulic oils. In turn when refueling the ship's tanks or performing maintenance on engines a certain amount of fuel and/or lubricants are always flowing or leaking out.

Research has shown that 1 L gasoline could contaminate1 million L water, 40 L of gasoline could spread on water surface of 1 km^2, disabling atmospheric O_2 to reach water layers, contaminating fish gills, as a result, these animals die due to lack of oxygen. Beyond that, these materials endanger the entire fauna of the seas.

In relation to the above, further literature or other written resources would have been necessary to continue my research. The probable cause of seclusion from the handover of such resources could be nothing else but the lack of specialized literature.

The requested materials were the following: how much/what kind of waste arisen from maintenance and trips, introduction of systems of waste management, environmental protection and regulation or elements of safety engineering related to waste. I wanted to familiarize myself with the related regulation systems, and I also wanted to know the given industrial wastes and hazardous materials, Havaria-events, environmental damages, catastrophe or disastrous event, written resources related to transportation and maintenance, wastes, processes, safety engineering.

Are there any resources, photos or information, related to the research program and are they available for this purpose? I requested help to organize personal visits, consultations, and I also wanted to perform field studies in the ports and on board ships. Some visits would have been also useful at the coastal waste deposits, to get know these systems personally. Unfortunately, I haven't got any help from the relevant organizations and I failed to obtain the necessary permissions.

TABLE II
During river and sea traffic the following types of harmless wastes may arise:

EWC code	Designation	Methods of secure collection and storage
20 01 01	Cardboard and carton	Selectively, compressed in a closed plastic container, resp. incinerator
15 01 01	Paper and carton package waste	Selectively, compressed in a closed plastic container, resp. incinerator
15 01 07	Glass package waste	Selectively, compressed in a closed plastic container, resp. incinerator
15 01 03	Metal package waste	Selectively, in closed plastic container, resp. compressed
15 01 02	Plastic package waste	Selectively, compressed in a closed plastic container, resp. incinerator
15 01 06	Other mingled package waste	Selectively, compressed in a closed plastic container, resp. incinerator
20 03 01	Other urban waste, including mingled urban waste	Selectively, compressed in a closed plastic container, resp. disintegrator, incinerator, masticator
20 02 01	bio-degradable waste	Selectively, compressed in a closed plastic container, resp. disintegrator, incinerator

Based on 92. § of the Hungarian Waste Law, they established the following directives related to waste handling in the areas of river and sea traffic, with particular regard to solid urban waste:

By 01 December 2020, joint percentage of reuse and recycling of paper-, metal-, plastic,- and glass waste – similarly to the types of household waste – should be increased to 50% on national level, in accordance with the total quantity arisen.

Quantities- of degradable organic materials should be reduced to 35% by 01 July 2016 - compared to 1995 on national level, considering the measured annual composition and weight by ingredients of the waste in the urban solid waste landfills.

In the following diagram the orange color regards the ships of the Cruise Line, but this could be also relevant to other ships using simpler waste handling systems:

