The 12th Annual General Assembly
International Association of Maritime University

GREEN SHIPS
ECO SHIPPING
CLEAN SEAS

Editor:

Bogumil Laczynski

Gdynia Maritime University

12–14 June 2011

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Dear Colleagues, IAMU Members,

Gdynia Maritime University (GMU) has a privilege to do honours of the Host to the 12th Annual General Assembly (AGA) of the International Association of Maritime Universities (IAMU) to be held in Gdynia, Poland from June 12 to 14 June 2011.

Our Association of Maritime Universities convenes every year at the premises of each consecutive Respectable IAMU Member and in the year 2011 you are very much welcome to the premises of the GMU which is the successor and continuator of the 90 years of maritime education in Poland.

The encounter of the world's leading universities' representatives will foster further development of beneficial cooperation, exchange of experiences, discussion and also presentation, by IAMU Members, research projects accompanied by presentations within the frames of the scientific conference to be concurrently held. We wish to focus special attention on cooperation among students and this will be facilitated through visits of a number of training vessels to the Port of Gdynia on the days of AGA12. The motto for this year encounter is:

Green Ships, Eco Shipping, Clean Seas

We wish all participants adopted the guiding principle to leave clean, non-polluted seas and oceans to younger generations.

We welcome you to Gdynia - to the city, which concurrently to our University, has entered its 90 years of its incorporation as city, no doubt maritime capitol of Poland. Apart from exchange of experiences at the conference, visiting training vessels, students' encounters, visits to laboratories and simulators we also wish to create opportunities to introduce the Guests to our history, culture and to allow them meet friendly people living in Gdynia, Sopot and Gdańsk which make up one million metropolitan area of the TriCity with its picturesque surroundings.

With thirty-four papers and five IAMU projects presentations, being presented at the 12th Annual General Assembly of the IAMU, we look forward to informative and innovative discussions with all our maritime colleagues, and hope that our mutual collaborations will continue to shape global maritime education and policy.

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Green Ships – Eco Shipping – Clean Seas

Editor:

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Gdynia Maritime University

AGA12
Green Ships – Eco Shipping – Clean Seas

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This volume includes the papers presented at the 12th Annual General Assembly of International Association of Maritime Universities (IAMU), which was held on the basis of the Gdynia Maritime University in Gdynia 12-14 June 2011.

The texts of the papers in this volume were set individually by the authors. Only minor corrections to the text pertaining to style and/or formatting may been carried out by the editors.

Contents

Management of The Safety of Automation Challenges The Training of Ship Officers

Sauli Ahvenjärvi
Principal lecturer, Satakunta University of Applied Sciences,
sauli.ahvenjarvi@samk.fi

Abstract: Management of the safety of the increasing automation onboard ships is a challenging task for ship officers. In this paper, the competency requirements and the training of deck and engine officers on this area is discussed. Ship officers must be able to operate the automation systems safely, not only in normal operational situations, but also in abnormal situations. Preserving the safety is a key issue also in the maintenance of these systems. The safety of automation can be ruined by poor maintenance. As the training of officers is considered, It is crucial to define correctly the knowledge and the skills that the officers should possess on this area. What and how should be trained? On one hand, the training should not be too general, and on the other hand, it should not be loaded with in-depth information about the finesses of digital technology. It is important to understand what is essential for succesfull management of safety of automation. The aim of this paper is to give some answers to these questions. A draft syllabus for a training course on management of the safety of automation is presented. The proposed course syllabus is created in the ongoing SURPASS project, which is carried out by Satakunta University of Applied Sciences together with four other European institutions. The general outline of the SURPASS project and its goals are briefly described in this paper.
Keywords: Ship automation, safety, training

1. INTRODUCTION

Automation has had a major role in the development of the modern society during the past decades. It has been possible to improve the productivity, the effectiveness and the quality of production on many branches of the industry by utilising new automation technology. Automation has also given a significant contribution to the development of the safety. During the course of years, automation has gained a very important role also on ships.

The modern automation is based on digital information technology. Even though our world is not digital, all the information collected from the real-life systems to be controlled is processed, stored and transmitted in digital form. This branch of technology has been - and still is - under fierce development on the component level. Distributed digital machinery automation systems for ships were introduced on the late 1970's and in the beginning of 1980's. On the bridge the computer appeared a few years later. Although the core tasks of the automation systems have not changed so much and the users of the systems are still ordinary human beings, the technology to implement these systems has been replaced several times. New processor generations, new memory technologies, new ideas of transmitting the information from one place to another have been introduced within a few years' interval. For instance, although the architecture of the machinery automation systems in the late 80's were already distributed, the data transmission was still based on point-to-point connections reaching the capacity of a few kilobytes per second. Nowadays the systems utilise buses and networks on different levels of the system. Typical networks within a ship automation system is able to transmit information with ten thousand times bigger bitrate than the old serial connections only twenty years ago. Also the integration has occupied ever-increasing areas as the shipping industry has been looking for better efficiency and safety. Examples of extreme integration related with ships are the satellite based navigation, communication and Search-And-Rescue systems, Automatic Identification System (AIS) and the e-navigation concept. that are all based on the utilization of advanced automation, digital data processing and modern information transmission technologies [1].

This rapid development on a most critical area of the operation of ships is a major challenge for all parties involved in such a conservative business as seagoing. Technology changes but the user is still the same human-being, who must be able to operate and to maintain these systems correctly. The importance of the human element is not eliminated or even reduced as automation has been increased, especially when the safety aspects are considered. The new automation systems must be maintained and operated in a safe way, even under abnormal conditions. These tasks require good knowledge about the operation and about the structure of the systems. This is a big challenge for the education of seafarers. Rapid development of the technology must not lead into a situation where a large part of seafarers have a formal education and the licences required by IMO and the national seafaring officials, but in fact are not able to maintain and operate the latest technlology in a safe way. We mus ask if the Maritime Education and Training institutes are really able to give the students such education that fulfills the demanding requirements set by the latest technology. And what about those seafarers who have got their education twenty or thirty years ago? Are they still able to cope with the computer-based systems they are operating on new ships? It is quite clear thet the older seafarers did not get any training about the safe usage and maintenance of the latest system generations when they were students at the Maritime University.

2. THE LIFETIME APPROACH TO THE SAFETY OF AUTOMATION

The safety of complex technical systems, such as nuclear power plants, can be managed by looking at the whole lifetime of the safety-critical entity. The lifetime approach is very useful also in management of the safety of automation systems of ships. The lifetime of an automation system can be divided into several phases, one following the other. Typical phases are the specification, the design of the hardware and the software, the manufacturing, the testing, the assembly of the system onbord, the commissioning, the maintenance and operation and finally the dismounting and wrecking the system. The system is safe, or the integrity of the safety is maintained, only if all safety aspects have been properly treated and all requirements are fulfilled during each phase of the entire lifetime of the system. The standard IEC 61508 is one of the basic regulations of management of the risk of safety-critical systems, based on the lifetime, or safety life cycle, approach [2].

Many rules and regulations have been published in order to ensure that the safety aspects have been properly taken into in different phases of the lifetime of the critical systems of ships. Publishers of such documents are International maritime Organisation (IMO), International Hydrographic Organisation (IHO), International Standardisation Organisatio (ISO), European Union, national maritime authorities, the classification societies and the International Electrotechnical Commission (IEC), among others. For instance, IEC has published regulations about the testing of the equipment used onboard ships [3]. Classification societies refer to this document in their rules and regulations.

It is interesting, that the vast majority of these regulations are targeted at proper design and testing of the systems. The most important rule related with the maintenance and the operation of automation systems on ships is in fact the STCW 1995 convention by IMO. The STCW 1995 with its amendments defines the minimum standard for the training and the competence of seafarers all over the world. It is quite obvious that in this phase of the lifetime of the automation system, the human element plays the most important role. Even the system designed, manufactured, tested and commisioned according to all rules and regulations is safe only if it is operated and maintained in a proper way. There are several examples in the history of safety-critical systems about serious accidents caused by poor or neglected maintenance or wrong usage of a well designed system.

3. THE SURPASS PROJECT

The STCW-1995 with the 2010 amendment sets the minimum standard for the training and the competence for users of the automation onbord ships. However, the importance and validity of this standard - as so many other official regulations regarding new technology - is weakened by the rapid development of the technology. An official standard of this kind can not be too detailed and it cannot be updated immediately after every new technical innovation. And even if it was possible, there would still be a long delay between the introduction of the new technology and the time when trained seafarers enter the labour market with knowledge about this particular matter. This delay is caused by different factors on the management and the way of operation of the maritime education and training providers.

There is a need for special training for seafarers to update their knowledge about the safe use and maintenance of the latest automation technology. The level of the skills and the knowledge on this area is not even. The older generations that have got their education two or three decades ago are less familiar with new technology than the younger generations that have become familiar with computer systems in their everyday life. But even for the younger generations, it is important to give education about proper maintenance and use of safety-critical computer systems. Operating the Integrated Navigation System (INS) of a big passenger ship is not the same as playing a computer game!

Satakunta University of Applied Sciences together with five other European organisations has initiated an EU project called SURPASS, in order to give a solution for this apparent trainig need. The project started in October 2009 and will be concluded in September 2011. The The main aim of the project is to create a special training course for seafarers to enable them to have a better understanding of the structure and operating principles of automated systems and of these systems' weaknesses and limitations and the management of the safety of these systems. The course material to be produced will support web-based learning [4].

4. THE GOALS AND THE METHODS

An essential question is: what should be trained if the goal is to give the officers the skills and the knowledge to cope with modern automation technology onboard? The answer to this question about the contents of the training can be found by thinking about the tasks of the officers onboard in relation with the automation systems. It is quite obvious that the officers have only two main roles. The first one is to use the systems and the other one is to take care of the maintenance of the systems. Hence the training should focus on proper maintenance of modern automation systems onboard and on a safe and efficient way of using the systems. Maximising the safety and minimising the probability of an accident, especially due to a human error, should be the general perspective in designing the contents of the training.

Training of users of technical systems is often focused on operation of the system under normal conditions, while the management of abnormal situations gets very little attention. However, the user must be able to cope with different kinds of abnormal situations as well. These situations can be caused by hardware failures, software errors, different kinds of disturbances or by extraordinary environmental conditions. It is important that the user can efficiently monitor the system and that he/she is also able to notice abnormal variations on the performance of the system. If the user can not do this, he/she becomes totally dependent on the system's built-in ability to perform self-diagnostics, to detect malfunctions and failures and to give alarms or warnings to the user in such situations. There are several accident cases, however, showing that the users should not rely on the self-diagnostcs of complex automatic systems [5]. Especially in complex systems, consisting of several computer-based units and subsystems, it is practically impossible to create such self-diagnostics that would be able to give an alarm of every possible failure mode. Consequently, there is always a risk of such failure mode that can not be identified by the self-diagnostics. When the system does not give the user a proper alarm about a serious malfunction or a failure, a dangerous "automation surprise" takes place: The system suddenly behaves in a way that the user did not expect and the consequence can be an accident. The event-tree of an accident resulting from poor monitoring and incomplete self-diagnostics of a safety-critical system is shown in Figure 1.

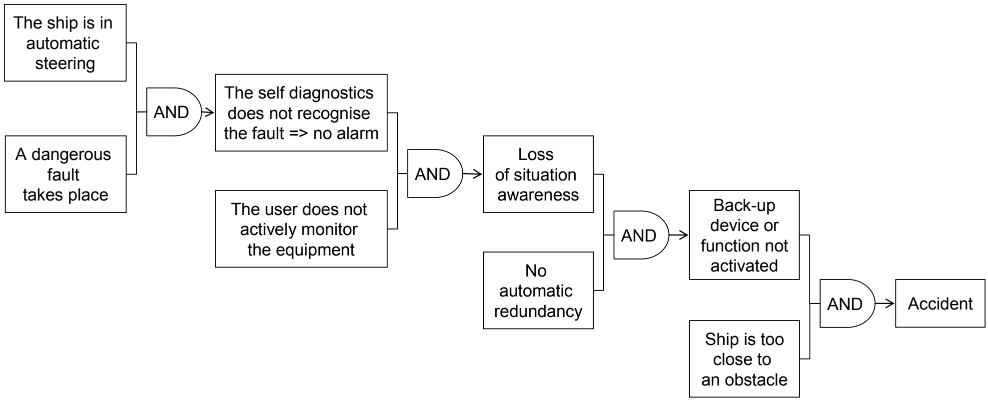

Figure 1. The event-tree presentation of a typical accident after a failure in a safety-critical automation system

Training of management of abnormal situations, however, is not a simple task. Efficient management of failure situations and proper monitoring of the performance of the system require good understanding of the structure and the operation of the system. This should be an essential part of the training, but on the other hand, training can not be loaded with too many technical details and theoretical information about the algorithms and functions. Moreover, such information is usually very system-specific, which means that every system and every ship should be studied individually. That is impossible in real life. So the conclusion is that the general training of users can contain principles of the structure and operation of modern automation systems. Also understanding of interrelations and dependencies between various sub-systems in a large integrated system and the data transmission between the sub-systems should be handled. Technical problems within automation systems are very often connected somehow with transmission of signals. But no detailed ship-specific subjects can be included. These skills and knowledge must be studied onboard. The general course should contain material to motivate the students to complement their knowledge onboard. Accident cases from real life would perhaps be useful for this purpose. The ship owner has the responsibility of arranging appropriate training for all users on the ship-specific subjects. An extremely useful tool for training of managemenet of abnormal situations is a type-specific simulator. Air traffic industry has used type-specific simulators for decades to train cockpit personnel to handle different kinds of abnormal situations. Unfortunately in shipping industry this is not usually possible, because ships are more or less individuals and each ship should require its own type-specific training simulator.

In training of proper maintenance of modern automation systems, it is important to pay much attention to human errors. Both in understanding why human errors occur and in learning how to prevent them. A useful book on these subjects is "Managing Maintenance error" by Reason and Hobbs [6]. The book gives information about the nature of human error and draws some guidelines towards error-free maintenance.

When the contents of the user training is being planned, it is wise to utilise modelling of the human behaviour. One alternative is the famous three-level model of human behaviour by Jens Rasmussen. This model divides the behaviour of a human operator into three levels: the Konwledge-based level, the Rule-based level and the Skill-based level. There are also other classifications available. A model for maintenance of situation awareness would also be very useful. Figure 2 illustrates the structure of this model.

The process of situation awareness is recoursive, consisting of reception of information from the real world, combining it with the expectations, updating and maintaining the mental model of the reality and finally the task of controlling both the information reception and the real system in concern. Which ever model is used, it helps to ensure that all important areas and aspects of the human behaviour are taken into account.

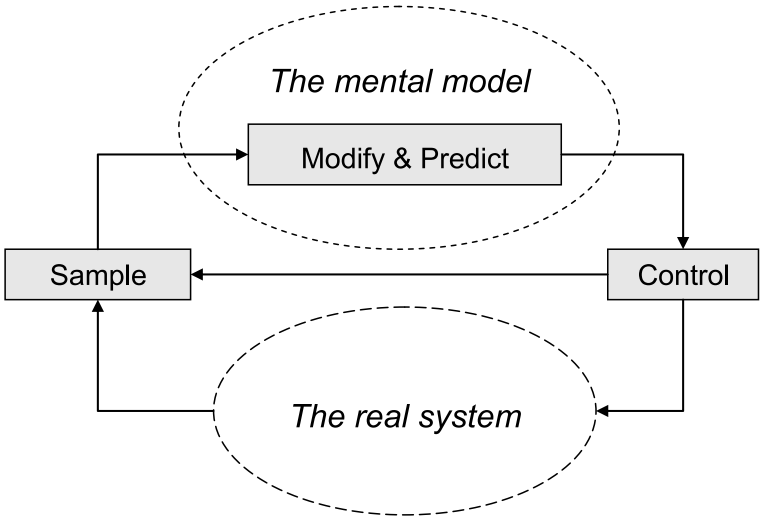

Figure 2. The recoursive model of Situation Awareness [5]

5. THE PROPOSED CONTENTS OF THE TRAINING COURSE

The proposed contents of the training course on the safe use and maintenance of automation systems is presented in Table 1. It can be seen that there are quite many different subjects to be included in the syllabusof the course. It is, indeed, quite challenging to design a course on a rather demanding technical subject for people that do not necessarily have much earlier training on electronics, computers or automation. However, if there is not enough knowledge about the structure and operation of the system, the user may not be able to manage critical fault situations safely. Also the deck and the engine officers of the ship must know something about risk analysis techniques and about avoiding the human error during maintenance, in order to succesfully handle the maintenance of the automation systems onboard.

The course contents shown in the table is not the final one, and it will be adjusted according to the feedback from seafarers and other interest groups during the SURPASS project.

Table 1. The proposed course contents

1. Introduction of applications of automation on ships - machinery automation systems - bridge automation systems 2. Principles of real-time digital data processing and digital data transmission - the idea of real-time digital computing - from analog to digital and from digital to analog - digital data storages - the software - principles of digital data transmission in automation - the importance of the Human-Machine Interface 3. Principles of the safety of automation - basic terminology - ensuring the safety during the whole lifetime of the automation system - the human element in safety of automation 4. Knowing the risks of ship automation - Introduction of common risk evaluation techniques 5. Safe use of an automation system - minimising operator errors - coping with failures and disturbances during the operation 6. Safe maintenance of ship automation - critical areas in maintenance - eliminating the human error in maintenance 7. Special safety issues - typical disturbances - proper earthing - uninterruptible power supplies - galvanic isolation

6. CONCLUSIONS

If the development of the training of seafarers can not keep the pace of the development of the technology, the users will not be able to use and to maintain the modern automated systems of ships safely and efficiently. STCW-2010 does not set precise requirements for the knowledge of automation-related issues and for the training of these subjects. Obviously these official requirements must be complemented, as the development of technology goes on. The aim of the SURPASS project is to develop special training course for seafarers to update their knowledge of the structure and the operation principles as well as the safe use and safe maintenance of modern automation systems. The syllabus of the proposed training course is rather wide. There are a great number of different subjects to be covered by the training course. The SURPASS project is still going on and the final result of the project are not available before the end of 2011.

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Comparative Analysis of Combustion verses Hydrogen fueled Cargo Ships

Yaqub M. Amani
SUNY Maritime College

Catherine Strez
SUNY Maritime College

Charlie Musch
SUNY Maritime College

Abstract: The main objective of this paper is to present detailed analysis of hydrogen as fuel for shipping. The primary source of hydrogen considered for this purpose is methane reformers. The use of carbon sequestration technology and cost related effects will be discussed. Although water is the cleanest way to produce hydrogen, but the technology for compact, high volume hydrogen production by electrolysis is in the research stage and cannot be implemented for this purpose at this time. We will compare storage volume and total space required for a combustion engine and methane hydrogen reformer fuel cell electric propulsion system for cargo feeder ships.
Keywords: green ships, hydrogen, maritime, ship propulsion

1. INTRODUCTION

The question of hydrogen economy and pollution associated with combustion engines using fossil fuel and criteria pollutants have been investigated. Ships, specifically cargo ships and the volume of trade point to alarming findings regarding pollution contribution of criteria emissions by cargo and all ships small and big[1,2]

It is clear that a sustainable shipping economy is the solution for resolving these problems. Hydrogen is cited as the most abundant and clean energy if renewable sources are used for hydrogen generation from water using electrolysis. The question of hydrogen economy, design of hydrogen fuelled cargo ships and specially designed drive system, integrating low power hydrogen fuel cells for large drives are discussed in [3, 4]

This paper will consider a limited horse power cargo ship and compare the same ship equipped with hydrogen storage; hydrogen fuel cell and electric drive and associated electronics. The hydrogen ship design in this paper assumes mobile and stationary hydrogen fuelling stations are available along the shipping routes.

Hydrogen economy is developing in a rapid pace. Hydrogen vehicles are commercialized and soon will be available to consumers. The main problem remaining is to utilize this technology for ships that runs on pure hydrogen. The storage of hydrogen and safety has been investigated and a number of storage devices have been ISO certified. Volumetric data points to a larger volume ratio for hydrogen compare to liquefied hydrocarbons. Here we will consider a number of options available for ships.

2. HIGH-PRESSURE TANKS

The first possibility is to assume that hydrogen is available on shipping routes and the ship is equipped with sufficient storage capacity. Hydrogen tanks for 5,000 psi (35 MPa) and 10,000 psi (70 MPa)have been certified worldwide, however, driving ranges for compressed tanks remain inadequate and the energy consumed to compress the hydrogen reduces the efficiency of this storage media. The weight and size of the tanks are also an impediment commercial vehicle application, but can be used for cargo ships.

Liquefied Hydrogen**,** will improve density however, hydrogen loss is the concern and thermal jackets are required. Liquefying hydrogen requires extra energy. Hydrogen can be stored in metal hydride. This technology is based on the fact that hydrogen atoms can be stored in spaces between atoms of alloys under moderate pressure and temperature, creating hydrides. A metal hydride tank contains a granular metal, which adsorbs hydrogen and releases it with the application of heat. The heat may be supplied as excess heat from a fuel cell. Conventional high capacity metal hydrides require high temperatures (300°-350°C) to liberate hydrogen, but sufficient heat is not generally available in fuel cell for transportation applications.

Carbon Nano-tubes store hydrogen in microscopic pores on the tubes and within the tube structures. Similar to metal hydrides in their mechanism for storing and releasing hydrogen they hold the potential to store a significant volume of hydrogen. However, the amount of storage and the mechanism through which hydrogen is stored in these materials are not yet well-defined. [5]

3. HYDROGEN FUEL CELL

Hydrogen fuel cell is the heart of non- combustion hydrogen drive system. This technology has developed to implementation level. International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE), [6] is dedicated to accelerating the development of hydrogen, and fuel cell technologies, the IPHE has established the following overarching priorities:

1. Accelerating the market penetration and early adoption of hydrogen and fuel cell technologies and its supporting infrastructure.
2. Adopting policy and regulatory actions to support widespread deployment.
3. Raising the profile with policy-makers and the public.
4. Monitoring hydrogen, fuel cell and complementary technology developments.