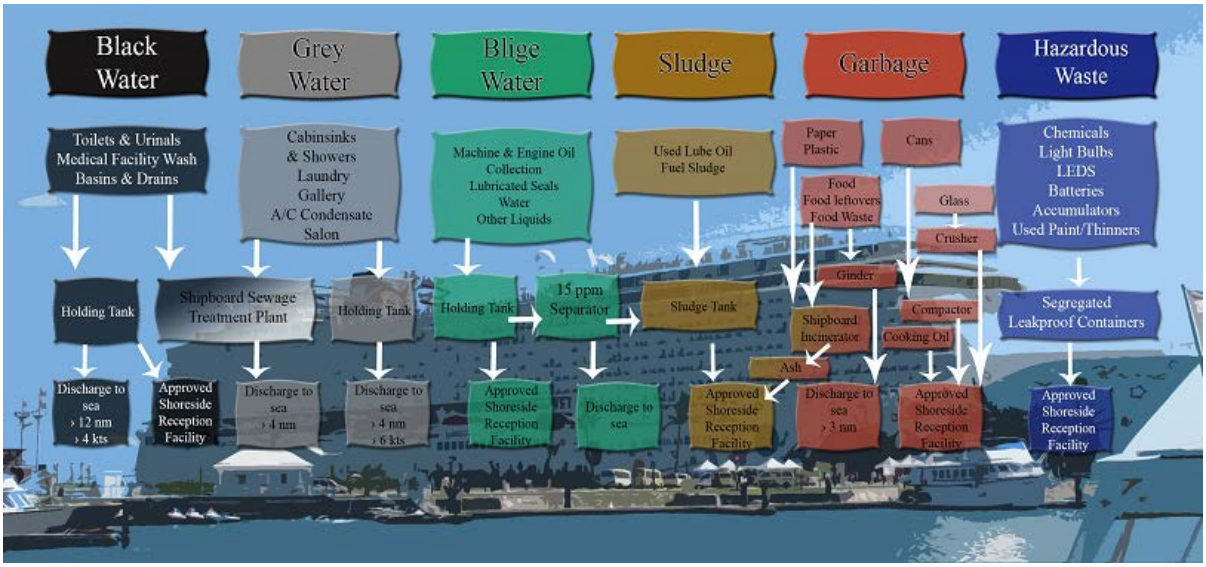

Fig.1. Complex waste handling system used on the luxury cruise liners (resource: personal & http://maritimesolutions.co.uk/)

In Hungary, transportation and appropriate handling of urban solid (communal) waste was provided by the local public services, based on valid contracts and waste handling licenses.

Energy consumption of the urban solid waste takes place in the Capital Recycling Plant in Budapest. Harmless emplacement of urban solid waste was guaranteed in the Regional Waste Handling Centers, in accordance with standards of the EU.

Wastes arisen from shipping and transportation

In 2014, the total amount of cargo moved by ships via European interior waterways was 551 million tons, 3% more than a year before. The main product categories moved via interior waterways were the following: metal ores and other mining products, coke and refined petroleum products. The largest-scale interior waterway transport processes were accomplished in Germany and in the Netherlands [5].

The European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN), signed at Geneva on 26 May 2000, and the Standard attached to the ADN states the following:

A Safety Committee shall be established to consider all proposals for the amendment of the Regulations annexed to the Agreement, particularly as regards safety of navigation in relation to the construction, equipment and crews of vessels. The Safety Committee shall function within the framework of the activities of the bodies of the Economic Commission for Europe, of the Central Commission for the Navigation of the Rhine and of the Danube Commission which are competent in the transport of dangerous goods by inland waterways (Article 18) [7].

ADN-control is a very important task, especially at the capital, Budapest (due to the special geographical situation) and Mohács (Schengen border). Ship control service was established on 04 July 2012 in the coastal building of the port of Mohács, where employees of the Disaster Management are controlling all vessels transporting hazardous materials in- or outbound to/from the EU, as well as other watercrafts out of AND's scope [7].

N-type waste collector vessels with 300 tons capacity are capable to decontaminate oleaginous and fatty areas from the water surface. The ship was designed to collect and transport oily and fatty waste produced by the vessels' maintenance.

Regulations of the ADN shall not apply in the following cases:

a) Transportation activities of companies (businesses) related to their main profile, for example supply of engineering working areas or building construction sites, or transportation related to measurement, repair or maintenance, furthermore, return services with up to 450 L/consignment of dangerous goods – in that case, in accordance with limits of quantity laid down in Article 1.1.3.6. All necessary steps of security arrangements should be taken in order to prevent dangerous cargo to get away at normal transportation circumstances [2].

Regulation looks debatable, because „flammable liquid materials and other dangerous items" spilling out during a disastrous event in a quantity of 60 L/container or 240 L/transport unit, or 450 L of other type of dangerous material may cause extraordinary environmental pollution. 1 L gasoline could contaminate 1 million L of water, 40 L of gasoline could spread on water surface of 1 km^2. D**econtamination may bring up critical financial, moral and socio-economic problems.**

15 years have passed since the signing of the European Treaty of Geneva on International Carriage of Dangerous Goods by Inland Waterways, in the meantime, environmental protection, waste handling and waste management has undergone many changes.

Therefore propagation of up-to-date information related to the handling of hazardous and other wastes is very important. Supervision and updating of the related national and international legislation is highly recommended.