To illustrate the possibility of a hydrogen feeder ship, we will consider limited horse power cargo ships ranging from 6MW to 36MW. Fig.1 depicts the hydrogen storage volume at different pressures, required per hour for ships ranging from 6 to 36 MW. A typical Hydrogenic 100kW fuel cell will consume 1140 liters/minute or 68.4m^3/h at standard pressure and temperature. Thus for a six mega- watt propulsion drive it will require 60x68.4= 4104 m^3 of H_2 per hour equal to 363.19 Kg/hr.

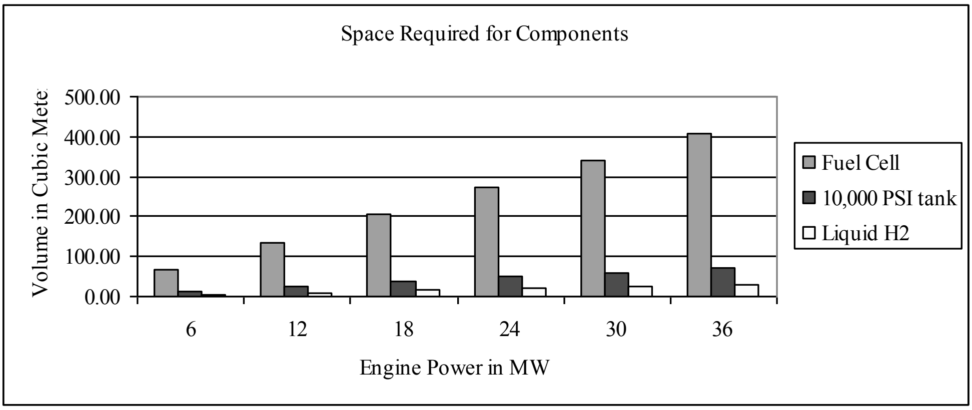

Figure 1.

The relationship between storage weight and fuel cell weight as function of engine power is depicted in Fig.2, We assume 100kW fuel cells each weighing 500Kg and that gravimetric ratio of liquid hydrogen storage, to storage vessel is 0.07

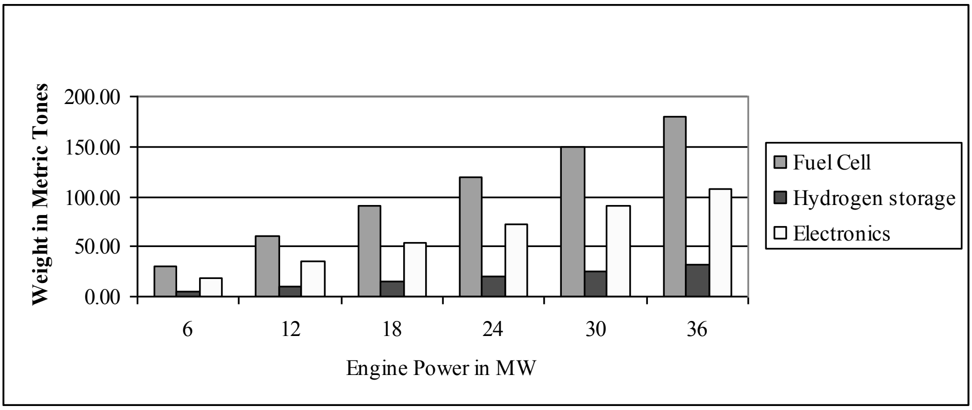

Figure 2. Power System Component Weight

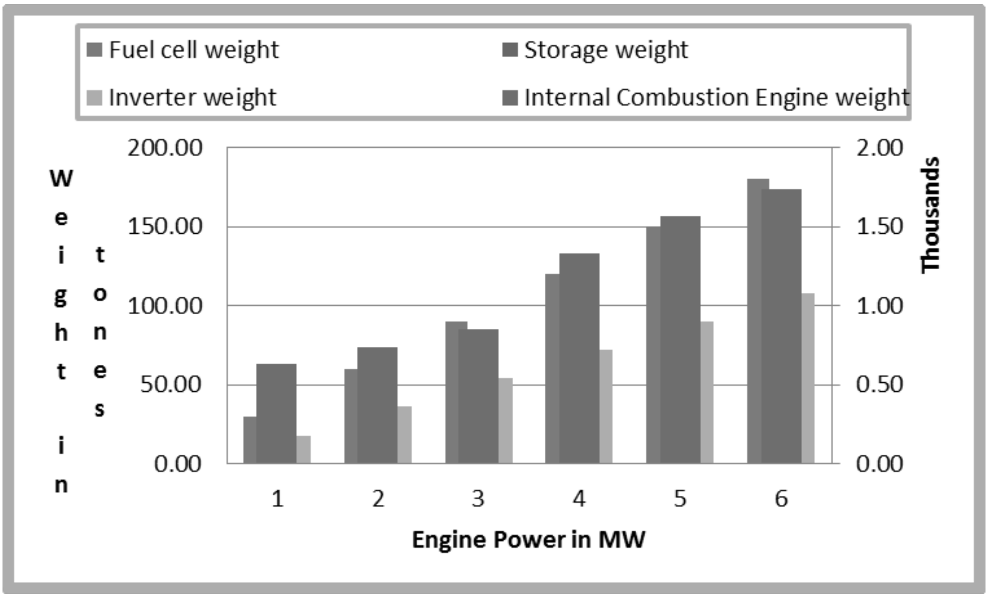

Figure 3. Hydrogen and Internal Combustion Engine Power System Component Weights

Figure 3 shows a comparison of the weight of hydrogen power components to that of similarly powered internal combustion engine. The engines weights displayed are for the Sultzer RTA line of two –stroke marine diesel engines at rated equivalent MW ratings. [7] Obviously engine weights will vary by manufacture and features but there are obvious and substantial differences in weights for the power system components.

To establish the relationship between space required and distance traveled, we assume an 18 MW ship traveling at 18 nautical miles per hour. Fig.4 shows the storage space required for hydrogen as a liquid and hydrogen in 10,000 psi tanks. For reference purposes we have calculated theoretical fuel consumption rates for HFO of a similarly powered motor vessel and plotted the corresponding fuel storage required.

The fuel consumption for the reference internal combustion engine was calculated based on specific fuel consumption (SFC) for an 18 MW slow speed large bore two stroke cycle engine. [8] The SFC was assumed to be 180g/kw h. It is important to note that the SFC figures will vary across the engine loading conditions. The storage of HFO (m3) for the 5000 nautical mile distance represents approx. 30% of the overall storage capacity for fuel oil on this vessel.

Fig. 3 shows that for large distances at this stage of hydrogen storage development, building ships to cover large distances is not practical.

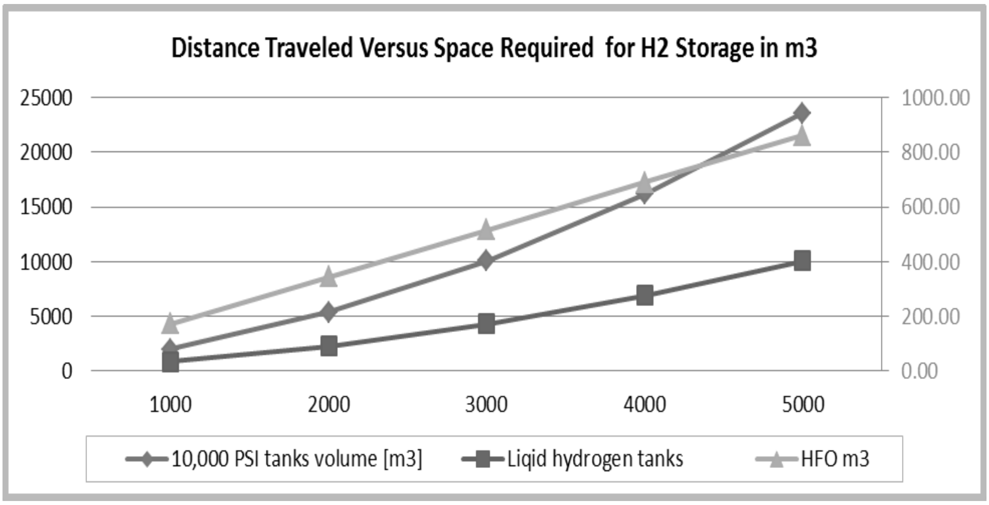

Figure 3.

4. USING METHANE STEAM REFORMERS

The storage of hydrogen requires space which is practical in liquid hydrogen form as evident from the above graph. But liquid hydrogen requires energy for cooling. To present what is required for onboard hydrogen production we look at two possibilities, MSR and electrolysis. Electrolysis requires an average of 4.5 KWh/Nm^3 of hydrogen produced. This will require specially designed ships that utilizes solar and wind on board. This requires some additional storage to guarantee sufficient supply of hydrogen for short distances and will be practical only for ships traveling along the sunny routes. Fig.4 shows required volume for onboard reformers and liquid natural gas.

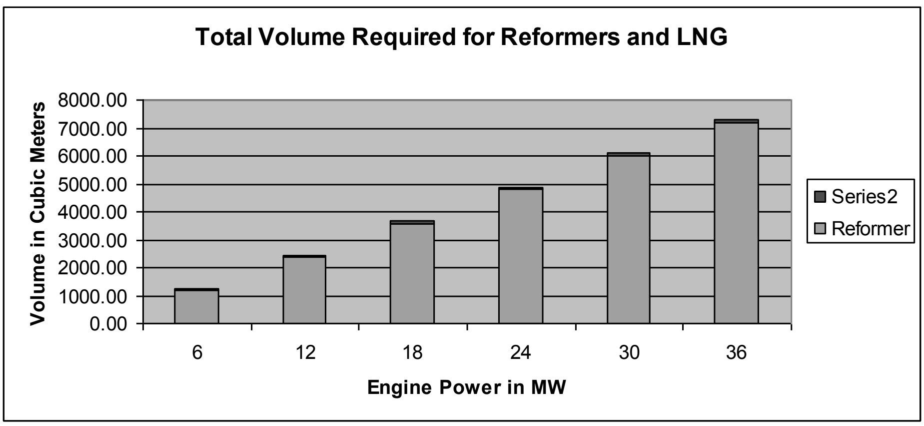

Figure 4.

In Fig. 5, we compare space required verses distance traveled for three different technologies, liquid hydrogen supply, natural gas onboard reformers with limited storage and electrolysis, for hydrogen supply on board of a feeder ship of 18 MW(24120 hp) assuming it travels at an average speed of 18 nautical miles per hour. The volume of electronics control system and the electric drive have not been taken into account. Also it is important to point that hydrogen fuel cells require air flow defined by the manufacturer.

Another important fact to mention is that electrolysis will require an average of 4.5 KWh/ Nm^3 of hydrogen production. This in turn will require solar panels which are addressed by the naval architects.

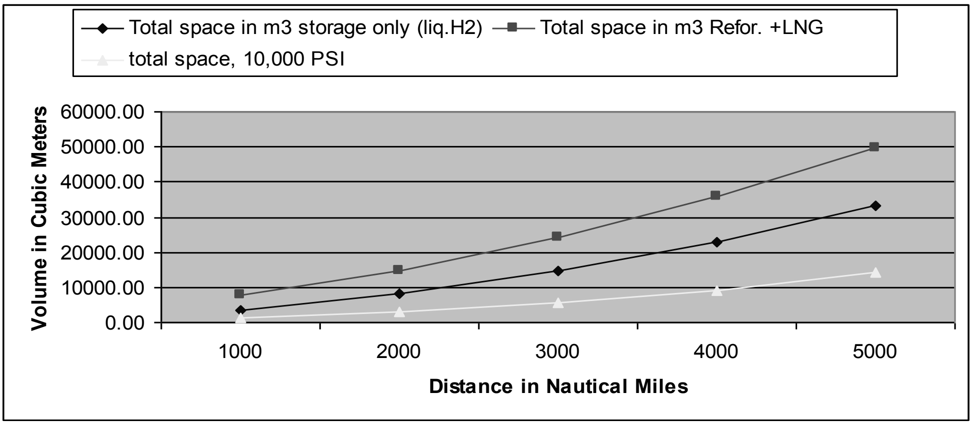

Fig.5

The emission of criteria pollutants from a ship, equipped with 12k90MC, Hitachi MAN B&W 1290mk, built in 1998 and rated at 54,840 Kw, operating at about 90% rated speed produces six grams of CO2 per kWh [7]. We have calculated CO2 emission as function of distance assuming the ship travels at 18 nautical miles per hour for our model feeder ship rated at 18 MW. Fig.6 shows emission for the same engine power using hydrogen produced by solar and other renewable and a methane reformers hydrogen ship.

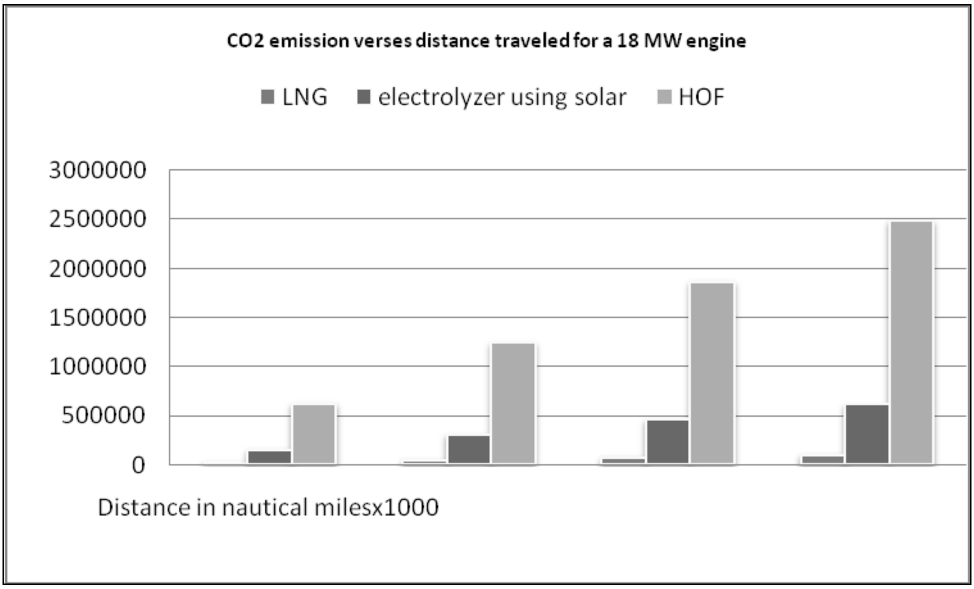

Figure 6.

5. THE HYDROGEN ECONOMY TODAY

The latest "Zemship", which stands for zero emission ship was launched into regular line service on the Alster River in Hamburg, Germany. Zemship use two, 48 kW maritime fuel cells and a lead-gel battery in a hybrid system for propulsion. The ship can transport 100 passengers while demonstrating nearly twice the efficiency of a standard diesel vessel.

The independently conducted studies show that hydrogen and fuel cell technologies are likely to be cost competitive with other alternative technologies and that countries should take a portfolio approach to addressing the world's energy, environmental, and economic issues.

The United States organization Fuel Cells 2000 published "The Business Case for Fuel Cells" in September 2010 which showcases successful use of fuel cells by 38 companies. Research Progress the rising levels of investment in developing transformative energy technologies, coupled with broad international cooperation and innovative research and development (R&D), has produced substantial advances in hydrogen and fuel cell technologies and in the production, storage, and transport infrastructure needed to support their growth. [8]

6. RECOMMENDATIONS

To initiate the building of hydrogen cargo ships, it is necessary to decide which path to follow. There are a number of choices and the possibilities are:

1. Use liquid Methane or Ethanol as source of high density hydrogen and reformers.
2. Use existing 10,000 psi cylinders each containing 175kg of hydrogen

3. Use Elecrolizers, compact batteries used in electric vehicles and solar panels to produce hydrogen with limited storage.
4. Design hybrid ship propulsion systems using a combination of above.

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Maritime Education as the Development Locomotive of Maritime Transport and the Aspired Role of Maritime Academies

Captain Mohye El Din El Ashmawy
M.Sc. in MET, WMU, Consultant to President Arab Academy for Science, Technology and Maritime Transport
IAMU News and Journal Editorial Board Correspondence African Region
mohyldin_a@yahoo.com & mohyldin@aast.edu

Abstract: The maritime community, headed by the International Maritime Organization "IMO", traditionally considers maritime education institutions, whatever their size, as noble destinations located in the heart of this community and the heart of its organizations and entities that are interested in the affairs of this community, in general. As repositories of knowledge that play a pivotal role in human societies, the function of these institutions is thus expected to be the promotion of the numerous fundamental functions and tasks that are indispensable for the development of this community and the achievement of its progress at all levels.

The question that should be posed is: What is the final product that is desired from maritime education and learning? In other words, what is the target pursued by States, maritime communities, families and individuals behind their expenditure on maritime education and learning, and the demand to increase its financial allocations? If there is no specific goal, eligible benefit, or tangible outcome, such expenditures on this type of maritime education and learning would simply be a waste. However, if the State, society, families or individuals have a rational goal of this educational and learning process, then it is necessary to increase the allocated expenditure on this process and to work on achieving this.

The final product of this educational process incorporates what it is expected to be acquired by individuals within the different stages of this type of education such as ideas, behavior, skills and practices that contribute to improving the quality of maritime transport, including all its related issues and affairs, as well as the standard of progress aspired by the maritime community.

We, in this association - here and now - want the young people and men who work on board ships and in the maritime field to be capable of understanding and recognizing differences well; of making sensible decisions and good choices; of expressing themselves well, participating and taking initiative; of innovating and easily adopting to other settings; of taking on self-criticism and autonomous learning; and of maintaining continuous communication and respecting diversity in the maritime community.

Keywords: Maritime community, Maritime education institution, Final product.

1. INTRODUCTION

Quality education is an education that empowers states and communities to boost their progress status from the developing circle to the developed one. Therefore, an interest in education remains the essence of moving a community forward since it helps in forming future generations and is capable of endorsing a change to its fabric on different levels and dimensions and by complex visions that ultimately lead to prosperity and progress of life. Maritime education has, thus, become one of the main productive factors in the development of maritime transport and one of the main contributors to any state's economy based on knowledge, research and development; a reality that is understood by the maritime communities nowadays.

The goal of a good quality maritime education is not merely learning but also raising the awareness and educating in order to create a global maritime community that converge on the value of intellect, ethics and culture as well as on solidarity. As is the case within all other communities, in the maritime community, which includes the maritime transport system, the prosperity or degradation of maritime education institutions is related to their ability to respond to community needs and requirements for its development, and to the extent of grasping all of its variables. The openness of these institutions to the maritime community has become a necessity implied by the current circumstances and changes to the present world, which have witnessed rapid changes in the field of information and communication. This openness has spurred a change to the classic role played by concerned institutions. They have adopted new roles and innovative means by which they could produce scientific knowledge and apply it in reality whether to itself or to the maritime community in general.

2. EDUCATION AND LEARNING

There are significant differences between education and learning. First, education is a systematic institutional process that a person undergoes at a certain stage; usually at the beginning of his life, whereas learning is a process that continues for a lifetime. Second, the initiative in education is in the hand of the instructor who is the one to give and the student is the one to receive. However, learning is the ability of a human being to obtain information by looking for the data and making sense of it himself. Third, education is related to certain curricula or to certain specialization, whereas learning is related to all aspects of life.

Education refines the capabilities of the human brain by enabling it to access different sources of knowledge and to apply different research methods, in addition to enriching it with specific information. Therefore, a truly educated man is one who realizes that science is infinite and that knowledge is an inexhaustible wealth awaiting him to heap up from it throughout his life. Hence, the ability to learn is connected to the extent education can succeed in forming a mature mind that desires to know. A human being does not only learn from what he reads or hears but his personality is also shaped by what is going on around him. A systematic process of educating is the process that develops the talent of learning and making choice; thus, a human being becomes what he has learned and what he knows from his surroundings.

Education is a mind blossoming, liberating, and horizons exploring process; a quantum leap in the human life that elevates man to the highest levels of progress, culture and civilization. Learning, on the other hand, is the key to science, power, knowledge, progress and prosperity. Nowadays, the power of a nation is measured by its creative minds, innovative ideas and up-to-date methods. Education must be regarded as the sole key to present and future success and the best means to achieve social progress. It is a responsibility to be held by everyone, not only by schools or universities on their own. Everyone must participate in education as a national duty; a duty in which the wide array of institutions and companies is involved. Does this apply and correspond to the process of maritime teaching and learning? Positively, it does. At this point, we must not forget the close augmenting relationship between education and competitiveness.

3. EDUCATION AS A DEVELOPMENT LOCOMOTIVE

Education is the locomotive of transformation in societies that aspire to progress. There are many unique scientific experiments in which education and training have been considered one of the pillars of progress and transformation, such as that of the World Maritime University; an experiment that impacted maritime communities in developing countries and was reflected on the whole world later on.

Maritime education is directly linked to the future of the maritime community in general and to the maritime transport in the whole world in particular. This is not only because it is a cognitive process through which the student receives organized knowledge, required skills and techniques but also because of its growing role in the preparation of generations that are capable of effective participation, of conscious planning for the future, and of being equipped with worthwhile values, technical skills and correct orientations, all of which would lead to the development of maritime transport in general. There is consensus among those concerned with maritime issues on the importance of this type of education and its increasing role in the modernization and development of maritime transport. Consequently, a lot of discussions about the importance of developing maritime education are going on and many conferences have been held or are to be held in this regard; not to mention quality assurance entities which pay great attention to this issue as well.

The question that should be posed is: What is the final product desired from maritime education and learning? The exact specification of the desired final product of the educational process is the basis upon which we shall determine the components of this process, such as the curriculum, the instructor, the buildings, the equipment and the educational/ tutorial methods…etc. Therefore, we need to determine which type of instructor we shall admit to the classroom, what curriculum our students shall hold in their hands and minds, which institutional components shall help them release their energy and interact with the reality in which they live. In addition, our youth needs to acquire technical credentials through the educational process that would qualify them to get access to the labor market with competitive skills and good competence, as well as enable them to initiate innovative projects in which they appreciate the significance of work and maintain honesty in performance.

To this end, the pivotal question persists: what final product is desired of the educational process in maritime education institutions? If we, in this association, are seeking to achieve this product, it is logical then to ask: Are our instructors at the moment in our maritime academies qualified enough to help our students become this desired product? Are the form and content of taught courses in our institutions right now qualified enough to equip our students with the required skills and work systems? Do our maritime educational institutions provide its members with the effective means to express themselves, to exercise critical thinking and to consolidate the culture of marine safety, maritime security and marine environmental protection?

There are a number of complex interrelated elements that control the educational process in maritime institutions: instructors, students, educational curricula, buildings, equipment and others; all of which must be treated with the same degree of attention and consciousness. However, the unavoidable perfect starting point, as long as the quality of education is assured, is to generously finance the education process. Such expenditure is imperative to improve the quality of education. By increasing the financial budget of the educational process, we would be able to generally improve instructors' conditions, to qualify them and to keep his good social status, all of which would not make him run away from the educational process. The same principal applies to students who currently need to develop their skills to pursue the requirements upgrade within the local and global job market.

Increased expenditure on education is an imperative necessity to expand, to improve the quality of services in maritime education institutions and to develop the quality of education. There is no doubt that education and scientific research in general are two of the most important means by which progress and industrial, economic, cultural and civilian growth are to be achieved. This statement is also applicable to the maritime domain. The administration of maritime education and training and scientific research in the maritime domain is closely related to quality management systems and standards. Being an unusual business that cannot afford making mistakes, there is a dire need for this administration to show precision and skillfulness in extracting, analysing and interpreting the results.

Envisioning education through the participatory approach as one of the key elements in the development of personality of the learner, there are interactive means by which a creative and innovative generation can be built. In this approach, education aims at:

1. Providing learners with knowledge and information relevant to their scientific and cultural needs.
2. Enabling learners to acquire different skills in order to discover those talented, to sponsor them and to develop their creative thinking abilities.
3. Raising learners' awareness and interest by applying their knowledge to reality.

4. QUALITY ASSURANCE AS A CURRENT DEMAND

It seems that the concept of "quality" is quite ambiguous; an ambiguity that is relative to it being part of a modern culture; therefore, the time has come for such a concept to be dealt with more seriously. Quality assurance should originate from a reading of the situation these educational institutions are experiencing themselves. This mission is to be carried out via the self-study and the self-assessment of the performance of these institutions which requires putting into action the culture of objective and transparent self-examination and critique. This process starts off from not surrendering to following classic curricula, drifting behind the stagnation of thought, absence of instructors, student negligence of attending conferences, and non-activation of office hours to other forms of negligence which cannot be monitored except through self-censorship.

The real challenge that persists when we demand quality assurance is generating new sources of finance, starting from the community partnership of businessmen who are interested in maritime issues and maritime transport to the civil community institutions and the maritime community, to maintain supporting scholarships and scientific research in order to enrich the academic arena. This highlights the importance of the role to be played by the sectors of both the civil community and the maritime community.

Consequently, quality assurance has become a demand of the current phase; a demand that is governed by competitiveness, accumulation of knowledge, successive scientific revolutions, the widening gap between underdevelopment and development, and meeting market needs of required skills and qualifications. Quality assurance of education has become a global culture to an extent that no nation should lag behind; it is a strategic choice not an option.

5. DEVELOPMENT OF EDUCATION IN THE GLOBALIZATION ERA

By the beginning of this century and in face of the enormous scientific and technological revolutions, it is necessary to counter such challenges with an educational system that assures quality and provides the opportunity to obtain educational experiences that meet the immediate and future development demands of shipping and maritime transport on all levels. Therefore, maritime education has become the essence of the development process, as well as the foundation upon which maritime transport is based. It is no longer enough for education to depend upon transferring experience from instructors to future generations since the future holds many challenges. Hence, it is necessary to arm our youth with capacities that enable them to deal with problems and scenarios that we have not faced or even the possibility of their occurrence.

The concept of education, in general, and of maritime education, in particular, has dramatically and comprehensively changed in this era of globalization – an era that is controlled by the technological revolution and the potency of the electronic pod "herd" – where total knowledge replaced stenograph and education is no longer limited to educational institutions and formal study phases but rather a continuous process of learning. Education has become the main drive behind the development matrix, in general, and the development of maritime transport, in particular. It is the effective means to equip humans with experiences and capacities in order to hunt employment opportunities, which is the pillar of development.

6. MARITIME EDUCATION

Maritime education is the process that provides seafarers at both the operational and management levels of the shipping industry with knowledge, attitudes and skills necessary to perform the various duties in the sector of maritime transport. Maritime education can be defined as a series of interdependent processes of teaching, learning, researching and investing in resources including the human element, material and information that interact harmoniously to carry out chosen educational objectives. The influence of the human element is paramount. The human element is a very important factor in the process of carrying out the various functions within shipping companies. The human element plays the most crucial role in almost all operations at sea and ashore. The significant task of the entities providing this human element with maritime education should be highlighted. These human elements should be highly qualified, well motivated and stimulated, and offered later on a work environment and suitable compensation that consider their high qualifications and support them in their professional responsibility.

The constant development of the shipping industry requires the development of maritime education. The development of maritime education should thus keep pace with the development of the shipping industry which includes both developments in technology and in the science of maritime management. Under the tutelage of educational maritime institutions of developed maritime nations in the 21st century, the new mission of education is to endorse educated personnel who are of a quality that is far beyond the minimum requirements set by IMO, and to encourage them to have an international perspective that would enable them to contribute to all aspects of maritime transport management. The accelerating development of shipping industry necessitates the evolvement of maritime education and confronts it with many new requirements, such as the requirements of further fostering seafarers' practical skills and proficiency.

6.1 Maritime education and development issues

Any developing project cannot be carried out without the availability of high efficient manpower; in addition, the level of preparation and qualification of that manpower matches level of the maritime education system in which they studied. Thus, maritime education systems are responsible for the development of manpower as well as handling the issues related to the development of the maritime community and shipping. Some of these development issues are:

1. Attending to environmental issues, in general, and the development and saving of the marine environment, in particular.
2. Keeping up with scientific and technological progress since we live in a revolutionary exception.
3. Keeping pace with changes to the labor market, imposed by the economics of globalization and the revolution of knowledge via the preparation of qualified cadres.
4. Attending to unemployment issues in the maritime domain; a serious issue that is resulting in social and economic crises in many countries of the world.
5. Financing issues related to provision of expenditure and to finding alternative financing sources so as not to lose the important role of maritime education.
6. Marketing of maritime education since it is possible to develop education via international marketing.

7. SHIPPING AND MARITIME TRANSPORT

The purpose of shipping is to provide a profitable service. Maritime transport is a global industry and will always respond to radical political, economic, technological as well as educational changes. Shipping is a service that economists prefer to think of as "Capital intensive". This is not due to the tremendous costs of the developed equipment used but due to all of that its personnel and workers extraordinarily endure to handle and manage this equipment safely and productively in the inimical environment that never changes. The provision of skilled and experienced personnel and workers for such a context along the long-term requirements of the global industry is a difficult issue that encounters owners in every shipping center all over the world. Since antiquity, the spirit of man could not be confined to a country's borders. It has been noticed that shipping has continually served humanity in trading and in exporting civilization along with goods. It has been observed in the field of the shipping industry that technical innovation develops very quickly. In fact, the progress of the shipping industry and related issues has been affected by the improvement of maritime education. The principle for maritime education is to guarantee the quality of seafarers who are to face the future demands of this global industry. In fact, the progress in shipping industry and the related issues (maritime transport) have been followed by the improvement of maritime education.

Shipping industry and maritime transport are among the most multifarious and global services in the world; it is a truly global market. The shipping industry so far is characterized by an infinite set of rules and regulations that have taken away the selection process of crucial personnel from employers and handed it over to regulators. There is very little to show that these changes have so improved the industry's personnel that can be content with the progress made.

The navigator of the future will become the manager of the system. He may also be required to undertake certain manipulative tasks simply because it is less costly and equally efficient to use a human under certain circumstances. It seems that innovation and automation will in any case call for a different set of skills from those traditionally learnt by seafarers. The essence of and the objective on which all maritime education experts approve is seen as serving the shipping industry and maritime transport and as improving the efficiency of the operation of shipping, on one hand, and developing employability of maritime academies graduates that propounds avocation in the maritime field and industry as a whole on board ship and on shore, on the other hand.

8. MARITIME EDUCATION AND MARITIME TRANSPORT

Good maritime education is peremptory to the success of maritime transport. Thus, its job is to educate and train candidates to approved levels of that industry. Eventually, it is expected that people in the field will update their knowledge regularly. Due to its nature, the maritime industry is subject to a global concession. In spite of this, global compatibility of maritime education standards have became a challenge. The prosperity of the maritime industry is bounded by the harmony among its people who belong to different nationalities, different cultures and different backgrounds, yet they show evidence of excellent team work and efficient cooperation.

8.1 The Importance of Maritime English as the Language of Maritime Industry

With regard to SOLAS Convention, Chapter V, Regulation 14 *"Ships' manning"*, Paragraph 3 and Paragraph 4:

Paragraph 3: “On all ships, to ensure effective crew performance in safety matters, a working language shall be established and recorded in the ship's log-book…etc.” Paragraph 4: “On ships which chapter 1 applies, English shall be used on the bridge as working Language for bridge-to-bridge and bridge-to-shore safety communications …etc.”

Maritime English, the language of the sea, is required in today's shipping industry. It is very important for the future development of both maritime education and maritime transport. Once we ensure it is effectively taught to our students, whether on the undergraduate or the graduate levels, we would thus fulfill the new provisions of STCW and SOLAS Conventions and accordingly the requirements of maritime industry and maritime transport. This successively affects the structure of maritime English courses, curricula and all related issues. MET institutions should excel in designing the syllabi for teaching maritime English, and maritime English course designers should find the most operative ways to teach the said language.

9. THE ASPIRED ROLE OF MARITIME INSTITUTIONS

The identity of maritime education institutions has seen light many decades ago in order to meet the educational, scientific, economic, and research needs of the maritime transport industry; an industry that is as ancient as human civilization exhibited in the development of ships, their types, ships tong, and kinds of cargo…etc. These educational institutions embody the processes of change where its role in the maritime community is to innovate, perceive the new, transfer and formulate knowledge, achieve harmony and adaptation between knowledge, on one hand, and the means to obtain it and use it in the present time and in the future, on the other hand. Maritime education institutions are not merely established for education and training. They play a central and crucial role in identifying the maritime community and developing the sector of maritime transport, providing suggestions and solutions and contributing to the development of the marine environment. Maritime education institutions with all its sectors, educational, research and training, enable all members of maritime communities or maritime transport to achieve the maximum possible benefits, using means and methods of modern technology. Maritime education institutions have the responsibility to hand over efficacy courses that meet the needs of the individuals, of the shipping industry as well as of the maritime transport. Maritime education institutions, which are responsible for tutoring, should connect educational procedures to the shipping industry in order to ultimately attain a constructive practice that avoids problems resulting from new technologies, changes to international conventions or new trends in international transport. The role of maritime education institutions is important in the delivery of higher education. They have an active and crucial role in diversifying and forming graduates' attitudes, professionalism and effectual performance. In these days, the discussion in all maritime education institutions revolves around originating a new maritime education program that puts into action effectual teaching tools that meet global standards as well as the demands of the shipping industry and maritime transport, and that provides its applicants with vision, care and professional mobility founded on developed high technology. Some of these institutions apparently desired to provide national and international shipping industry with well educated personnel. It is clear that not every maritime education institution can be the most splendid but that every maritime education institutions can yearn to realize the properties of quality maritime education. Institutions of higher education trigger change processes in any community since their role in the society – in addition to the educational and training role – is to innovate and implement innovations, and to transfer knowledge by providing the means to gaining it in the first place and then to making use of it in both the present and the future, in addition to initiating and supporting research and providing assistance to all activities in the surrounding community. Everywhere, universities – as well as maritime education institutions – try to meet and carry out some objectives, namely welfare, social systems, intent, and truism. Thus, these objectives combined represent the reason behind the presence of these educational institutions. First, these institutions focus on the welfare of the community by preparing its students for constructive integration within the labor market through the acquisition of knowledge and skills which are the means to achieve progress and development, and through developing fields of research and innovation in these communities to enhance the economic force of a particular nation.

As for the social system, these educational institutions help the community to be a "harmonious society" in which different groups exchange references, and also make science, knowledge and technical skills relevant and appropriate. With regard to intent, these academic institutions study life assumptions as defined by the community, looking at it from the different world views, old and new, and reorganize data according to the new and different standards. Consequently, these institutions have the ability to indicate possible reforms in the society, which is considered the basis for any ushering carried out by nations through their universities and academies to serve their communities. In addressing truism, these institutions will explore the unknown as it is the ordinary system of which humanity is an indispensable part.

9.1 What is the role of a maritime institution in the maritime industry?

One might succinctly express the role of a maritime institution in the maritime industry as to provide students from all levels with the essential material and experiences they need to become "Safe, well-trained seafarers, and good educated employers". The maritime education process is concerned with the educational innovations, particularly those aimed at communicating abstract academic knowledge in a way that is helpful and meaningful to pragmatically oriented professionals and prospective seafarers and employers in maritime affair issues. The dominate innovation tradition learning approaches including internship, and almost a yearlong sea duty.

9.2 The role of World Maritime University

The WMU in Malmo, Sweden was established in 1983 as the center of excellence for maritime education to develop the highest practicable standards in all maritime affairs such as MET, Port Management, Shipping Management…etc, and to provide a mechanism for international exchange and transfer of knowledge and application. Thus, to developing countries, WMU is a development locomotive for maritime transport.

9.3 The aspired role of maritime institutions for working, openness and services

In this modern era, maritime education institutions play a pivotal role in human societies, in general, and in maritime communities, in particular. In the field of maritime industry in many countries, the experiences of some maritime institutions are interrelated with maritime industry institutions. This can establish the former as expertise houses that meet the needs of specialists in the fields of marine engineering, ship construction, marine environmental protection, port management, and shipping management…etc. Moreover, encouraging making research and publishing the results of this research are very crucial to maritime educational institutions. This can be carried out via three means:

1. Exchanging experiences through joint research among maritime educational institutions and leaderships, as well as exchanging visit of academic specialists and staff. This sort of cooperation is vital to attain the scientific progress.
2. Maximizing the benefits of educational scholarship missions and bodies that have received education abroad.

3. Encouraging different civil community bodies, maritime community, and maritime institutions which are interrelated via international, scientific and practical relations to cooperate with the maritime educational institution in these fields.

9.4 Privacy of Maritime Institutions

We can say that academies and universities are generally based on two axes: one moves from a focus on direct presence (the needs of welfare) to a focus on new reality (the call to search for the truth), and the other axe moves from the opposition (the critical side) to the approval (the commitment and contribution of institutions in social productivity). Exerted efforts in achieving the consistency among these functions always lead to searching for unity of purpose as is revealed in the word “uni-versitan” itself. The evaluation of the performance of maritime education institutions, which could lead to development, depends on several points:

1. The independence of the institution and its principal system.
2. Number of courses and grades awarded by the institutions.
3. Life span of the institution.
4. Quality standard of the academic staff, diversity of their experiences, their research achievements, and their intellectual leadership.
5. Quality standard of students and scholars of scientific degrees
6. Institution's entry requirements
7. The content and development of the curricula
8. Quality standard of teaching, instructors and their assistants
9. Quality standard of the administration of the institution, colleges and subsidiary institutes.
10. The range of job opportunities opened for graduates and the extent of support provided to the development of their educational and applied capabilities
11. Quality standards of infrastructure (buildings, parks and services)
12. Quality standards of the financial system, the budget and investment plans, and the available back-up to the institution from all relevant bodies.
13. Quality standard of libraries
14. The equipment and upgrading of computer systems
15. Financing the means for scientific research, equipment and infrastructure
16. Number of academic staff and the available research base on competitiveness
17. Interaction and balance between academic education and sports education.

These standards are primarily based on the concept of commitment to quality, the collective sum of which gives a general indication on the quality of a maritime education institution. These standards compromise all the required influential factors which strongly interweave the advanced and independent academic thinking and the maritime community, and which are key contributors in supporting the educational environment and scientific research inside such an institution.

10. CONCLUSION: VISION TO ACTIVATING MARITIME EDUCATION IN THE SERVICE AND DEVELOPMENT OF MARITIME TRANSPORT

The relationship of maritime education institutions with the maritime industry and with the maritime transport system, and the role maritime education plays in serving and developing the said community constitutes a large part of the strategic pivots of maritime education in the world. A look at the strategic vision of maritime education in many countries, we find that it confirms that the maritime education institutions are cultural and educative foundations whose function is to tutor and qualify as well as to guide and educate. Such a vision stresses the necessity for these institutions to achieve operational coordination as well as the need to interact and engage in participation with and other production and services foundations (represented in the maritime transport foundation).

There are four important and essential issues that must be taken into consideration when discussing the future of maritime education systems in light of globalization and the progress of science and technology. The first of these is the ability of maritime education systems to become a major factor in the development and evolution of maritime transport by exercising the triple economic, scientific and culturing function. The second issue is the ability of maritime education systems to adapt to new trends in maritime transport. The third issue is the relationship between the system of maritime education and the State – represented in the maritime transport sector – and the balance between State maritime education and private maritime education, existing in some countries. The fourth issue is the ability of maritime education systems to spread the values of openness and mutual understanding with others.

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Compulsory Simulator Training Stages for Deck Cadets

Eugen Barsan
Vice Rector Constantza Maritime University,
ebirsan@inbox.com

Codrut Muntean
Assitant lecturer, Constantza Maritime University,
codrut.muntean@gmail.com

Abstract: For the maritime officers, the most important issues that we have are insufficient knowledge of the capabilities, and limitations of the electronical equipment especially regarding the use of ECDIS. Other identified problems are overconfidence in own capabilities, poor team work, lack of good knowledge of the maritime area that own ship is sailing on, and insufficient or severe lack of knowledge of the ship's characteristics.
In our paper we are trying to address these issues, in the form of simulator scenarios that use the participants' knowledge and teamwork skills to the limit. During these exercises, up to seven virtual bridges are used to provide a realistic feeling of stress and sensorial and intellectual fatigue. The aim is to encourage team work and improvement of individual performance, as well as a realisation of own limitations and the limitations of the available equipment.
With the compulsory new requirements imposed by STCW we extended the navigation simulation stages also to our students from the second year of study. Based on the experience that we will achieve this academic year, we will see if a familiarization with the SHS will be suitable to start from the second semester of the first year of study.
Keywords: maritime training, deck officers, cadets, simulation, maritime students

1. INTRODUCTION

The maritime trade industry along with the maritime transportation of goods and persons, have long been considered of strategic importance for the economy of any country. The reason is: no country is self sufficient, nonetheless because it requires raw materials or specific processed goods from another part of the world; or simply because it takes part in the open market intrinsic activities. Thus, there will always be a need for shipping large quantities of cargo, especially over large distances. As lucrative or strategically important the shipping industry may be, it also presents unique dangers and challenges both to the ship herself and to her cargo. Among these the most common are: the act of God, piracy, pollution and human error (that be can and usually is the cause for most incidents and near misses on board ships).

Over time a lot of energy and effort had been put into developing or adapting existing reliable technologies that are able to neutralise or at least diminish these risks. It is rather unfortunate that most of these developments were processes of trials and errors, but end result is that today's newly built ships are incredibly safe and easy to operate.

However these technologies took a long time to develop as the need for them became apparent after major incidents occurred that was so severe, that international legislations had to be changed. These new laws usually enforced upon the ship-owners the use of modern ship equipment for navigation, safety and security purposes, and set standards for minimal equipment function level.

Despite the never ending advances in computer based navigational systems, integrated bridge consoles, and modern communication equipments, together with an ever more stricter standards of training for maritime officers and ratings, every year brings a new and rather surprising high number of marine casualties. Naturally each of these incidents is investigated and, most unfortunately, usually the fault lies with the person (or persons) responsible for specific operations (i.e. holding the watch, cargo operations or other). That said just as the equipment producers have come up with redundant systems that almost never fail, so should the maritime training centres try to identify the means by which the human element on board ships could be improved in its performance.

We at Constanta Maritime University (CMU) believe that the answer lies with rigorous training and selection of the future maritime officers along with continuous training programs afterwards in collaboration with shipwoning companies. But the training programs should be better adapted to suit the needs and requirements both of the students and their employers [1].