III. ENGINEERING SAFETY ISSUES OF WASTE GENERATED DURING DISASTERS

Water transport and traffic requires a variety of materials, needed to be on board of the ships. In case of an accident or catastrophe, these materials could easily become wastes. River and sea transport is available to move a variety of products over long distances, therefore, conveyance of dangerous goods is also possible.

In the Hungarian section of the Danube transportation of dangerous goods is accomplished almost exclusively by tankers. This is due to the fact that largest volume of local river trade is depending on the return of fuel, consisting gasoline (UN 1202) and petroleum products (UN 1203). Sometimes it happens that loose cargo is passing through Hungarian territory, mostly consists chemical fertilizer, under the scope of the AND. During the examined period, they have not seen ships transporting mail piece dangerous goods in Hungarian waterways[7].

Waste could be generated during disasters, when the ship sinks, runs aground, crashes over or suffers so heavy damage that it must be scrapped.

Two swamp boats involved in an accident in September 2015 in the Everglades National Park, 21 people had to be hospitalized. Knowing the events only a limited quantity of waste was expected, because at the moment of the accident only the fuel tank suffered some damage, as a result, the liquid started to flow away. When such event happens, water pollution has to be treated as soon as possible, by neutralizing the hydrocarbon waste, decontamination, abolishment of pollution and rehabilitation of the area.

Fortunately, accidents are rare in Hungary, referring to water transportation of dangerous goods. There were two accidents altogether in the past two years, when the vessels beached, but the environment remained intact in both cases [7].

Catastrophes of ocean-going ships, containers, tankers or cruise liners are completely different. In these cases, multiple kind of wastes (even illegally transported materials) may surface in large quantities, but certain part of fuel, synthetic slush, metal and plastic components and other flammable materials are burning away.

Waste generated by ships like Costa Concordia and other „floating cities" are very similar to solid urban waste. This kind of waste includes a large quantity of wrappers and kitchen waste generated by the consumer society and luxury lifestyle.

Vessels like Royal Caribbean International Explorer of the Seas or Norwegian Cruise Line Breakaway are emitting approximately 40 000 L of waste water (black water), 450 000 L of grey water, 4000 L of oleos bilge water and 19 tons of solid waste.

After the usually one week long trips, the remaining food supplies are entirely depleted into the sea by the crew. It is also interesting to mention the elevated caffeine content of the world's seas Maybe the large amount of brewed coffee-grounds of the shipping waste is responsible for this .

It is important to note that composition of traditional waste has changed, it includes new materials e.g. wet-wipes. Such materials have several artificial ingredients, raising new waste management problems. These wipes mostly coming from smaller boats, popular beaches. Due to the special composition, natural degradation of these materials is very slow, but the wind, the ocean flow and coastal waves mostly wash them up. Sea-water partly incapacitates these wipes, as a result, these materials are not so dangerous to human health. Apart from this, the most secure way to eliminate these waste is the destruction by fire.

Typical composition of wet-wipes: water, Potassium Laureth Phosphate, Glycerin, Polysorbate 20, DMDM Hydantoin, Tetrasodium EDTA, Methylparaben, Malic Acid, Aloe Barbadensis Leaf Extract, Calendula Officinalis Flower Extract, Camellia Oleifera Leaf Extract, Cucumis Sativus (Cucumber) Fruit Extract, Retinyl Palmitate, Tocopheryl Acetate, Zea Mays (Corn) Oil, Phenoxyethanol, Butylparaben, Ethylparaben, Propylparaben, Isobutylparaben, Fragrance.

In case of plastics, estimated degradation time in sea-water may rise to more than 400 years.

Cruise liner Grandeur of the Seas (Royal Caribbean International Company) was on her way between Venice-Barcelona-Miami when an oil spill occurred during a docking maneuver. The crew successfully used oil barriers and absorbent tools to decontaminate the surface of the water. A report was made about the accident by the Spanish Guardia Civil (border police) [10].

Aspects of safety engineering should be taken into consideration in the designing period of the ships, in order to prevent waste to get out from the vessels' hull.