2. THE STUDENTS

From the very beginning of this article we would like to emphasise that at CMU we consider the initial training period as an integral part of any person's professional career and life as an maritime officer. Because of this we are trying to identify heir specific needs and requirements by conducting research programs and paying attention to other similar programs that are undergoing in other training centres. One interesting find is that in recent years, there are an ever increasing number of students that are the very first in their families to take up a career as a mariner. Even more surprising is that some of the come from communities that have no traditions or experiences related to ships or seafaring. They are attracted by the prospect of earning large amounts of money relatively early in life and starting a private enterprise on their own, and generally have an idyllic image of life on board. Very few of them desire to reach a managerial position, and even fewer envision retiring after having a successful career as a master [2]. Unfortunately however, these students have also the largest percentage of dropouts. We also consider them as having a higher risk of becoming depressed later in life for not having achieved their goals and thus become more accident prone. For these reasons we are encouraging former students now chiefs mates or masters, and teachers in our staff who have senior experience at sea to interact with the students. These interactions usually take place as seminars on topics ranging from what are the absolute necessities that must be in the bag when leaving for a voyage, to how life on board a ship is and how to interact with persons of different culture. Generally speaking they are given great liberty in their choice and developments of topics and this is why these seminars are so popular.

Another interesting find was that we had to adapt our teaching methods and to some degree change them to suit the mentality and skills that the students now commonly have [3]. It is a common belief in Romanian universities that the student's training level prior to the admission is at an all times low. Nonetheless we have found that these students are somewhat different from the ones that were in our classes only 10 years ago. They are more computer orientated, because they use their pc intensively especially for entertainment purposes. It is because o this that the more abstract and theoretical topic do not especially appeal to them. We do not mean to imply that we have renounced important parts of the teaching syllabus such as mathematics, or maritime law. We are simply stating that we have discovered that students react better to lessons that have practical applications. Especially the students that are studying to become maritime deck officers become more attentive especially interested when they reach that part in their training that relies heavily on simulations [4]. This is why we are considering the introduction of simulator training exercises for students in their first year of study, although there are some concerns related to the overuse and costs of maintenance and use as well as available time schedules.

The simulator training exercises are of varying difficulties, from simple accommodation routines to the more advanced exercises that are inspired from regrettable real life maritime incidents, which we analyze over the years. Such scenarios may include collision avoidance, coastal navigation into or in proximity to shallow waters, and dangers to navigation. They may include also navigation during rough seas, or stormy weather, or navigation in waters that are notorious for their heavy traffic, such as the English Channel and the Asian waters. The primary objective is the student's familiarisation with the navigational equipment such as the ARPA radar, the ECDIS, VHF emitter/receiver, ad of course different types of ships. They use these equipments in a controlled virtual environment, they learn its limitations and weaknesses so that when they go on board a real ship they will have a much easier job at adapting to the life as a seamen. Also, most of these exercises have a requirement that most if not all communications are done in English, primarily using the Standard Maritime Communication Phrases.

During these exercises we are interested in showing them their own limitation by putting them through difficult situations where they can not multitask, and have to work as a team, and delegate responsibilities between them. During such exercises, they are expected to communicate with different stations or ships (usually instructors or other student teams), while dealing with other problems such as heavy weather, heavy traffic, a wide variety of alarms or equipment failures, or faulty information that has to be filtered or compared with information obtained from a different source [5]. Furthermore, we are about to integrate de engine and the bridge simulators, along with the cargo simulators, thus the complexity and realism of the exercises is vastly improved.

In the last year of their studies, we concentrate on their training as maritime officers [6], with courses specifically designed to address matters such as the planning and executions of a maritime voyage, loading stowage and unloading operations for liquid and dry cargo, together with more special applications of the maritime law regarding ship operations in port and at sea.

As an element of novelty we are also looking for the possibility to include special procedures for pirate boarding avoidance manoeuvres as part of these courses and of the normal curricula as well. As piracy acts are becoming more an more a commonality [7], and as international efforts are getting more and more efficient, it is still the job of the officer of the watch to take the necessary actions to prevent pirates from boarding, at least until help arrives. These theoretical seminars would then be rehearsed in simulations [8]. The evasive (escape) manoeuvres are similar with the ones used in the Navy. For this training we have to take into account the limitations imposed by the own ship speed (that in most cases is inferior of the speed of pirates boats) and the maximum angle of ruder that can be used for zigzag manoeuvres in order to prevent violent bends of the ship that can damage the cargo. In order to increase the chance of success in discouraging pirates boarding, escape manoeuvres must start as soon as the danger of pirates is acknowledged. For this reason, special radar training is needed in order to teach the students how to monitor the stern sector and how to early detect high speed small targets coming from the stern.

3. THE MARITIME OFFICERS

As the men and women that are on board ships they are the eyes and ears of their vessels. They share the responsibility for safely operating the ship and the safety of her crew. Their work relies mainly on their experience, and good seamanship, as well as with a good understanding of company safety and security policy and protocols, along with a good professional relationship with the other crewmates, and an excellent professional conduct.

It goes without saying that to be a good ship officer you have to be an specialist in your area of occupation be it navigation or electrical or engineering, it takes a long time to train and prepare such an individual. And generally speaking after certification to the STCW 98 required levels these individuals are usually more than qualified to do their jobs. However there are exceptions to this rule. We are not referring only to the newly certified freshmen, that are doing their best to prove themselves under the watchful eye of the master, but we are also referring to the more seasoned officers. As stated above these men and women rely on their experience to take decisions [9], experience that would usually be gained form operating on board of tens of ships. Just as this is a blessing it can also become a burden because each ship is unique. From the protocols by which they are operated or handled to intrinsic faults due to operation or technical failures, even sister ships differ quite a lot from one another. This is why ship handing over procedures was developed. The problem is that for every ship that has a proper handing over procedure there are at least tens in which newly arrived officers have only a few hours to take up to speed what kind of papers are due for forwarding and “where is what” on the ship.

This is why CMU is planning to devise special courses in collaboration with crewing and ship owning companies [10] with the aim of reducing the stress of being transferred on a new ship, along with reducing the risk of incidents that can occur with it. We hope to achieve this by including in this programs simulation sessions with a virtual recreation of the ship these officers a going to take on the near future, along with realistic recreations of the electronical equipment they are going to find on board the ship. These simulations are going to include ship handling scenarios in real like ports that their future route are is likely to take them. This way they can practice port entering and exiting operations during day or night or in restricted visibility conditions, in a perfectly secured and controlled environment. This is important especially for ports that have a problematic accessibility due to naturally occurring phenomenons such as wind or tide currents, or because of the particulars of the ship regarding ship length, breadth, size and propulsion or steering system. In addition during these simulations will put great emphasis emergency procedures for prevention of pollution or for reducing the pollution during cargo operations for liquid or gaseous cargos, company and port and/or terminal procedures for cargo operations and ship landing and departure protocols. Also included in such courses will be damage

We are confident that such programs will be vital for officers at managerial positions with special thought for masters, especially masters that are changing the type and size of ships they have had usually commanded.

The indirect, but very important, benefits of such programs are that apart from refreshing their knowledge and reinforcing their beliefs in their own skills, along with a thorough verification of their teamwork skills. Moreover the crewing agencies and the ship owning that are subsequent beneficiaries of such courses and are also provided with detailed progress report of each individual, so that they are well informed about each individual performance.

We are also looking into improving our master programs. It is not a novelty that each new maritime officer is required by the international Bologna treaty to graduate a relevant master and obtain a degree in a relevant area of expertise should he or she desire to be granted a managerial position on board a ship. Until recently, at our university these educational programs were view as a furthering of knowledge that has been previously thought. Although this approach was not entirely faulty, it soon became apparent to us that much more was needed. We are currently analyzing the possibility to implement leadership courses in the syllabus. The idea behind this concept is that even the most professionally well prepared chief mate or chief engineer or master can be hard stricken by the realities of command or the hardness of leading a community of men through the hardships of life on board a ship [11]. For many years, at CMU, the leadership concept was assimilated with the Navy on board discipline and was ignored as part of the training for the merchant marine officers. Some men and women have a naturally developed instinct of leadership, while others do not and usually end up becoming the type of leader that keeps to himself, and remains secluded in his cabin, or when he has to come out and face one situation or another is already unease and has to shout out his authority. Such group leaders are unfortunately common on board ships [12] and to some extent it is expected of them to behave as such. However recent studies and researches in this field have shown that such an approach to leadership is counter-productive. This is why we are trying in our new leadership course, to adapt the classic “best practice” principles to the realities of the multi-cultural crews and cross-cultural interchange that are a day by day reality on board all maritime ships.

In an effort to improve upon such performances, we at the CMU are planning to develop theoretical courses that are comprised of group sociology, leadership classes along with practical exercises that include simulator exercises. These simulations will have objectives that the officers can not achieve only by themselves. They will have a team, made up of variety of persons that will have some training but not sufficient expertise, possibly students that have previous experience with the simulator. The final objective of such exercises should be a quantifiable improvement of how these officers work in a team and a verification of how they implement their newly acquired theoretical leadership skills.

4. CONCLUSIONS

It is said that the world of the maritime trade and transport is full of many immovable traditions. Indeed in many cases such is the truth but with good reasons. From customs such as the cadet's baptism to the OOW`s (Officer of the watch) morning gyro verification with the sun's azimuth or double verification of the ship`s position with different kind of fixes, all of these traditions are now considered proofs of good seamanship. They are considered as such because over time they proved their value, and thus were passed along through generations down to present day, when they have taken the form of protocols or regulations such as COLREG.

However, most if not all these traditions were at on time an innovation, untried or untested, but often the result of a necessity. Whether behavioural or mainly technical in nature, they have shaped the maritime transport industry into what we now today [13]. Nonetheless there is a twist: if we make a comparison between the maritime incidents in the not so distant past, let us say 50 years ago, and the ones in the present we will find that the more recent accidents are almost always caused by "human error" as opposed to the past ones that were mainly caused by "mechanical or equipment failure". This is because every time there has been a maritime disaster due to "equipment failure" it had been followed by a leap in the quality and complexity of the respective systems. This is how all the electronic system that on board nowadays ships is of the highest standard and performance. If the performance of the maritime equipment is the responsibility of the producing companies, so should the maritime educational system take, at least a partial, moral responsibility for how their former students perform. Consequently we, as maritime training institutions must devote a great deal of resources into not just having training program that satisfies the requirements of the STCW convention. Instead we should both meet these requirements and go beyond them, trying new approaches to the maritime training [14].

Of course there is the problem that each individual has his unique personality, and his performance is altered if fatigued and under stressful conditions. They make it almost impossible for any training programs to guarantee that their student will never be participants in a maritime accident. Despite this, a rigorous and adaptive training program may be the key element for ensuring just that. And one of the most important parts of such a program is the simulator training. No longer just a modern way of teaching, it has already become a vital piece of the training experience. Both for the students who have increasingly higher computer skills and more easily acquire new ones by using the simulator complex, and for the maritime officers. Especially important for the later ones, is that it provides them with information about the personal and equipment limitations, which we have found are primary causes of accidents.

At CMU, the maritime simulation training starts in the 3rd year of study. Based on the experience that we will achieve this academic year, we will see if a familiarization with the SHS will be suitable to start from the second semester of the first year of study.

We are looking forward to seeing the results of our programs and share them with the rest of the maritime education and training institutions family, as well as contributing to the tradition of educating men and women for safely navigating the oceans and seas.

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Oil Spill Scenarios in the aftermath of Ship Accidents at the Anchorage Area for the Marmara Sea Entrance of the Istanbul Strait

Ersan Başar
Dr.Capt., Karadeniz Technical University, Faculty of Marine Sciences, ebasar@ktu.edu.tr

Özkan Uğurlu
Lectr.Capt., Karadeniz Technical University, Faculty of Marine Sciences, ougurlu@ktu.edu.tr

Abstract: The Istanbul Strait, which is a part of Turkish Strait System (TSS), is narrow and navigationally risky waterway for ships. This risk increases daily due to oil transportation from Central Asian and Russia. Crude oil tanker traffic is getting denser as the need for the transportation of Asian and Caucasian petroleum increases. In the present work, the risky region of the tanker waiting for in the queue for the Marmara sea entrance of the Istanbul Strait is run for simulations studies. It is assumed that 500 tonnes of medium crude oil may be spilled in the aftermath of a tanker accident. The oil spill is then determined with respect to time and space by considering 2 different dominant wind directions and scale. The simulation code GNOME™ version 1.3.3 is utilized to generate the oil spill scenarios. As a result of these runs, risky areas were identified and necessary actions to minimize the effect of spill were discussed in the Marmara Sea entrance of the Istanbul Strait. Florya and Ahırkapı coast were identified as the high risk areas. In order to minimize the effect on these areas, stocking booms and skimmers at other risky areas were found to be helpful for speedy action.
Keyword: Oil Spill, Istanbul Strait, Simulation, Marmara Sea, GNOME, Tanker Accident, Marine Pollution

1. INTRODUCTION

North western Turkey is divided the Istanbul Strait by a complex waterway that connects the Black Sea to the Sea of Marmara and the Aegean Sea. The channel passing between the Black Sea and the Sea of Marmara is named the Istanbul Strait. Istanbul is positioned at the south end of the Istanbul Strait. The very narrow and winding shape of the strait is more a kin to that of the river. It is an established fact that the Turkish Straits are one of the most hazardous, crowded, difficult and potentially dangerous, waterways in the world for marines. All the dangers and obstacles characteristic of narrow waterways are present and acute in this critical sea lane. The Sinuous geometry of the strait (Figure 1) and the narrowness of some sections make this waterway an extremely difficult passage for oil tankers. These negative effect is also couplet with hydrographical and meteorology of the area.

Particularly for the Black Sea, the Straits are the only water exchange passage with other water mass. However, due to various environmental problems, 52 marine species in the Straits are severely threatened. One of the most serious problems is oil spill, related to ship traffic, because the Istanbul Strait is one of the world's busiest waterways: 50,000 ships passed in 2000, 5 % of which were supertankers more than 200 m in length with a potential carrying capacity of 100 million tons of crude oil. Accidents of shipping in the straits are examined under four categories: collision, grounding, fire and stranding. Each of them has a direct effect on the marine ecosystem. Collision is the dominant type of accidents. It is caused by poor visibility and strong current, which result in navigation failure. One of the largest collisions occurred in 1979 between a Greek cargo ship Evriyali (10,000 dwt) and a Romanian tanker Independenta (165,000 dwt) which carried 94,000 tons of Libyan crude oil. In 1994, the marine environment was seriously affected by the Nassia tanker accident which resulted in the discharge of 20,000 tons of oil into the Black Sea, Istanbul Strait and Marmara Sea. The most recent disaster was caused by a Russian river ship, Volganeft 248 that split in two in bad weather close to Istanbul in December 1999. Some 2,000 tons of oil were spilt into the sea [1].

The Strait of Istanbul is not very convenient for maritime traffic due to the morphological characteristics mentioned above. However, the greatest dangers to navigation are posed by surface and subsurface current, eddies and counter currents. Oceanographic and meteorological conditions that make navigation more difficult in the Strait of Istanbul are currents-counter currents, cross-currents at the bends rain and fog.

Southern entrance of strait is chosen as simulation area. While ships are waiting for entrance, they either anchoring or drifting. Therefore, there is congestion at this location. This increases the risk at accident at this region. It is well known that if there is an accident at this region, there would be oil pollution in the strait.

Transit traffic consists of the goods imported and exported by the Black Sea countries and also at an alarmingly increasing rate, of the oil Liquefied Natural Gas (LNG) and Liquefied Petroleum Gas (LPG). In the past decade the system consisting of the Istanbul and Canakkale Straits with the inner Sea of Marmara in between became a major oil hub of the world energy transportation system [2].

1.1 Current and Environmental Parameters

The Strait of Istanbul is approximately 16.74 nautical miles long, with an average width of 0.81 nautical miles. It is only 0.378 nautical miles wide at its narrowest. The Straits of Istanbul takes several sharp turns. The ships are bound alter course at least 12 times at these bends. At the narrowest point, Kandilli (700 m), a 45 degree course alteration is required. The current can reach 7-8 knots at this point. At Yenikoy, the necessary course alteration is 80 degrees. At the above mentioned turns (Kandilli and Yenikoy) where significant course alterations have to be made, the rear and forward sights are totally blocked prior to and during the course alteration.

Current the Marmara Sea entrance of Istanbul Strait is generally accepted that the flow from Black Sea to Marmara sea Figure 2 [3]. Also, It is know that flow field in the Istanbul Strait has a 2 layer structure [4].

Figure 1. The Istanbul strait.

The ships approaching from the opposite direction cannot be seen round these bends. There is also very heavy ferry traffic in the Strait of Istanbul, which crosses between European and Asiatic sides of the city. There are two suspension-bridges spanning the Istanbul Strait which connects Europe and Asia. Istanbul - Bosphorus suspension bridges 3 miles within the Strait connects Europe and Asia. It is 1074 m long between the legs and has a vertical clearance of 64 m over a width of 400 m decreasing to 58 m at each end.

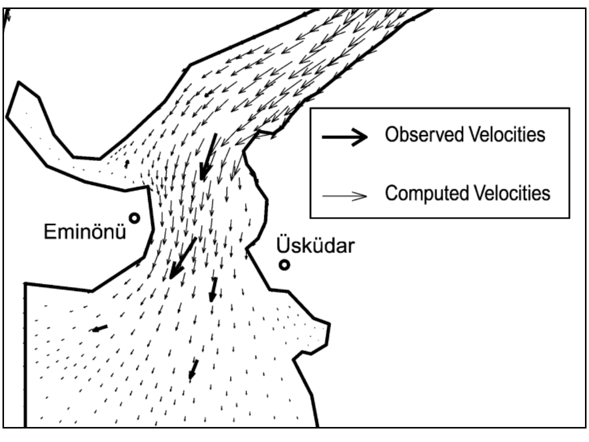

Figure 2. The current in the Istanbul strait entrance. Source [3]

2. METHOD AND SCENARIOS

GNOME™ developed by NOAA was used to simulate spatial and temporal distribution of oil [5]. This software uses wind, tide, and current values to calculate the movement of oil at sea surface [6]. The simulation code GNOME™ version 1.3.3 is utilized to generate the oil spill scenarios. Başar *et all*, simulated risky areas for oil spillage after tanker accidents at Istanbul Strait [7].

Simulations were run for tankers waiting at the northern entrance of the strait. It is assumed that 500 tonnes of medium crude oil may be spilled in the aftermath of a tanker accident. The oil spill is then determined with respect to time and space by considering 2 different wind directions (South and North West) and speed (4 knots and 14 knots) Table 1. The tide is negligible at the strait therefore it is not taken into account [8].

Scenarios was run for coordinate longitude 40° 59' 34" N – latitude 28° 57' 09" E at the Black Sea entrance of the Istanbul Strait (Figure 3). It means that two or three tankers collide at this coordinate after that oil spill starts from tankers. All simulations were running for 30 minutes.

Table 1. Scenarios

Scenarios	Wind Direction	Wind Speed (knot)
Scenario 1	W	14
Scenario 2	W	4
Scenario 3	S	14
Scenario 4	S	4

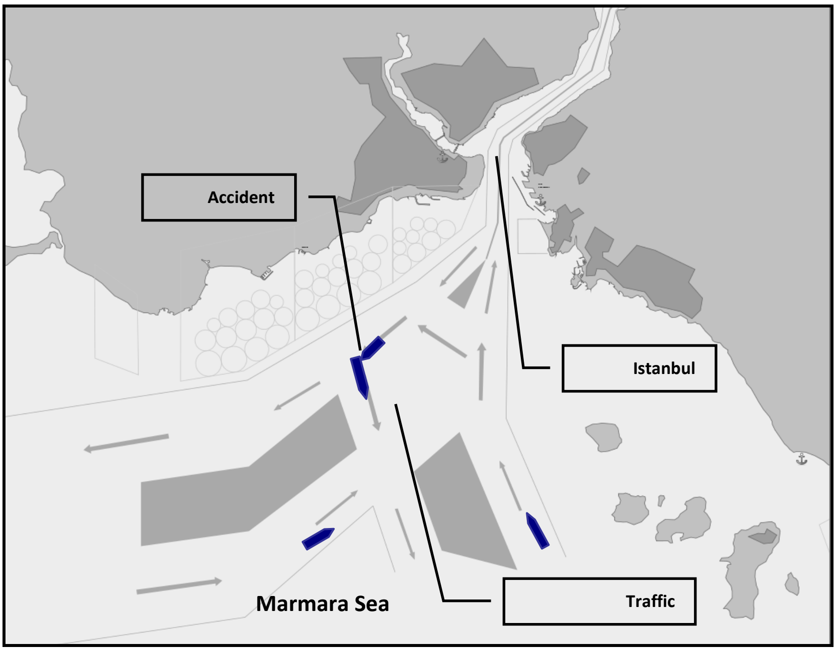

Figure 3. Tankers collision scenarios

In order to input straits data to GNOME, map with Mercator projection was digitized at 1290 latitude and longitude points. Currents data for simulation was input as 50 x 85 matrix with the special format. Current values were u and v (m/s) at x and y directions respectively [9]. The simulation code GNOME^{TM} version 1.3.3 is utilized to generate the oil spill scenarios.

3. RESULTS

The first simulation was run by using 14 knots wind speed and W wind direction at the Marmara entrance of Istanbul strait. As a result of the first simulation, which runs for 30 minutes, the oil spill affected offshore of Marmara sea if necessary action is not taken, oil spill reaches into the Marmara sea (Figure 4). Then wind speed was reduced to 4 knots and the simulation run again. As seen from figure 5, the spill was under the effect of current and gone into the Marmara sea.