During passenger transport-related ship disasters, beyond well known types of waste, the following substances may also harm the marine environment: light bulbs, bottle caps, toothbrushes, popsicle sticks and tiny pieces of plastic, each

the size of a micro-bead, inhabit the Pacific garbage patch. This area of widely dispersed trash doubles in size every decade and is now believed to be roughly twice the size of Texas.

Newest cruise liners have improved on board devices, in order to decrease shipping risks and to increase safety of life, estate and environment [3].

In case of transportation of high security cargo or hazardous materials, all collaborating parties – transporters, companies, senders – have to create, initiate and follow safety plans. Customers are recommended to choose environmentally friendly companies possessing all necessary certificates and licenses.

Unfortunately, the safety plan does not include provisions regarding waste resulting from Havaria-events. There are no references to the handling or neutralization of hazardous materials. Safety plans are primarily focusing on terrorist threats, which is a major risk factor in our age [9].

In order to preserve the Great Lakes' high quality water in Canada and reduce the emission of watercrafts, local authorities set up the following measures:

- They prohibit/disallow accumulated oil and hazardous materials from getting out;
- They prohibit emission of waste;
- They minimalize hazardous waste arisen from cargo;
- They prohibit the unlimited deflection of waste water;
- They control the deflection of waste water;
- They counteract the spread of invasive species, pathogens, harmful urban organics, algae and other animals by shipping;
- They protect anti-slime systems of the environment;
- They prevent invasive species from overgrowth in ballast water;
- They establish special facilities to affiliate, elaborate and neutralize shipping waste;
- They supervise the Great Lakes' water quality in order to maintain and develop maritime systems [1].

Based on Government Regulation 65/2013. (III. 8.) about the identification, designation and protection of crucial systems and facilities, Law CLXVI. 2012 determines the following criteria of "environmental impact":

An event or process affecting natural or artificial environment, damages or malfunctions of the infrastructure, generating further damages in natural or artificial environment, resulting in:

- Pollution of an area of 100 km^2minimum;
- Permanent damage of groundwater and water holding formations, rivers and natural lakes, riverbed and fauna.

Vessels transporting special cargo, hazardous materials or radioactive waste could be potential targets of terrorist attacks, because incidental or planned explosion of such toxic materials may result in environmental disasters.

Pillage or impoundment of such cargo may pose a threat, if the content of the carriage becomes out of control in terrorist hands. Hazardous materials could be used as ingredients of explosive devices [9].

Vessels' safety regulations must be extended to cover waste handling actions of prevention, to immediately decrease the consequences of a disastrous event, furthermore, to stop pollution as soon as possible in light of the time factor. For example, fuel tank's damage must be treated with Vetter-cushions. Such tools are easy to apply by the crew at the critical points of the malfunction.

Elimination of pollution of oil spills may result in large quantities of dangerous waste. Typically, the following waste arises in case of an accident of an oil tanker:

- Elements of the ship's hull;
- Sand, plant life, animals and residue contamination with oil;
- Tools and protective clothes used during remediation.

Quantity of waste emerging from actions of remediation may reach ten times the amount of the oil spilled out. Additionally, surrounding waste deposits and facilities of neutralization are usually unable to manage such amount of load. At first, wastes of remediation actions are contemporarily laid down to be stored, in order to plan the program of neutralization. Coastal waste (oily sand, sediment, plant life) should be placed into barrels and containers, well above the water level of high tide. Housing area must be defined, and must be secured to prevent pollution of the surrounding area and ground water.

Most economical and practical solutions employ the traditional waste handling methods: burning or inerting.

Due to the high oil content and burning heat, such wastes cannot be treated as communal waste in designated urban facilities. It is possible to burn such materials in special incineration establishments only, but in these cases spare capacities could be difficult to arrange. In general, emplacement in the landfill is the one and only solution, but nowadays this method encounters problems in many countries, especially in the EU, because maximum quantity and type of waste are strictly regulated [12].

Additional opportunities:

- Stabilization of the polluted oily sand with quicklime, later, deployment at road construction
- Recovery and recycling as much oil as possible (re-refining or burning in designated facilities)

US Congress created the Oil Pollution Law in 1990, which provides that all oil companies have to pay money into the foundation created by the Congress, in order to provide financial supplies to manage future disastrous events.