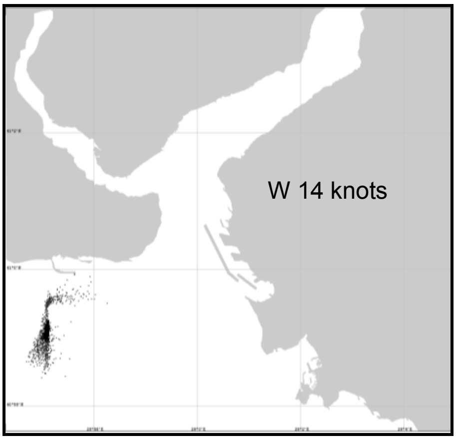

Figure 4. Distribution of crude oil at 1st. scenario

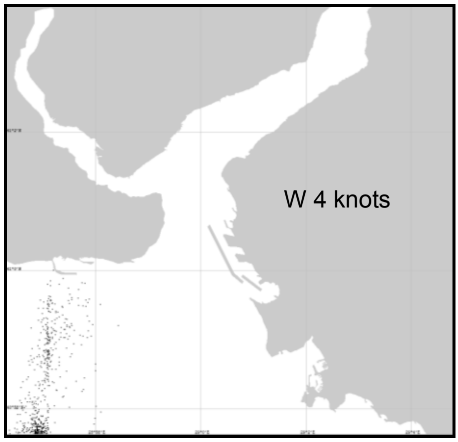

Figure 5. Distribution of crude oil at 2nd. scenario

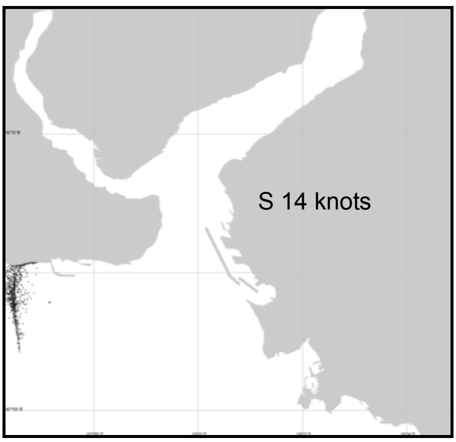

Figure 6. Distribution of crude oil at 3rd. scenario

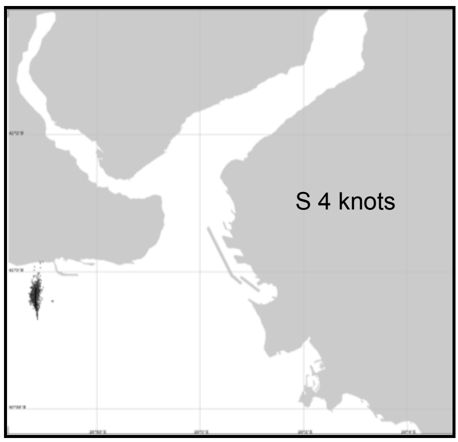

Figure 7. Distribution of crude oil at 4th. scenario

Third scenario was to run with a south wind direction. In this scenario, oil spill effected the north side of the entrance of strait and the oil spill reached Ahırkapı coast line (Figure 6). Also, Florya beached by the oil and it was a fast spill due to wind affect. Forth scenario was to run south wind direction and 4 knots speed. The spill was under the effect of current and gone to the Ahırkapı coast line (Figure 7). Florya beach beached by the oil and it was a slowly spill than scenarios 3 due to slowly wind affect.

All simulations result showed that simulations with south and west strong wind were important to oil spill behavior. The spill affected from Ahırkapı to Florya coast line. These areas were identified as the risky line (Figure 8).

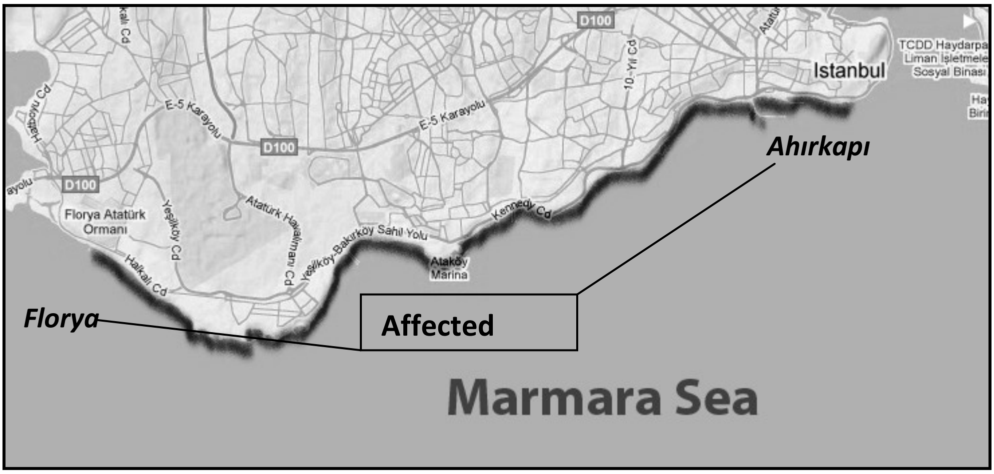

Figure 8. Affected Areas

4. CONCLUSIONS

The ever growing demand for energy in the modern world continues to increase the risks of major oil spills during the lengthy travel of this natural resource along global sea routes. The Istanbul Strait is under ever increasing tanker traffic.

In this study, the movement of the oil spill issuing from a tanker accident has been simulated in the entrance of Istanbul Strait, south boundary. It is show that under the strong wind, oil reaches the Florya coast. It is obvious that this will cause oil pollution in the beach, and cleaning will be troublesome. It is important that necessary action should be taken, if necessary action is not taken, the oil spill reaches to Florya coast in 120 minutes. First action has to be fast and effective with the barrier at accident area, so that it can stop oil spill to reach to Florya coast. In order to act fast and efficiently, stocking booms and skimmers at risky areas is advisable and would reduce the damage and cleaning cost.

Tanker accident risk increases daily due to oil transportation from Central Asian and Russia. Crude oil tanker traffic is getting denser as the need for the transportation of Asian and Caucasian petroleum increases.

We suggest that pipeline system, like Tbilisi-Baku-Ceyhan (TBC) pipeline or planed new pipeline for crude oil transportation, should be used instead at carrying by ships.

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New Simulation Technology for Safety & Security Training in MET

Knud Benedict
Prof. Dr. Ing. habil. Hochschule Wismar Dept. of Maritime Studies / MSCW
knud.benedict@hs-wismar.de

Christoph Felsenstein
Capt. Dr. Ing. Hochschule Wismar Dept. of Maritime Studies / MSCW
cristoph.felsensteint@hs-wismar.de

Michael Baldauf
Prof. Dr. Ing. World Maritime University Malmoe Sewden
mbf@wmu.se

Abstract: New technologies as Fast Time Simulation (FTS) and serious game engine software have great potential for teaching and learning in the maritime training environment and for use on board of ships. New concepts for application of these new technologies were developed at Maritime Simulation Centre Warnemunde MSCW in a research project for training of safety and security elements.

A new type of simulator called the Safety and Security Trainer (SST) was developed in a research project VESPER dedicated to the enhancement of passengers' safety on Ro-Pax- ferries using new technologies of game engines. A 3D-model of such a ship was implemented for full 3-D training environment for scenarios representing fire fighting, water inrush and security measures. An integrated support and decision system, called MADRAS, was interfaced into the SST and the entire system was interfaced to the Ship Handling simulator at MSCW in order to assists officers in coping with safety and security challenges during manoeuvres of the vessel.

The paper will introduce the basic concepts and examples will be given for results from tests in the Maritime Simulation Centre Warnemunde interfacing the full mission ship handling simulator and the Safety and Security trainer SST for complex integrated exercises

Keywords*:* maritime education, integrated training, simulation, safety and security

1. INTRODUCTION - RESEARCH PROJECT “VESPER” AND SST

1.1 Elements of the Research Project “VESPER”

The research project "VeSPer" is dedicated to the "Enhancement of passengers' safety on RoRo-Pax-ferries" and was designed thanks to various initiatives from the German government such as "Research for civil safety" and specifically "Protection of traffic infrastructures". The project is supported by the Ministry of Education and Research, under the aegis of the Technology Centre Düsseldorf (VDI). Hochschule Wismar Dept. of Maritime Studies / MSCW is involved into that project which will be finished in Aug 2011.

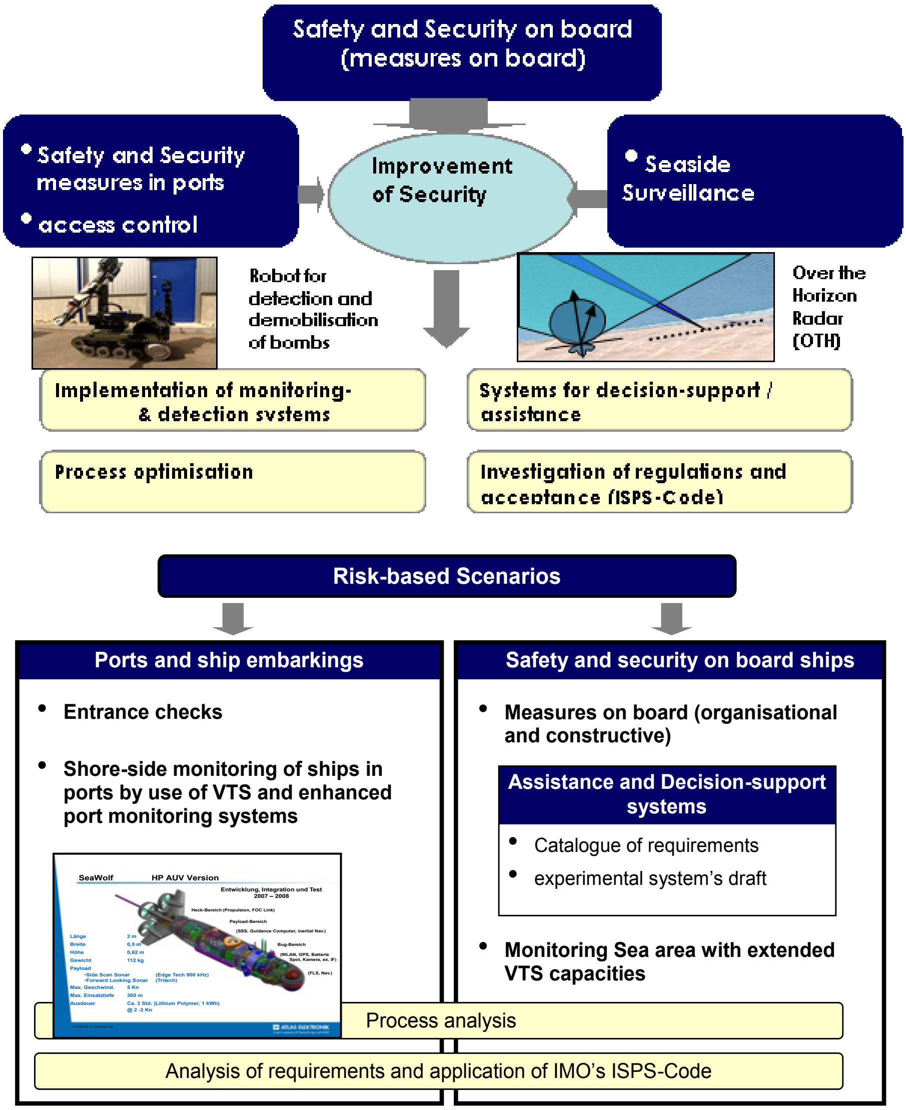

Figure 1. Research project "Enhancement of passengers' safety on RoRo-Pax-ferries" -structure, content and methods

The focus of investigations within the project "VeSPer" is laid on
- check-in procedures to increase the safety level for entrances to ferry ships and ports
- preventive measures on board (constructive and administrative)
- Sea side protection of ships in ports as well as in open sea when sailing
- investigations into potential improvement of measures in the case of a crisis

The analysis and investigations deal with subjects such as:
- use and optimisation of monitoring and detection systems
- aspects of potential integration of decision support systems on board ships
- identification of potential for optimisation of processes and measures/procedures including the integration of new innovative technologies and
- consideration and application of rules and regulations according to national and international law

Aims and structure of the overall project are given in the Figure 1. With reference to risk based scenarios in ports and on board the vessels following investigations are processed
- Process Analysis from entering the port, including booking and check in procedures, on approaching access to the vessel and access of embarkation
- Process Analysis on board the vessel from embarkation/departure until arrival/disembarkation
- Analysis of the ISPS Code and measures for the full integrated application on board
- Measurements for improved processes on board and access to the vessels and developing new security technologies and procedures
- Development of a support decision system for emergency measures on board the vessel in case of safety and/or security casualties

1.2 Initial version of Safety and Security Trainer SST and Overall Concept

From the very beginning of the VESPER project in 2008 it was planned to use the Safety and Security Trainer (SST) which was available as a basic version in the design of 2D-presentation at our Department at that time 0. It has been used for student lectures and courses for shipping companies; this simulator supports specifically the training of management level personnel. Each station consists of two monitors. One screen is called Situation Monitor and the other is named Action Monitor. The workplace, comprises the instructor console and two to sixteen stations, provides full equipment for comprehensive safety and security training. The trainee can freely move through all rooms and decks, previously only in birds eye view. The environment is shown on the situation monitor; the operation of equipment is to be done on the action monitor. The most important characteristic of the simulator is its physical model for the processes:

A fire model is incorporated into the simulator and calculates the fire propagation according to flammable materials and gives obvious realistic effects for easy perception by trainees. A modern fire alarm management system with smoke detectors and manual calling points is built into the interior of the ship and easily flammable materials are protected by fire resistant A60 walls and doors. The fire model includes smoke visualisation and a fire fighting system and equipment such as fire extinguishers, water hoses and hydrants, breathing apparatus, CO2 systems and foam. This enables the trainee to simulate a realistic fire fighting situation on board and interact with supporting teams as well as the management team on the bridge and in the engine room. During the simulation the persons' health condition is monitored in relation to oxygen, smoke, temperature and other health influencing parameters and the measurements are monitored in diagrams

One feature of the simulation system is a model calculating water inrush and its influence to the stability of the ship. A ballast system is implemented and can be used during simulation of an emergency instance to help stabilize the ship. The trim and stability calculator is used to predict the effect of a water inrush and show the stability, bending moments and share forces. Water tight doors are built into the modelled vessel. The ballast and stability measuring system is implemented in the simulator, which enables the trainee to take countermeasures.

2. SPECIFIC SIMULATION FEATURES FOR THE RESEARCH PROJECT "VESPER" IN THE SST-SIMULATOR

2.1 Integration of innovative 3D-visual model of SST

During the project it turned out that it would beneficiary to implement new features for safety and security measures and to take advantage from new technologies like game engines and 3D-modelling capabilities. One of the most challenging innovations developed during the research project is the improvement and further development of the Safety and Security Trainer SST 7, specifically the implementation of the 3D-designed RoPax ferry "Mecklenburg-Vorpommern" (**Figure 2.**) due to the strong ties between the Hochschule Wismar and the industry.

Figure 2. Co-operation between Hochschule Wismar and shipping company Scandlines in VESPER: Ferry "Mecklenburg Vorpommern" as object for simulation in SST and SHS

The first step was to develop an application of the ship plans which were intricately realised in a 3D Studio Max version for test trials of the spectacular 3D-visualisation of the entire vessel. All decks of the RoPax ferry are now available in the 3D-version and integrated along with the dynamic safety equipment into the games engine by RDE. Functional tests of the developed system are in progress and already running successfully. **Figure 3** and **Figure 4** show the 3D visualisation of decks and public areas of the ferry.

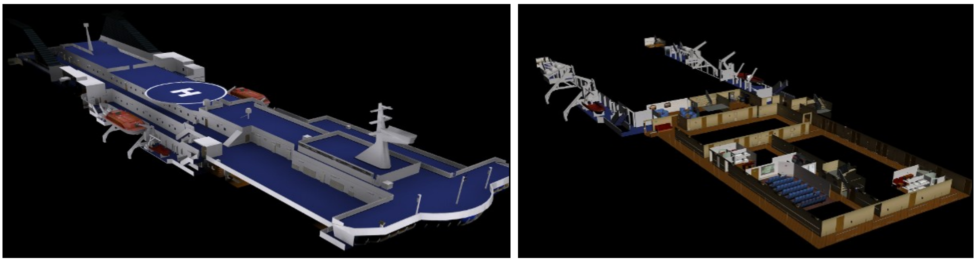

Figure 3. Deck 6 (left) and 9 (right) of the RoPax ferry in 3D visualisation

Figure 4. Public areas of the RoPax ferry in 3D visualisation

2.2 Safety and Security Components in the 3D Visualisation Model

In contrast to the 2D model, where the strategic figure is guided through the decks, now the trainee in the 3D model moves and reacts from his own perspective and can operate the entire spectrum of safety equipment on board the vessel. In the case of fire he activates the alarm from the next manual calling point. According to the safety procedure on board, and after the release of the fire alarm from the bridge, the fire squad team (each trainee with specific role) will operate the fire fighting equipment including the breathing apparatus, fire protection suits, fire extinguishers, fire hoses and other tools (**Figure 5** & **Figure 6**).

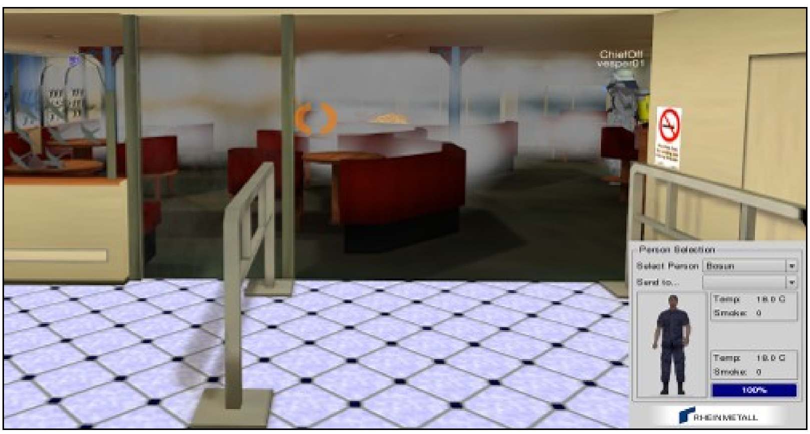

Figure 5. Situation monitor in 3D -Fire fighting / smoke propagation in public area on deck 5 RoPax ferry

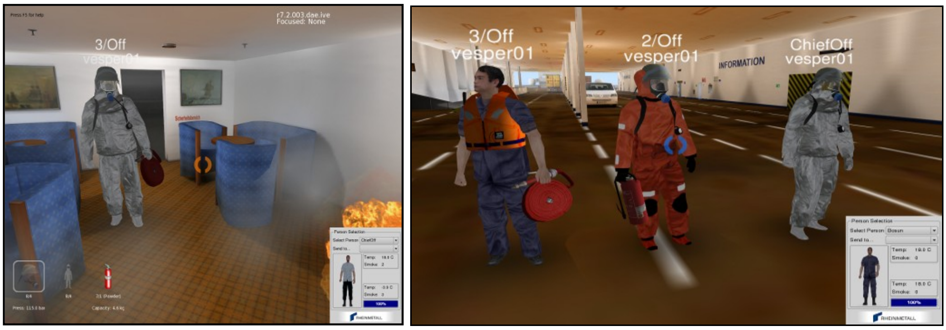

Figure 6. Crew in action with fire fighting equipment in lounge and car deck of RoPax ferry

On the bridge and in the engine control room (Figure 7.) all the operational consoles including; steering panel, fire panel, alarm panel, ballast- and stability panel and the water drenching system, are designed to a generic model and can be integrated on other designed vessels as well. All consoles and panels on the bridge and in the ECR correspond to the integrated sensors placed all over the vessel. The Master and officers operate an interactive board system and can be trained in a wide spectrum focussing on safety and security procedures.

Figure 7. Interactive consoles on Bridge and in Engine Control Room

In addition, the security components can be practised on the new simulator. For example the RFID based appliance, which is integrated into the SST bridge station, enables the officer to observe the movement of persons on board. In all security declared areas the doors are locked and the areas are accessible only by entering the specific code into the lock system beside the doors. On all decks cameras are installed and can be monitored from the bridge station. The camera view can be changed and adjusted by the instructor.

In the case of a bomb alert the crew can investigate the affected area with a bomb detector. On approaching any dangerous object, the detector sounds alarm. Figure 8 shows a crewmember crawling in the direction of a suspicious suitcase. When the bomb has been identified the dangerous object can be removed with a new remote controlled defence system called TELEMAX. This multipurpose vehicle can be used to detect and approach any suspicious objects from a safe distance using the remote control.

The threat of gas attack has also been integrated into the simulation system. In this kind of a threat the crew could approach the affected area wearing protection suits and breathing apparatus and can undertake all appropriate measures, i.e. for ventilation and evacuation of passengers.

Figure 8. Bomb search in the lounge and removal of suspicious object by TELEMAX

2.3 Support and Decision System MADRAS

The simulation platform includes a new support and decision system called MADRAS. This system was designed by the company MARSIG mbH Rostock and especially tailored for the SST simulator and the simulated RoPax Ferry "Mecklenburg-Vorpommern". The MADRAS computer is linked to the SST simulator and receives the sensor data from the SST. The control module selection contains the following elements for automatic survey; FIRE, EXPLOSIVES, SECURITY, EVACUATION, GROUNDING and FLOODING. In the event of any sensor alarm the Madras menu opens and displays the affected deck/area with the activated alarm sensor. The following menus can be selected:

– MONITORING – list of all existing sensors, grouped in different types and presenting the actual data of sensors
– DECISION SUPPORT – recommendation structure and decision advise in specific safety- and security issues including necessary procedures:
– OVERVIEW– deck overview displaying all installed sensors and highlighting the activated ones including diagrams
– DEVICE CONTROL – list of all sensors – according to type, location, showing maximum and minimum values and the adjustable alarm level
– PROTOCOL CHECK– date and time of sensor activation, location loop of sensors, duration of alarm, values of alarm and time record for reset
– CONTROL – menu for sensor connections, support manager, value input, extended functions and system options

MADRAS is an interactive system and is a helpful tool for Master and officers in critical situations. The system guides the officer through all necessary choices and helps in finding the correct emergency procedures. This helps to avoid dangerous mistakes and ensures not missing any steps imperative for the safety of the vessel. MADRAS was recently installed into the SST and is still under development. Test trials are running successfully (see Figure 9 & Figure 10). The basic system of MADRAS was tested on board of the ferry "Mecklenburg-Vorpommern" during the last two years.

Figure 9. MADRAS – Overview of deck and installed sensors, diagram of activated sensor

Figure 10. MADRAS - decision support for security measures and escape routes

3. INTEGRATION OF SST INTO THE MARITIME SIMULATION CENTRE MSCW FOR COMPLEX SCENARIO TRAINING

The new simulator, implemented as Safety and Security Trainer SST, was designed by the manufacturer Rheinmetall Defence Electronics Bremen in co-operation with Wismar University, Department of Maritime Studies ([2] to [4]). The simulator can specifically be used for stand alone and for integrated training with the MSCW. The complex simulation platform Figure 11 with several full mission simulators enables the department to simulate the entire "system ship" with the maritime environment including VTS and offers challenges to officers and crew on board the vessels (http://www.sf.hs-wismar.de/mscw/). The simulator arrangement (MSCW) comprises already

– Ship Handling Simulator SHS with for 4 Full Mission bridges and 8 Part Task Bridges,

– Ship Engine Simulator SES with 12 Part Task station and
– Vessel Traffic Services Simulator VTSS with 9 operator consoles

10 SST-stations are being additionally installed in the MSCW this year (Figure 12): eight training stations (one of the stations on the SHS Bridge 1) and two instructor consoles as well as one communication computer system and another computer for the new support and decision system MADRAS. Each station (with head phones or microphone for communication) consists of two monitors used as Situation Monitor and Action Monitor. Complex scenarios can be developed and trained as for example in Figure 13.

Figure 11. Overview on MSCW (left), Bridge 1 of Ship-Handling-Simulator (SHS) with new Displays of Bridge Safety & Security Centre of SST and MADRAS Decision Support System (right top) and Training room of new Safety & Security Trainer of SST (right bottom)

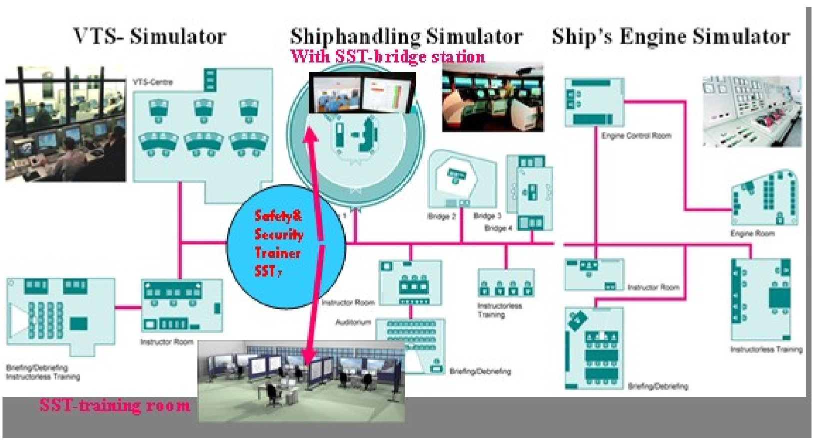

Figure 12. Simulation Centre Warnemünde (MSCW) – structure and interfacing network with new Safety & Security trainer SST

1. SST - Scenario 3D - MECK-POM - Fire in Lounge Deck 7
Objective: Fire Fighting and Training Procedures in case of fire event
Initial Parameter: 3 Fire Cells Lounge activated - wood material, quantity 20kos
Capt., Ch.Off., 02nd Off. on bridge, 03rd Off. in lounge with BA, 2 Passengers in lounge
Ch.Eng., 01st Eng., 03rd Eng. (ECR), 2nd Eng. (Boats Deck)

2. SST - Scenario 3D - MECK-POM - Gas Attack Lounge Deck 7
Objective: Precaution Meausures and Procedures in the event of gas attack
Initial Parameter: Lounge selected under parameter for gas attack - selected gas "Sarin"
Capt., Ch.Off., 02nd Off. on bridge, 03rd Off. located in front of lounge, equipped with HPS and BA.
Ch.Eng., 01st Eng., 03rd Eng. (ECR), 2nd Eng. (Boats Deck)

3. SST - Scenario 3D - MECK-POM - Bomb Alarm Lounge Deck 7
Objective: Precaution meausures and procedures in the event of bomb alarm
Initial Parameter: Lounge selected under Parameter for bomb alarm - suitcase with explosive placed in lounge
Capt., Ch.Off., 02nd Off. on bridge, 03rd Off. located in front of lounge, equipped with HPS and BA.
Ch.Eng., 01st Eng., 03rd Eng. (ECR), 2nd Eng. (Boats Deck)

Figure 13. Sample scenarios for interfacing ship handling simulator with new Safety & Security trainer SST

4. CONCLUSIONS AND ACKNOWLEDGEMENTS

Within the frame of investigations into potential enhancements of maritime safety and security the use of simulation facilities were investigated. The Safety and Security Trainer SST is a new product developed by Rheinmetall Defence Electronics (RDE) Bremen in co-operation with the Wismar University, Department of Maritime Studies in Rostock-Warnemuende. It can be operated in a standalone version for up to eight training stations and could be extended to include the training of the entire crew. The SST is also designed for integration into complex systems and was interfaced now with the existing ship handling simulator SHS of the MSCW for training of comprehensive scenarios in combination with the SHS, SES und VTS. The complex simulation platform with the full mission simulators enables the trainees to simulate the entire ship system and presents challenges to both officers and crew. A new quality of scenarios can be generated now for the comprehensive training of ship officers. On the other hand this new and enhanced simulation facility allows for in depth studies of the effects of ship's safety procedures and to evaluate their efficiency.

The investigations and developments described here are mainly performed in a project for research and technical development funded by the German Ministry of Education and Research Berlin and surveyed by VDI Technology Centre Düsseldorf. During the project also cooperation were established with World Maritime University. This cooperation covers e.g. aspects of international harmonisation of training requirements and standards. The authors would like to thank Rheinmetall Defence GmbH as well as the company AIDA Cruises Ltd and the involved ferry companies TT-Line and Scandlines for their grateful assistance and cooperation.

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Global Awareness, Global Stewardship and the Greening of Maritime Education

Graham Benton
Associate Professor, Program in Culture and Communications
The ABS School of Maritime Policy and Management
The California Maritime Academy
gbenton@csum.edu

Abstract: The 21st century has given rise to an increased awareness of, and commitment to, a variety of environmental concerns. Climatology studies, renewable energy research, and a plethora of reuse/recycle/renewal programs all point to an elevated ecological sensibility. This sensibility is global, multidimensional, and encompasses oceanic and maritime concerns: the design of more fuel-efficient ships, sophisticated ballast water treatment policies and tighter national and international environmental regulations all demonstrate an economic, political, social and technological engagement by industry and assorted government agencies. The primary question facing IAMU member institutions and maritime educators in general, however, may be broader in scope: what is the exact relationship of MET to environmental sustainability? Do we assume a merely reactive stance? Or is there a deeper, more proactive strategy? Is there a means by which we can change the consciousness of students – not just to get them to react and respond to changing technology and policy in an ecologically-mindful world, but to actually understand why these changes are put forth in the first place? This mission of The California Maritime Academy is to provide a college education combining intellectual learning, applied technology, leadership development and global awareness; and the institution has a set of learning outcomes affiliated with these four concepts that every student, regardless of major, is expected to achieve. According to the learning outcome devoted to "global awareness" students must "demonstrate an awareness of diversity in the global culture and environment, as well as the responsibilities associated with promoting the welfare of state, country, whole of humanity, and planet." The implications of this learning objective unfold in a number of ways, not least of which is a concern for environmental sustainability. Global stewardship implies a commitment to the responsible management of world resources (natural, human, and economic) through informed leadership and as such this doctrine assumes primacy as a learning objective at Cal Maritime. This paper explores the efficacy of such a learning objective, the difficulties of developing competencies to assess and measure this outcome, and the vexed relationship between global awareness and global stewardship in the context of politics, ethics, and academic freedom and responsibility. In the summer of 2011 The Cal Maritime Institution-Wide Assessment Council will analyze data from a variety of assessment tools which measure global stewardship, and the findings (both the positive and negative) may be of use to developing similar models at other IAMU institutions.

Keywords: Global Awareness, Stewardship, Maritime Environmentalism, Student Learning Outcomes

1. INTRODUCTION

The title of this paper incorporates a sly reference to Charles Reich's 1970 bestseller, "The Greening of America." In this popular book of the era, the Harvard law professor and prophet of the American countercultural movement wrote that "there is a revolution coming. It will not be like revolutions of the past. It will originate with the individual and with culture, and will change the political structure only as its final act…It is now spreading with amazing rapidity, and already our laws, institutions, and social structure are changing in consequence…Its ultimate creation will be a new and enduring wholeness and beauty – a renewed relationship of man to himself, to other men, to society, to nature, and to the land" [1]. The relative success or failure of Reich's "revolution" is not to be debated here; suffice to say that the climate of 1970 was still open to the idea of rapid, multidimensional change across a spectrum of cultural, social, and political processes. 1970 was also, not coincidently, the year of the first Earth Day – inaugurated in the United States but soon expanded internationally to inspire awareness and appreciation for the earth's natural resources. I bring both connotations of "greening" to the practice of Maritime Education and Training: the idea that a new movement has begun to seed and thrive, and this movement is motivated by an attention to natural resources, particularly within the context of the marine environment.There is little doubt that the 21st century has given rise to an increasing awareness of, and commitment to, a variety of environmental concerns. Climatology studies, renewable energy research, and a plethora of reuse/recycle/renewal programs all point to an elevated ecological sensibility, and the interdisciplinary nature of environmental studies has led scientists of the physical world to the scholarship of political, cultural, and social scientists in order to better understand human relationships, perceptions, and practices as they impact the planet. Prognosticators of the future (and generally cynical prognosticators at that) regularly foreground environmental concerns. For example, in *Hot, Flat, and Crowded*, Thomas Friedman claims that five trends – "energy and resource supply and demand, petro dictatorship, biodiversity loss, climate change and energy poverty" -- will dramatically alter human society in the near future and it is only through interdisciplinary work that we can understand the problems [2]. Oceanic affairs, obviously, play a crucial and primary role in environmental studies, and the rise of programs in marine biosciences, maritime conservation and resource sustainability, marine biodiversity, resource management, water ecology, wetlands ecology, and marine hazardous materials – just in the state of California – makes evident the extent of sustained environmental concern.

2. THE POLITICS OF MARITIME ENVIRONMENTALISM

Maritime environmentalism, therefore, like environmentalism in the broad sense is global and plural in that it draws from the multidisciplinary realms of energy, biology, technology, economics and cultural studies. Moreover, the maritime industry has responded accordingly with the design of ever more fuel-efficient ships, sophisticated ballast water treatment policies, and tighter national and international environmental regulations, all of which all demonstrate an engagement by industry and assorted government agencies.

Even a cursory glance at the International Maritime Organization's "Current Awareness Bulletin" under its "Knowledge Centre" website, which contains titles and abstracts of articles published in the legal and technical press, reveals a great deal of attention to environmental issues which drive innovation on the industry side and policy on the legislative side. (In fact, the very title of this page, conjoining "knowledge" with "awareness" will be of significance for later sections of this essay). An arbitrary sampling of headlines from the February 2011 volume includes the following: "Asia's maritime industry sees benefits of a green revolution;" "A growing green fervor finds its place in the sun;" "Study backs inclusion of shipping in EU emissions trading scheme;" "US states impose strict ballast regulations;" "Saving on ballast water management;" "Hong Kong budget adopts green focus" and "Samsung Heavy to build only eco-friendly ships by 2015" [3].

Additionally, green shipping initiatives are bankrolled by public and private enterprises at a rapid clip. The Environmental Shipping Index (ESI) identifies seagoing ships that perform better in reducing air emissions than required by the current emission standards of the International Maritime Organization. The ESI evaluates the amount of nitrogen oxide (NO_x), sulphur oxide (SO_x) that is released by a ship and includes a reporting scheme on the greenhouse gas emission of the ship [4]. Furthermore, the ESI, as an instrument designed to gauge the environmental performance of ocean going vessels, can be used by all stakeholders in marine transport as a means to improve their sustainability goals and will assist in identifying cleaner ships: "with respect to climate emissions, the IMO has put forward guidelines for the voluntary use of an Energy Efficient Operational Indicator (EEOI) and the Ship Energy Efficiency Management Plan (SEEMP). Both aim for an improvement of the energy efficiency of sea going ships" [5]. Additionally, stricter air quality standards have impact portside, and "Fifty-five of the world's key ports have committed themselves reducing their greenhouse gas emissions (GHG) while continuing their role as transportation and economic centres" through participation in the World Port Climate Initiative (WPCI) [6]. The WPCI thus seeks to influence the environmental liability of supply chains, taking into account local circumstances and varying port management structures.

This greening of the maritime industry, however, is not without complex obstacles and conflicts. There is, of course, the inevitable give and take between industry and government and between environmental agencies and economic interests that beleaguer all such endeavors. To return to the IMO's Environmental Bulletins for 2011, less optimistic legal and technical news items warn us that "Pricey renewables still no substitute for oil and gas;" "Prepare to meet the costs of new ECA;" "$3.6bn green-fuel shock for owners;" "Australian federal government lifts pollution levy;" "Uncertainty after Copenhagen: What now for ship emissions?" "IMO design index faces clash of interests;" and "Brussels questions IMO's ability to enforce emissions trading scheme" [7].

The point here is not to reiterate these deliberations but rather to highlight, in very broad strokes, the opportunities and challenges of the green maritime revolution in its uneven development because the central concern of this analysis is the role that maritime education and training (and IAMU member institutions) can and should play in this context. The primary question facing maritime educators and IAMU member institutions may be posed on a fundamentally philosophic and pedagogic level: what is the appropriate relationship of MET to environmental sustainability within a globalized framework? That is, do maritime educators assume a merely reactive stance (i.e., train for the operation of greener ships, lecture on new environmental maritime regulations, instruct in advanced oil spill response and containment procedures, pass on information on the most recent ballast water management systems, etc.)? Or is there a deeper, more proactive strategy? Is there a means by which maritime education can change the consciousness of students – not just to get them to react and respond to changing technology in an ecologically-mindful world, but to actually understand *why* these changes are put forth in the first place and become agents of change themselves?

The tussle between environmental regulation and economic growth – the give and take between, say, pollution control benchmarks and trade protection measures –will continue to ebb and flow. As green initiatives get played out in this arena, the proper role of maritime education must be interrogated. Discussions about the kind of disciplinary frameworks and traditions necessary to help shape a "green consciousness" -- without running the risk of capitulating to political dogmatism – should be opened.

A turn to the work of Paul Wapner may help serve to ground these questions and issues within a broad social and pedagogical context. In his analysis of globalized political movements – the study of norms, values, and discourse which operate in the global arena outside the domain of states – he first argues from the position that ideas within societies at large structure human collective life and that "transnational environmental groups contribute to addressing global environmental problems by heightening worldwide concern for the environment. They persuade vast numbers of people to care about and take actions to protect the earth's ecosystem" [8]. These groups, bluntly put, disseminate an ecological sensibility.

Now, according to Wapner, this sensibility operates as a political force insofar as it constrains and directs widespread behavior. It works at the ideational level to animate practices and is considered a form of *soft law* in contrast to the *hard law* of government directives and policies. Adherents of "hard law" claim that government action is the key to social change and therefore laws, policies, and directives drive and actually shape social norms. As our laws evolve, the entire configuration of social life will evolve. On the other hand, there are those who claim that social norms (or "soft law") are central to social change. Government decrees, from this perspective, are not the *source* of change but merely a *reflection* of it. "Laws and politics arise out of, or give authoritative expression to, norms that already enjoy widespread acceptance" [9].

When we adapt this observation to the global maritime environmental context, it is seen that widely held conceptualizations animate large-scale practices and this can show how efforts to disseminate an ecological sensibility have world political significance. Once more, Wapner points out that "what makes such efforts political […] is not that they are ultimately codified into law or governmental decree but that they represent the use of power to influence and guide widespread behavior. An ecological sensibility, then, is not itself an answer to global environment threats nor the agent for shifting one state of affairs to another. It is, however, an important part of any genuine response to environmental harm. Put simplistically for the moment, it creates an ideational context which inspires and motivates people to act in the service of environmental well-being and thus constitutes the milieu within which environmentally sound actions can arise and be undertaken" [10].

This last declaration is crucial for an understanding of how one may conceptualize the role of MET vis a vis the ecological sensibility: the maritime university may constitute part of the ground, or the ideational context, which motivates students to act in the service of environmental well-being. The maritime educator is not usually directly involved with writing laws and mandates to shape environmental policy, but the maritime educator does have the ability to disseminate an ecological sensibility which in turn represents a kind of power to influence and guide widespread behavior.

At its core, this idea is one which expresses the need for students to develop a sense of ethics; not only in the context of their vocational pursuits or chosen career, but in their lives in general, and this has become an increasingly powerful and vocal element in dialogues on American higher education practices. The American Association of Universities and Colleges (AAC&U) recently developed five distinct but related dimensions of personal and social responsibility to be integrated into learning goals for the 21st century. These "core commitments" include "constructing personal and academic integrity," "contributing to a larger community," "taking seriously the perspectives of others," and "developing competence in ethical and moral reasoning and action" [11]. Robert Franco more clearly aligns this commitment to ethics to both environmental issues and to a globalized perspective: "This new era requires American higher education to reform its educational programs to prepare an increasingly diverse generation of graduates for engaged citizenship. Now more than ever, all college graduates need to be scientifically literate in topics affecting what [is] called the 'global public square.' More graduates also need to be experts in the interdisciplinary realms where climate, energy, environment, economics, technology, spirituality, and human well-being coalesce and collide" [12]. The means by which an institution can adequately equip students with an environmental sensibility coupled with a sense of social responsibility which can be wielded in the global public sphere may be one of the more crucial facets to monitor and cultivate for educational administrators, and the following section outlines one way that Cal Maritime is grappling with this challenge.

3. LEARNING OUTCOMES, GLOBAL AWARENESS, AND ENVIRONMENTAL RESPONSIBILITY

The mission of the California Maritime Academy is, in part, to provide each student with a college education combining intellectual learning, applied technology, leadership development, and global awareness, and in order to better understand and measure this comprehensive mission the institution recently crafted Institution-Wide Student Learning Outcomes (IW-SLOs). I've previously written about these outcomes and objectives in the context of globalized trends in pedagogical reform in maritime education [13]. One of the difficulties encountered in developing these institution-wide outcomes was how to address the specific maritime focus of the academy and simultaneously encompass a set of more generalized competencies and then to align these with the strategic master plan of The California State University, the Western Association of Schools and Colleges, the AAC&U, and other influential administrative and accrediting bodies. It was the fourth "compass point" of the mission – that of "global awareness" – which spawned a great deal of intellectual argumentation. In the development of our outcomes (informed by current educational trends and drafted by our faculty), a concern for "global citizenship," for "global learning," for "global education," for "global engagement," for "responsible global education" both dramatized and muddied the argument. A rehearsal of that debate may provide insight into the ways that MET may (and may not) seek to address issues of environmental concerns because environmentalism is clearly a manifestation and subject of "global awareness" and is understood as such by Cal Maritime.

The deliberations initially hinged on word usage and linguistic connotation, and this is not a trivial matter of semantics, because the language of the learning outcomes ultimately impact course objectives, curricular development and academic resource allocations. We want our students to be "globally aware," and presumably this means not only knowledgeable in basic geography, but also to be educated in the political structures of various nation states, the myriad cultures of the world, and to possess a fundamental understanding of international trade and international maritime security. Concomitant to this would be an environmental literacy component to include knowledge of global climate change, ocean environmental management, and the like.

Yet, in aligning the mission to the aspired outcomes, language and intent shifted from simple "awareness" to "stewardship;" from "knowledge" to "responsibility;" from "understanding" to "engagement." Not only do all these binaries appear to involve an additional layer of development (one must be "globally aware" before one can be "globally responsible"), but they also imply a shift from the passive to the active: simply put, one can "know" about the earth and do nothing, but one cannot be "responsible" for the earth and remain so. This observation, then, begs the larger and more thorny questions: is it the role of the university to "teach" stewardship in this manner? If so, what does it look like? Do different academic departments even have the same definition of stewardship or the same understanding of what it means to be environmentally aware? Might not the political agenda of a particular faculty member impact the instruction of stewardship? At a maritime academy with close ties to industry, to what extent might radical environmental activism alienate institutional stakeholders? Conversely, might instructors with relationships to industry consciously or unconsciously neglect or ignore certain environmental considerations? Finally, when adopting global stewardship as a learning objective, how do you measure it?

Ultimately Cal Maritime adopted the following language for its student learning outcome:

Learning Objective:	Through participation in curricular and co-curricular learning opportunities, our graduates will be able to:
Global Stewardship	Demonstrate an awareness of diversity in the global culture and environment, as well as the responsibilities associated with promoting the welfare of state, country, whole of humanity and planet

Figure 1. Cal Maritime IW-SLO (K)

Clearly, the language of the second clause of this objective is a bit slippery: we do not require students to "promote the welfare of the planet;" rather, we require them to "demonstrate an awareness of the responsibilities associated with promoting the welfare of the planet." There is a very significant difference. On the one hand, the wording of this outcome neatly circumvents the vexed dichotomy between education as the dissemination of information and education as advocacy for a particular politicized agenda. On the other hand, it might not go far enough into what Caryn Musil would argue is a fundamental objective of education itself: "to engage more emphatically in helping students make sense of the world and of their responsibility to it" [14]. Traditionally, she writes, the university "had firmly ensconced knowledge as value neutral, as something that transcended and was cheapened by contact with the grittiness of life. [Now, however] colleges and universities are seeing the work of the world as inextricable from the life of the mind." One could argue that MET has always bound “the work of the world with the life of the mind” through experiential learning and applied technology. Yet, in terms of binding civic engagement with intellectual learning through the prism of cultivating an environmental consciousness, there may be some ways to go.