The Law provides that all tankers must have double bottom by 2015 [6].

I deliberately did not write about the major accidents of giant tankers in more detail, because such events are well known, thanks to the specialized literature. Methods of protection, neutralization were also evolved over the past few years. In my opinion, there are serious shortfalls and irregularities in the appropriate handling of other wastes, and hazardous wastes resulting from hazardous materials during disasters, many of them unexplored.

Summary tables indicating pollution, violations of law, fines etc. are very useful to follow the tendencies of spreading biological, chemical and other dangerous wastes [12].

IV. RESULTS

Previous research found that actions of remediation, aiming to eliminate the aftermath of catastrophes, may also increase the quantity of dangerous waste in the area of pollution. In some cases, the quantity of spilling oil during remediation processes could increase local oil pollution drastically. In such cases, capacities of coastal landfill areas and disposal facilities are often exceeded. At first, during actions of remediation, the ship-generated waste are going to be stored provisionally, until the planning of the specified program of neutralization. Coastal waste (oily sand, plant life, residue) are to be stored in barrels and containers, in safe distance above the level of flood-tide. Area of disposition must be demarcated, in the meantime, further spreading of the collected dangerous waste must be stopped, in line with the time-factor. Presence of groundwater is also a risk, it should be also taken into consideration.

By now, the most effective waste-management method is still the inert disposition and the burning. Due to the high oil content and the high heat of combustion, such wastes cannot be eliminated in conventional waste incinerators. High temperature industrial capacity is needed to burn them away, although, in some cases, the shortfall of the necessary spare capacities could be a problem. In many cases, the long-term disposal is the one and only alternative. The weak point of this solution is the legal restraint: for example, in the EU, disposal of dangerous waste is very strict, regarding the quantity and type of the waste [13].

Instead of allocation in disposal facilities, I recommend to stabilize the polluted sand with whitewash. This substance could be used in the course of construction, revegetation and stabilization of landfills, etc. I also recommend to recollect the spilled oil from the surface of the water, in order to re-refining or burning away in the specific facilities, cement factories or brickmakers. I would like to underline the importance of further research regarding transport processes of surface- and groundwater, due the time-factor. The American Congress created Oil Pollution Act in 1990, stating all oil companies should contribute to the Monetary Fund, made by the Congress, in order to generate a monetary background to handle industrial catastrophes. The Act provides that every tanker must have double bilge **[**14]. This ordinance should be extended to every vessel all over the World, especially to the ships transporting chemical materials, liquids and dangerous substances.

V. DISCUSSION

In connection with this article, I would require more literature to perform a more detailed research. The possible reason of the shortfall of such open literature is very simple: I suspect there are no written materials in this subject. I intended to look for the following subjects: quantity and details of wastes coming from operation during regular trips; waste handling systems; introduction of environmental and waste management plans, manuals; safety engineering elements of waste handling, etc. I was interested to know the regulatory regime, some other types of dangerous waste, Havaria-events, environmental damages, catastrophic events, materials and wastes of operation and transportation, processes, safety engineering methods, etc. I was also looking for more photos, open researches regarding this subject. I requested some help to organize personal visits, to perform personal consultations and field studies at harbours and on ships. I wanted to visit local areas of disposal too, furthermore, to get to know more points of contact

VI. CONCLUSION

In spite of all these security arrangements, we cannot ignore the significance of the human factor during such accidents. The complexity of security is based on how prepared are the workers/ employees, to use their knowledge and adhere to protocol. Our environmental safety depends on the level of our natural sense of danger. In absence of the necessary alertness, ideal environmental quality is more vulnerable. Characteristics of naval accidents should be taken

into consideration, as well as the difficulties of technical rescue, not to mention the weather circumstances at open sea during rescue, the spilled oil, the dwingling time when the ship starts to sink, etc.

In the operation of ships aspects of security should be highligted in relation of the dangerous wastes, because long-term maintainability of shipping depends on the secure operation of the relevant systems. Prevention is also crucial in this subject. During the handling of such disasters the main goal is to save human life; this objective is more important than any other envirenmental or economic aspect. The main value is the human life. Scientific approach is needed to analyze all accessible data of catastophic events, in order to draw professional conclusions effectively.

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