Nonetheless, Cal Maritime has pursued the assessment of this global awareness/stewardship outcome: a rubric was drafted and distributed across the campus into all courses which have a ‘global awareness” component [see Appendix I]. These courses were identified by drilling down from the institutional wide outcomes to the degree program outcomes and down further to the course level which was made possible because there is an alignment of student learning outcomes on all three levels (course, program, institution). While the assessment data is still being collected and thus has not been fully analyzed at this point, it is our hope that the findings will tell us something about the state of our commitment to both global awareness and global stewardship, and as a result, our commitment to environmental issues. The primary motivation for the creation of this learning outcome was to assure Cal Maritime was indeed educating globalized citizens. The process of *assessing* this outcome led to a host of other questions: are we preparing students to engage in the world as informed, ethical, socially responsible and productive citizens? How can we weave global education into general education, major courses, and faculty research and development? What exactly does it mean to be a responsible citizen in today’s global context? Is there a balance to be found between nihilistic relativism (“there are many different and equally valid relationships humans have with the world and the seas”) and institutionalized dogma (“there is only one appropriate way to act in all matters of the environment and oceanic ecology”)?

4. MARITIME STEWARDSHIP

If the impetus of Cal Maritime’s learning outcome is animated by the claim of Ernest Boyer that “the aim of the undergraduate experience is not only to prepare young for productive careers, but also to enable them to live lives of dignity and purpose; not only to generate new knowledge, but to channel that knowledge to humane ends; not merely to study government, but to help shape a citizenry that can promote the public good” [15], then the issue remains as to how to specifically share these practices and help inform a wider collective of maritime education and training programs. IAMU member institutions are different sizes, with different student bodies, different accrediting missions, different regulatory overseers and different accrediting agencies, and to espouse a shared commitment to “shape citizenry that can promote the public good” may be a tall order.

Yet, I argue that precisely because we are maritime universities and academies that have joined an international organization dedicated to “developing a comprehensive Maritime Education System for following generations” [16] as stated in the IAMU mission, we have an obligation to educate for social responsibility. This is especially the case given the unique nature of the maritime environment which is not explicitly bound by statist demarcations. If environmental stewardship is defined as “the responsibility for environmental quality shared by all those whose actions affect the environment” [17], then maritime education must necessarily embrace maritime stewardship.

The theoretical underpinnings of these claims can perhaps be deepened by turning to the work of the oceanic historian Philip Steinberg. In “Lines of Division, Lines of Connection,” he first writes that “because the modern system of competitive capitalist production governed by multiple, sovereign states encourages territorialization, or spatial enclosure, as a means of commodifying and guaranteeing rents from resources, the modern era has been characterized by a number of proclamations and events that generally are perceived as drawing lines designed to foster the enclosure, possession, and management of ocean space" [18]. Among these proclamations, Steinberg includes various provisions of the 1982 UN Convention on the Law of the Sea, including both its regime of Exclusive Economic Zones and its regime for management of the International Seabed Area. Steinberg contends that "the overarching norm present through the history of ocean government is one of stewardship. Spaces that are stewarded may not be possessed in full as alienable property. Yet individual social actors – or communities of actors – may in their capacity as stewards to temporarily appropriate, manage, and even transform the stewarded space in order to ensure that it continues to serve specified social ends" [19]. At different times, he writes, "stewardship has been operationalized by one actor over all known ocean space, by individual actors in their discrete, parceled domains, and collectively by a community of actors. It had been implemented for a range of ends, from military mobility to the conservation of the ocean's living resources." Moreover, "debates in modern ocean governance generally have revolved around who should compose the community of stewards and to what ends stewardship should be exercised, rather than being attempts at drawing lines to generate extreme relations of exclusion or connection." And finally, "Oceans may connect or divide, or they may be implicated in more radical strategies for the social organization of space that lie outside the norm of state stewardship that traditionally has guided social intervention in marine space" [20].

5. CONCLUSION

Perhaps, then, MET and IAMU institutions are in a unique position to participate in the social organization of maritime stewardship that lie "outside the norm of state stewardship that traditionally has guided social intervention in marine space." What may energize an environmental sensibility within MET practices is not a transparent and explicitly political engagement (with industry, with government, with environmental lobbyists, although this is certainly part of it), but rather a use of power to influence and guide behavior. A global awareness begets global stewardship which begets the greening of maritime education; not because we necessarily begin at the juncture of answering to marine environmental threats but because we inhabit and create the context which inspires and motivates students to act in the service of environmental well-being.

APPENDIX I: CAL MARITIME IW-SLO RUBRIC FOR GLOBAL AWARENESS/GLOBAL STEWARDSHIP

Analytic Rubric for Global Stewardship			
	Initial (1-2)	Satisfactory (3-4)	Exemplary (5-6)
Spectrum of Knowledge: How much knowledge does the student demonstrate in understanding one's self in relation to the complex identities of others, their histories, and their cultures?	Limited spectrum of knowledge: • mentions some issue(s) involving global concerns and problems, but does not discuss these areas in a meaningful way • contains some evidence of self-reflection in the area of global issues • demonstrates superficial reflection and reveals little or no questioning of established views • has knowledge of cultural differences, but is unable to establish connections with other concepts	Fair to good amount of knowledge in field of study: • thoughtfully analyzes situations in which global issues have played an important role • begins to investigate connections between areas of controversy and to extrapolate meaning from specific examples • applies learning in global issues to issues that arise in everyday life • contemplates the impact of personal choices and social action in the context of interpersonal and broader societal spheres • demonstrates some awareness of cultural, political, economic, and religious differences of the people of the world	In-depth knowledge with extensive variety of resources: • creatively and comprehensively articulates approaches to global issues, citing specific evidence • demonstrates an ability view multiple sides of these issues • constructs independent meaning and interpretations • presents well-developed ideas on the role of global issues in both private and public life • demonstrates a sense of the diverse aspects of culture, politics, economics, and religion
Understanding of Responsibilities: Does the student demonstrate an understanding of the responsibilities associated with promoting welfare of state, country, whole of humanity, and planet?	Lack of understanding of basic global issues, concerns and problems: • lacks awareness of individual's connection to global society and community • fails to understand how global issues and social responsibility manifest concretely in one's own personal choices, including decisions on when and how to act	Good grasp of global issues, concerns and problems: • shows some awareness of individual's connection to global society and community • begins to understand how global issues and social responsibility manifest concretely in one's own personal choices, including decisions on when and how to act	Deep and comprehensive understanding of global issues, concerns and problems: • clearly understands individual's connection to global society and community • fully understands how global issues and social responsibility manifest concretely in one's own personal choices, including decisions on when and how to act

Knowledge: The ability to demonstrate an awareness of diversity in global culture and environment. Understanding: The ability to demonstrate an understanding of the responsibilities associated with promoting welfare of state, country, whole of humanity, and planet.
Scoring
Exceeds standard (total points 10 - 12)
Meets standard (total points 7 - 9)
Approaches standard (total points 4 -6)
Begins standard or absent (total points 1 -3)

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Compliance Monitoring and Enforcement for Environmental Obligations

Capt. Suresh Bhardwaj
Vice Chancellor, AMET University,
capt.s.bhardwaj@ametindia.com

Abstract: Compliance Monitoring & Enforcement (CME) in the regime of Environmental Protection is an absolute necessity. It however remains a subject so little understood, both by the regulators and the regulated, that the real intent and purpose gets defeated. What are those basic fundamentals & principles behind framing of legislations, and its compliance monitoring & subsequent enforcement, how an effective CME is required to be undertaken to achieve the desired results, are the substance & element of this paper. It is pitched at the policy and the legislation designers, implementers / enforcement agencies and the regulated community alike.
Keywords*:* Compliance, Enforcement, Regulation

1. WHAT IS COMPLIANCE

The first step is legislation. Legislation has become the essential foundation for environment protection. Once the legislation is in place, and then the second step is to get the groups that are regulated, to fully implement the requirements. This is Compliance.

What is to be understood is that, achieving compliance usually involves efforts to encourage and compel the behavior changes needed to achieve compliance. This, change in behavior, has always been difficult to accomplish, both, at social and personal level.

2. WHAT IS ENFORCEMENT

Compliance occurs when requirements are met and desired changes are achieved. There is no magic formula for achieving compliance. There is merely trial, evaluation and response to what works and does not work in a particular setting. The key is designing of requirements. If the requirements are well designed, then compliance will achieve the desired results.

Enforcement is a set of actions that governments or others take to achieve compliance within the regulated community and to correct or halt situations that endanger the environment or public health.

Compliance with the nation's environmental laws is the goal, but enforcement is a vital part of encouraging governments, companies and others who are regulated, to meet their environmental obligations. Enforcement deters those who might otherwise profit from violating the law, and levels the playing field with environmentally compliant companies. [1]

Enforcement usually includes, -

(i) Inspections - to determine compliance status and to detect violations

(ii) Negotiations - with those, out of compliance, to develop mutually agreeable schedules and approaches for achieving compliance.

(iii) Legal Action - to compel compliance and to impose some consequence for violating the law as posing threat to public health environment.

Enforcement may also include: -

(iv) Compliance Promotion – for example educational programmes, technical assistance, subsidies etcetera, to encourage voluntary compliance.[2]

The components of an effective Enforcement Programme are: -

a. Creating requirements that are enforceable
b. Knowing who is subject to the requirements
c. Promoting compliance in the regulated community
d. Monitoring of compliance
e. Responding to violations
f. Clarifying roles & responsibilities
g. Evaluating the success of the programme and holding programme personnel accountable for its success.

3. WHY CME IS IMPORTANT

a) It ensures improved environmental quality.
b) It reinforces credibility of Environmental Protection & the legal system that supports them, and,
c) It ensures fairness for those who willingly comply with environmental requirements.

4. ROLE OF CME

To be sure that IMO and individual countries' requirements are properly implemented, it is necessary to have an accompanying mechanism to monitor compliance, and to provide enforcement. CME forms part of the national strategy, designed to establish if a ship has met the IMO and Port State requirements or not, and when necessary to 'enforce' those requirements.

As one of the primary goals of CME is to change human behavior, this involves –

i. Motivating the regulated community
ii. Removing of barriers that prevent not compliance, and
iii. Overcoming existing factors that encourage non-compliance

The basic approach thus being that of 'Carrot', and 'Stick'.

One of the main factors that affect compliance is 'deterrence'. [3]

In a regulatory situation, some people comply voluntarily, some will not comply, and some will comply only if they see others receive a sanction for non-compliance. This phenomenon that people change their behavior to avoid a sanction is called ‘deterrence’. This multiplier or leverage effect makes enforcement a powerful tool.

There are however, 4 factors that are critical to "deterrence".

a. There is a good chance that violation will be detected
b. The response to violation will be swift and predictable
c. The response will include an appropriate sanction, and
d. Those subject to requirements perceive that the above 3 factors are present.

The other factors those motivate or are barriers to compliance can be enumerated as below: -

Factors motivating compliance	Barriers to Compliance
ECONOMIC	
-Desire to avoid penalty	- Lack of funds
-Desire to avoid future liability	- Greed to achieve competitive advantage
-Desire to save money by more	
-Cost-effective & sound practices for resources	- Competing demands
SOCIAL/MORAL	
- Values for Env. Quality	- Lack of respect for env.
- Clear Govt. will to enforce law	- Lack of public support
	- Lack of Govt. willingness
PERSONAL	
-Positive personal relationship with Enforcing authority	- Fear of change
	- Inertia
-Desire to avoid jail/ legal process	- Ignorance
MANAGEMENT	
-Jobs / Training dedicated to compliance	- Lack of accountability
	- Lack of systems
-Bonus / Salary increases on compliance	- Lack of training
TECHNOLOGICAL	
- Availability of affordable technology	- Lack of appropriate Tech
	- Unreliable technology

5. MONITORING COMPLIANCE

Monitoring of compliance is about collecting & analyzing information on compliance status of the regulated community. Monitoring is essential to

a. Detect & Correct violations
b. Provide evidence to Support Enforcement Action
c. Evaluate programme progress by establishing the Compliance Status.

5.1 Primary sources of compliance information

There are 4 primary sources of compliance information

(i) Inspections - Conducted by programme Inspectors. These provide the most relevant & reliable information. However, this can be resource intensive, hence, must be carefully targeted and planned.

(ii) Self Monitoring - self record keeping and self-reporting by regulated community. This provides extensive information and shifts the economic burden of monitoring to the regulated community.

This, however, relies on the integrity and capability of source to provide accurate data.

(iii) Citizen Complaints - Can detect violations not detectable by Inspectors, but, it is sporadic

(iv) Monitoring Environmental Condition near facility - This is useful as can be done without entering the facility, but, many a times it becomes difficult to demonstrate connection between pollution & source.

5.2 Targeting inspections

Inspections thus being the best option, it becomes imperative to target and plan them out; as any enforcement programme, no matter how adequately funded, will never have enough resources.

Several factors are considered when targeting inspection, example,

a. Source's potential to harm environment
b. Complexity of inspection needed
c. Compliance history, and,
d. Availability of self reported data.

5.3 Tiered inspections

Tiered **i**nspection level is another strategy – start with less expensive inspection and take it to more intense level only if suspect.

In other words, incorporation of 'risk' and 'risk assessment' becomes imperative in the CME system. For example in the ballast water regime, risk posed by each ship is potentially different. This depends on ballast water uptake ports. One of the first decisions by regulatory authority is to assess the risk posed by a ship. The Port Ballast Water Management plan determines this risk & enables the CME to be applied in such a way as to target the 'high risk' vessels. This enables a 'selective' approach rather than a 'uniform' application approach of CME.

5.4 Stages of Inspection

Inspections being established as the backbone of any Enforcement Programme, must be carried out in 4 distinct stages of

a. Planning
b. Gathering data
c. Recording, and,
d. Reporting.

The Inspector shoulders tremendous responsibility and his conduct needs to be impeccable. He/she must realize that they are the personification of entire agency. Polite diplomacy thus becomes a mandatory skill. Aggressiveness needs being through a thorough work and not through on overbearing demeanor. Every inspection must be conducted as if it would go to court and hotly contested. Many times the agency's entire case hinges on an inspector's professionalism.[4]

6. ENFORCEMENT RESPONSE TO VIOLATIONS

As a result of the CME process, either

a. the ship is deemed to have complied, or
b. ship has not complied, and an enforcement/ mitigation measure needs to be considered.

6.1 Type of enforcement actions

6.1.1 Remedial Action

-Authority to impose a schedule of compliance
-Authority to shut down an operation permanently
-Authority to shut down an operation temporally
-Authority to deny permit
-Authority to require facility to clean up
-Emergency Powers to enter and correct immediate dangers

6.1.2 Others

- Authority to require specific testing & reporting
- Authority to request information on process

6.1.3 Sanctions

-Authority to impose monetary penalty
-Authority to seek imprisonment (jail term)
-Authority to seek reimbursement for clean-up expense
-Authority to ban facility entry

6.2 Enforcement Mechanism

Enforcement Mechanism is designed to perform one or more of following functions:
-Return violators to compliance
-Impose a sanction
-Remove the economic benefit of non-compliance

-Require that specific action be taken to test, monitor or provide more information
-Correct environmental damage
-Correct internal company management problems

6.3 Categories of Response Mechanism

6.3.1 Informal

Informal response is for example through phones, warning letters, notices etcetera, to violators.

Such informal response advises what violations are found, what should be done to correct it and by what date; the goal being to bring the violator into compliance. It could also be to initiate a legal process.

6.3.2 Formal

Formal response is always backed by law and accompanied by procedural requirements to protect the right of the individual.

6.3.3 Civil Administrative

Civil Administrative is a response directly imposed by the Enforcement Programme Manager. Here, a legal, independently enforceable order is issued. If the recipient violates, then, the managers can take further action by additional order or court system to directly force compliance.

There are two advantages in this system –

a. that it does not require coordination with separate judicial agency, &
b. it can be resolved more quickly & with less expense

This serves a number of important goals, including, returning violators to compliance and deterring misconduct in others, eliminating or preventing environmental harm, and preserving a level playing field for responsible companies that abide by the laws.

6.3.4 Civil Judicial

Civil Judicial are formal lawsuits before the court. These however require more time and more expenses. Nevertheless, they are more powerful and they set precedents.

6.3.5 Criminal Judicial

Criminal Judicial response is evoked when knowingly or willfully the law is violated, or the offence is very serious in nature. These responses seek criminal sanctions, which may include monitory penalties and / or imprisonments.

It is to be noted that for environmental enforcement, this in the most preferred response. It creates the most significant 'deterrence' as it personally affects the lives of people and also it is a social stigma. It however requires intensive investigation & case development, proof of violation & specially trained criminal investigators.

This is used against the most serious environmental violations as well as those which involve egregious negligence or conduct involving intentional, willful or knowing disregard of the law.

7. ENFORCEMENT PROCESS

Foremost comes the protection of basic right. Common to all democratic institutions are processes to balance the rights of the individual; and governments need to act often quickly on behalf of the public.

Notice of violation is issued prior to any enforcement action, with opportunity to contest the findings, appeals & dispute resolutions.

7.1 Negotiations

Negotiations are an integral part of the enforcement process as it sends signal that the government is responsive to concerns and difficulties faced by the regulated community and to work co-operatively to develop satisfactory solutions.

7.2 Creative Settlements

Creative settlements are often used where enforcement is leveraged for broader results. For example,

- Prevention of pollution – an agreement by facility to reduce or eliminate generation of pollutants at source
- Pollution reduction beyond compliance
- Restoration of the damaged environment
- Publicity sponsors
- Training sponsors
- Pay into a Bond account or a Fund.

This however is linked to

- Reduction in monitory penalty
- Extended compliance schedule
- Limited ability to pay
- Strong level of cooperation with Government.

7.3 Categories of Noncompliance

Categories of Noncompliance are

a. a non-compliance that results in a potential risk & a mitigative action is required, or,

b. that does not result in a potential risk

In case of (a) above, the situation must be discussed with the ship's master as soon as possible and action taken that is commensurate with the risk, with a minimum delay to the ship and be safe to ship and its crew.

It must then be ensured that the ship does undertake the mitigation measure, which may call for a re-sample or re-check.

In case of (b) above, when noncompliance does not result in a potential risk, example, a case of incomplete record keeping, the CME process must determine the action considering the degree of offence, potential seriousness, and compliance history of the ship.

7.4 Penalties and Sanctions

This action must have statuary backing.

Penalties and sanctions are proportional to the seriousness of the offence and the risk. This may vary from simple, unintentional and inconsequential to a more serious and deliberate attempt to deceive.

The offence must be confirmed with the appropriate authority, example the ship's master and penalty/sanction applied in accordance with national legislation and consistent with provisions relating to international shipping.

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The Integrated Maritime Education and Research Activity of Gdynia Maritime University for Seafarers

Romuald Cwilewicz
Professor, Gdynia Maritime University,
rector@am.gdynia.pl

Józef Lisowski
Professor, Gdynia Maritime University,
jlis@am.gdynia.pl

Abstract: In this paper, authors describe maritime engineering and technology education, training and research in Poland based on the example of Gdynia Maritime University. The purpose of the paper is to present an integrated educational and training system for professional staff who are capable of meeting the current demands for maritime specialists of any description from ship-owners and shore-based companies of the sea economy. The integration involves the following: curricula, research projects and the development of scientific staff on the one hand and a course on seagoing services, as well as shore-based industrial experience of marine professionals on the other hand. The paper contains the goals and aims of the system, the profile of a graduate of a maritime university and the educational process that is effected through a multilevel structure of the system. The authors conclude by looking at issues that are connected with an improvement of the current system, the establishment of new lines of study, and the quality of the training process with regard to both safety at sea and the effectiveness of shipboard apprenticeship as each year, the world market demands more and better qualified professionals for ship operations, repairs and service.

Keywords: marine education and training, marine engineering fields and specializations, scientific maritime research

1. GENERAL EDUCATIONAL CONDITIONING

The present technical standards of ship equipment require a high level of competence and skills from a professional shipboard officer. This is because, within a predictable span of time, world trends in shipbuilding are set to generate even higher demands regarding the qualification standards of a ship's crewmembers.

Despite the present economically difficult situation in Poland, it is still possible – even necessary – to maintain the number of engineers and deck officers to be educated by Polish maritime schools, although a systematic reduction in the costs of their education has also become another necessity.

The following characteristics should be noted:

- The maritime engineering education process has been implemented in accordance with the Bologna Process embarked upon by the European Union (EU);
- University graduates, as a rule, first find their employment with state and private ship-owners in Poland, and then in the global maritime labour market;
- Maritime studies do not repeat, in any way, the study courses at universities or technical universities because of their specifically marine and operational nature;
- The present premises and teaching staff resources justify the maintenance of the usual number of candidates for studies within the 8 fields in 38 specializations, as well as an increase in the number of paying part-time candidates. Both factors have an essential impact on the reduction of unemployment and an increase in the spread of education in Poland.

The Polish maritime education has built a tradition for the past 91 years, and maritime schools have survived despite difficult periods in the history of the Polish sea economy [6].

2. THE MISSION AND STRATEGIC GOALS

2.1 Mission

The mission of the Gdynia Maritime University (GMU) is to train marine officers for shipboard positions on merchant marine vessels and educate managers for positions at land-based enterprises of maritime industries in compliance with Polish, European and international educational standards by providing them with a solid basis for their professional careers where the awareness of global labour markets is harmonized with developments in the employment opportunities offered in Polish maritime regions, Poland and the EU.

2.2 Strategic goals

The strategic goals are as follows:

- Ensure that students are taught by high quality scientific and teaching academic staff;
- Obtain the rights to award PhD and DSc degrees by all faculties;
- Develop a three-stage Bologna system of studies by offering bachelor or engineer degrees (stage one), master of science degrees (stage two), and doctoral degree (stage three);
- Strengthen the specific maritime profile of the University by developing unique fields, minors and majors of study;
- Attain a balance in the number of students studying within the full-time and part-time systems, with a simultaneous development of postgraduate studies offering new professional opportunities;
- Enhance the development of scientific and teaching staff in those domains that constitute a specific maritime flavour of the GMU;
- Participate in the University's research teams in national, European and international research projects;
- Upgrade laboratory facilities and the quality standards of the University's premises;
- Develop cooperation with national, European and international universities seeking to upgrade educational standards and to undertake scientific research;

- Strengthen the links between the GMU and enterprises, self-government bodies, welfare organisations, as well as regional, national and international scientific and professional associations;
- Strengthen the role of the University as a world centre of maritime education and training.

3. PROFILE OF A GRADUATE OF MARITIME STUDIES

A graduate of maritime studies at the university level is a highly educated specialist who is prepared to work onboard ships, for shore-based sea-oriented companies and the shipping industry. The professional competence of such a graduate may be described by the following characteristics:

- He/she holds the following professional degrees: BSc, Eng, MSc and science degrees - PhD, DSc and Title of Professor;
- Shipboard and shore-based workshop apprenticeship experience, as well as the qualifications that, when combined, make it possible for him/her to apply for a merchant fleet officer's certificate issued by the Polish Maritime Administration (PMA);
- Professional apprenticeship and qualifications to assume operational positions with a sea economy oriented and regional seaside enterprises.

The aim of the integrated system is to optimize the maritime education of professional staff for the needs of the sea economy, with very limited financial resources allocated by the State budget, on the basis of a curricula that is harmonized with the educational standards and requirements contained in the provisions of the International Maritime Organization (IMO), the Ministry of Science and Higher Education (MSHE), the State Accreditation Commission (SAC) and the International Standards Organization (ISO). The system is complemented by apprenticeship experience conducted on simulators and training ships and through wide cooperation with foreign maritime universities.

4. THE INTEGRATED MARITIME EDUCATION AND RESEARCH SYSTEM

Polish maritime universities in Gdynia and Szczecin, apart from conducting their own curricula, have also assumed the role of coordinators in charge of the development and effectiveness of the integrated system of staff education for the sea economy under the authority of the Ministry of Infrastructure (MI) at the following four levels:

4.1 Secondary maritime education, supervised by the MI, covering:

- Basic maritime education;
- Apprenticeship onboard training ships, and the supply of candidates to maritime academies that educate the teaching staff for these schools. Moreover, maritime post secondary schools have been established in response to the needs of the labour market. These schools are both private and state run and offer two-year education courses.

4.2 Graduate studies:

- Two-level, full-time studies in Gdynia that are free of charge;
- Two-levels, part-time, payable studies in Gdynia.

4.3 Postgraduate studies:

- Postgraduate courses in updating and completing knowledge in a particular specialization;
- Permanent postgraduate maritime training for shipboard officers at the operational and management levels.

4.4 Doctoral and Habilitation studies that lead to:

- The Doctoral studies (PhD);
- The Habilitation programme (DSc);
- The Title of Professor.

4.5 Structure of the integrated system

The structure of the integrated system is shown in Figure 1. The essence of the system is its effectiveness in the professional promotion - each level ensures the appropriate coverage of marine competence and performance (deck or engine rating, engineer, MSc, merchant fleet deck or engineer officer, doctor, associate professor and professor). Furthermore, the system enables students to obtain dual marine certificates (navigator-engineer, navigator-electronical engineer, navigator-electrician, engineer-electrician, etc) and also dual diplomas for academic teachers (professor - master mariner, professor - chief engineer, doctor - ship electrician, etc).
This system is based on the following:

- Education financed by the Ministry of Infrastructure (MI);
- Scientific research financed by the Ministry of Science and Higher Education (MSHE);
- International scientific and educational cooperation between maritime academic establishments under direct agreements or within such programme as *Live Long Learning Programme ERASMUS*.
- For example, from the academic year 2011/2012, Gdynia Maritime University will cooperate with 25 European universities, namely: Universidad de La Coruna (Spain), Universidad de Vigo (Spain), Universidad de Cadiz (Spain), Universitat Politecnica de Catalunya (Spain), Universidad de la Laguna (Spain), Universidad del Pais Vasco (Spain), Universidad de Extremadura (Spain), Universidad de Oviedo (Spain), Hochschule Bremerhaven (Germany), Fachhochschule Stralsund (Germany), Rheinisch-Westfaelische Technische Hochschule Aachen (Germany), Helmut-Schmidt Universitaet/Universitaet der Bundeswehr (Germany), Universita degli Studi del Sannio (Italy), Universita degli Studi di Perugia (Italy), Politecnico di Milano (Italy), Kymenlaakson Ammattikorkeakoulu (Finland), Cork Institute of Technology (Ireland), Stord/Haugesund University College (Norway), Lithuanian Maritime College (Lithuania), Latvian Maritime Academy (Latvia), Transilvania University of Brasov (Romania), Universite de Poitiers (France), University of Gavle (Sweden), Yasar University (Turkey), Universidade Tecnica de Lisboa (Portugal), under the *ERASMUS* programme for student and staff mobility in maritime studies;

- For many years, the GMU has been cooperating with over 30 esteemed and renown international maritime academies Europe, as well as in such diverse countries as the USA, Australia, China, Vietnam, Korea, Japan and Russia, to name a few;
- Student apprenticeship on training ships and ships owned by national and international carriers, as well as industrial apprenticeship with shipyards, ship-owner operations and manufacturing plants.

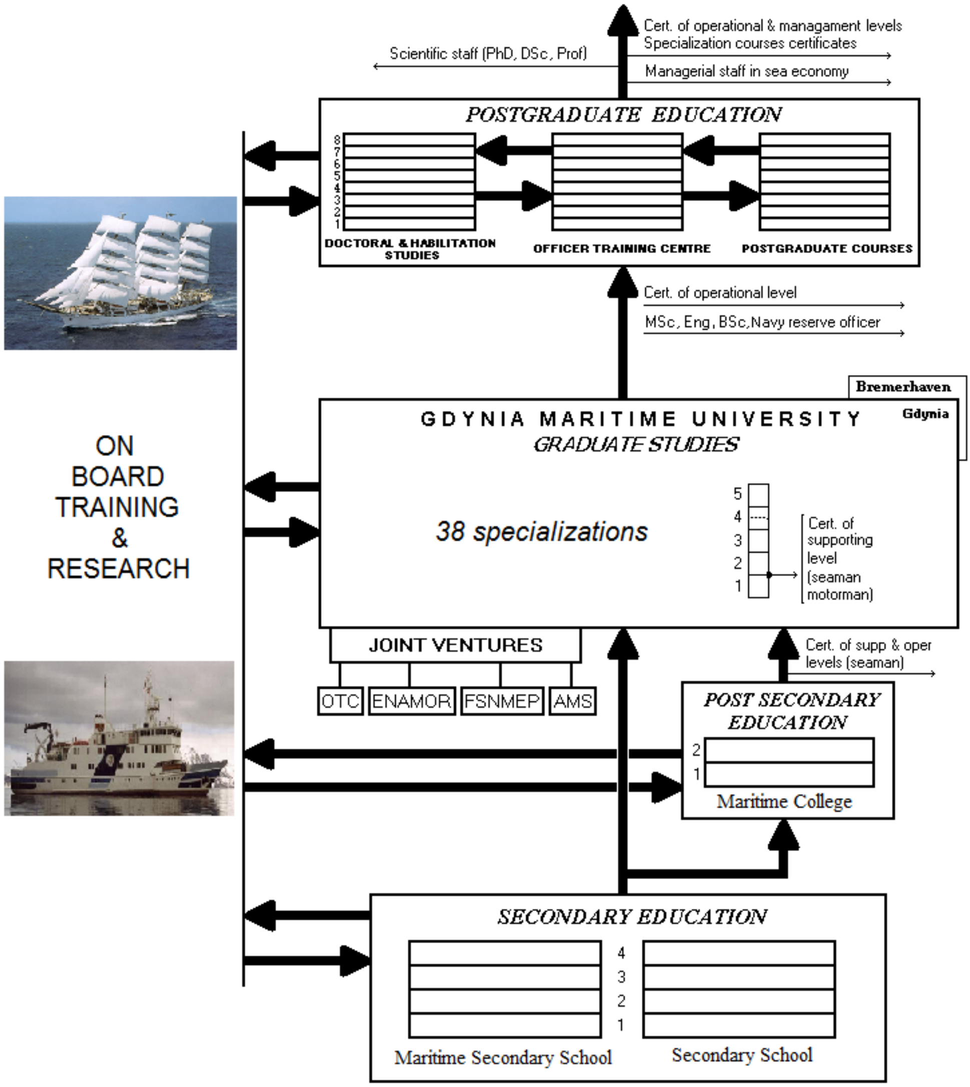


Figure 1. The structure of the integrated engineering maritime education and research system in the GMU.

5. INTERNATIONAL MARITIME REQUIREMENTS

The paramount objective of education in this area of maritime engineering is to convey required knowledge of the construction and operation of a ship's systems in accordance with the requirements of the International Maritime Organization (IMO) as formulated in the STCW 78/95 Convention.
The requirements concerning the officers have been distributed over three levels of competence:

- Supporting Level, concerning seaman and motorman certificates;
- Operational Level, concerning all shipboard officers;
- Management Level, concerning chief officers and masters.

Details are specified in the STCW Code separately for navigators and marine engineers in the form of *minimum standards of competence for officers in charge.*

6. MARITIME UNIVERSITY LEVEL EDUCATION

6.1 Graduate Studies

The higher education provided at Gdynia Maritime University is conducted in four faculties, 8 fields and in 38 specializations. These are described in more detail below.
The Faculty of Navigation conducts full-time and part-time studies in two fields, as follows:

- *Navigation (N)* with specializations in: Sea Transport (ST), Sea Traffic Engineering (STE), Marine Safety Systems (MSS), Offshore Technology (OT), Safety Transport Management (STM), Arctic Shipping (AS);
- *Transport (T)* with specializations in: Transport and Logistics (TL), Transport and Logistic Marine Systems (TLMS).

The Faculty of Marine Engineering carries out full-time and part-time studies in two fields:

- *Mechanics and Machine Building (MMB)* with specializations in: Marine Propulsion Plant Operation (MPO), Marine Propulsion Plant and Offshore Construction Operation (MPPOCO), Technology of Repairs of Ship and Port Units (TRSPU), Operation of Industrial Installations (OII), Operational Engineering (OE), Produce Engineering (PE), Repair Engineering Management (REM);
- *Safety Engineering (SE)* with specializations in: Industrial Plant Safety Engineering (IPSE), Marine Environment Safety Engineering (MESE) [1,2].

The Faculty of Marine Electrical Engineering educates students within full-time and part-time studies in two fields as follows:

- Electrical Engineering (EE) with specializations in: Ship Electro-Automation (SEA), Electro-Automation (EA), Computer Control Systems (CCS);
- Electronics and Telecommunication (ET) with specializations in: Marine Electronics (ME), Digital Radio Communication (DRC), Radio Electronics (RE) and Tele-Computer Systems and Networks (TCSN) [3,4].

The Faculty of Entrepreneurship and Commodity Science has both full-time and part-time studies in two fields, specifically:

- *Commodity Science (CS)* with specializations in: Commodity Science and Quality Management (CSQM), Hotel and Tourism Service Management (HTSM), Commerce and Services Product Manager (CSPM), Cosmetic Products Manager (CPM), Nourishment and Dietetic Services (NDS).
- *Management and Marketing (MM)* with specializations in: Enterprise Management (EM), Logistics and Seaborne Trade (LST), Computer Science in Transport and Trade (CSTT), Internet and Multimedia in Management (IMM), Modern Tools of Management (MTM), Accountancy and Finance of Enterprises (AFE), Management Information in Public Administration (MIPA), Management of Human Capital (MHC), Project Management of European Union (PMEU), Management of Shift (MS).

The curricula of all the specializations of studies consist of a subject's timetable with approved credit points in the European Credit Transfer System (ECTS) for the BSc and MSc degrees. One credit equals about 40 hours of student work: 16 teaching hours and the rest is the individual work of the student. One year of studies is equalized to 60 credits [5].

From the academic year 1995/1996, both the Faculty of Marine Engineering and the Faculty of Marine Electrical Engineering provide a specialization in Industrial Plant Engineering (IPE) on the basis of a European Union curricula obtained from Hochschule Bremerhaven, Germany.

The GMU has to its name two training vessels, namely the famous sailing vessel *s/v Dar Młodzieży* (*Gift of Youth*), which is used to facilitate sea practice for future marine personnel and the research-training ship *m/s Horyzont II*, which is used for practice in manoeuvring and radar positioning, as well as polar science carried out in cooperation with the Polish Academy of Sciences at Spitsbergen and Antarctica.

6.2 Postgraduate Studies

Basically, postgraduate studies are realized by the Faculties in the following fields:

- Ship and industrial of automation systems;
- Programmable controllers PLC and visualization systems;
- Industrial safety systems technologies;
- Electronics elements and power systems;
- Modern antennas and microwave elements;
- Optoelectronics in modern world technique;
- Tourism and hotel management;
- Accountancy;
- Management;
- Nourishment services and dietetics;
- Logistics and international trade.

It should be mentioned that permanent postgraduate maritime training is conducted by the Officer Training Centre Ltd (OTC) in the form of the following courses:

- Courses for certificates of competence for:
    - Operational level (watch keeping officer, watch keeping engineer);
    - Management level (chief officer, master mariner, II engineer, chief engineer).
- Specialist courses for the following certificates:
    - Radar/ARPA operational and management level;
    - Radar simulator;

- Dynamic positioning operators training - basic, advanced;
- Personal safety and social responsibilities;
- Tanker familiarization training;
- Advanced oil tanker training;
- Advanced liquefied gas tanker training;
- Advanced chemical tanker training;
- Plans for co-operation between passenger ship on fixed routes and search and rescue services;
- Elementary first aid;
- Medical first aid;
- Medical care;
- Basic fire fighting;
- Advanced fire fighting;
- Crowd management, passenger safety and safety training for personnel providing direct services to passengers in passenger spaces on ro-ro and other than ro-ro passenger ships;
- Crisis management and human behaviour, passenger safety, cargo safety and hull integrity on ro-ro and other than ro-ro passenger ship;
- International safety management code;
- Safe handling, stowage and securing of dangerous, hazardous and harmful cargo;
- Bridge team management;
- Electronic navigational charts and ECDIS laboratory;
- ECDIS;
- Practical training in handling of large ships and ships with unusual manoeuvring characteristics;
- Engine room resource management;
- Ship security officer;
- Company security officer;
- Port facility security officer;
- Training in operation and maintenance of main propulsion other than marine diesel engines;
- Training in didactics for instructors;
- VTS training;
- Cargo and ballast hull stability.

6.3 Doctoral and Habilitation Studies

The constant development of teaching staff has been assured by doctoral and habilitation study programs. They are initiated at other educational institutions, but conducted within the scientific laboratories at the GMU.
The studies cover the four fields of scientific research:

- Transport;
- Machine construction and operation;
- Electrotechnics;
- Commodity expertise.

7. SCIENTIFIC MARITIME RESEARCH

The University is supported by the Ministry of Science and Higher Education (MSHE) and European Union (EU) research grants in the following forms:

- National research funds: base and statute, allowed according of the scientific and research obtained results in the past years;
- National grants: PhD and DSc, research projects, development projects, allowed by national competition way;
- EU projects;
- International projects.

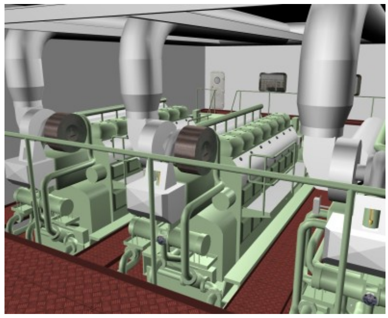
Each year, the GMU has realized about 20 national and 10 European and international projects. The GMU is now completing certain projects, for example:

- Support system of ship entry to port and mooring as the element of intelligent transport system;
- Quality analysis of electrical energy in shipping electroenergy-systems for the purpose of Chinese Classificatory Companionship regulations modification;
- Real-time detection and presentation of especially large intensity sea traffic areas;
- Analysis and research of the exploitive characteristics active filters to shipping uses;
- Construction of diagnostic and measuring system to research of exploitive features shipping engines and auxiliary devices;
- Construction of specialized project-research system of the latest generation energo-electronics devices in electro-energy distributional systems;
- Mobile system of command, observations, recognitions and communications;
- Navigational algorithm of determining trajectory parameters in ECDIS electronic map systems;
- Application of asynchronous programmatic agents teams to optimization, simulation and machine-teaching.

The greatest research-education project referred Namibe Fishery Academy in Angola, included of the technical infrastructure, organization and curricula of maritime specializations on 4 faculties and 21 departments for 2000 students:

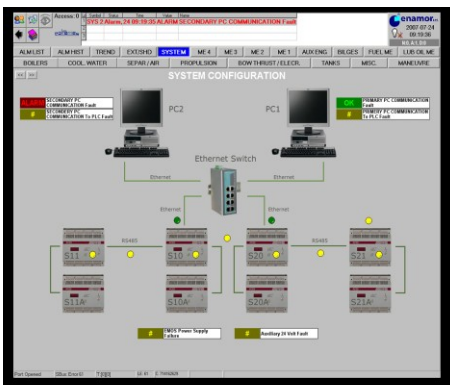

An effect of finished research are practiced devices, for example:

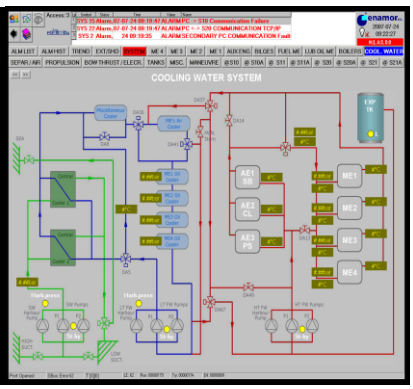
- Engine Room Simulator ERSIM (Department of Marine Propulsion Plants GMU & UNITEST Gdynia):

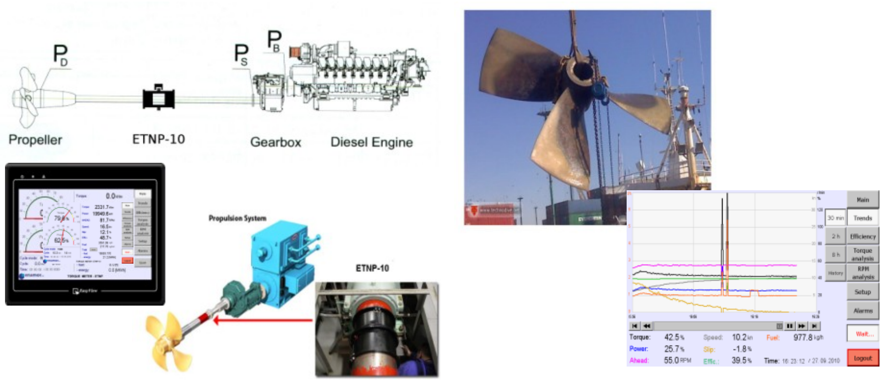
- LPG/LNG Cargo Handling Simulator CHSIM (Department of Marine Propulsion Plants GMU):


- Integrated monitoring and control system EMOS (Department of Ship Automation GMU & PBP ENAMOR Gdynia):





- Control assistance system with torque meter ETNP (Department of Ship Automation GMU & PBP ENAMOR Gdynia):



8. JOINT VENTURES

Gdynia Maritime University is engaged in the following joint ventures that support its activities:

- Officer Training Centre Ltd (OTC): postgraduate maritime training;
- Research-Production Enterprise for Maritime Industry Ltd (ENAMOR): projects for shipyards, ship-owners, navy and maritime administration, services in the range of overhauling and repairing ship equipment concerning communication and navigational, marine power plant, electrical and deck gear and cargo handling;
- Foundation for Safety in Navigation and Marine Environment Protection (FSNMEP): ship-handling practical training course for foreign pilots, masters and senior officers, and the use of seven manned models of large ships in scale $^1/_{16}$ and $^1/_{24}$ situated on a lake;
- Academy Maritime Services Ltd (AMS): crewing of Polish officers and ratings for traditional and specialized tonnage and personnel for offshore industry.

9. CONCLUSIONS

The current integrated education system, although serving its purpose well, could be further developed through the following means:

- At present working:
  - Curricula harmonization at the secondary level of education;
  - Cooperation between maritime higher education establishments and other industry schools;
  - Wide cooperation of higher education establishments in Poland with foreign institutions.
- Starting up new lines of studies that meet the current needs of the market economy, for example: oil platform operations, mechatronic equipment operations, geographic information systems, commanding large deep sea yachts, etc;

- Starting up new training programs to improve sea safety;
- Introduction of the licensee system to be awarded by the Ministry of Infrastructure for the training centres to improve their quality and to ensure better standards of safety at sea.

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The Training Ship Golden Bear Ballast Water Treatment Testing Facility - from Concept to Activation to Inspiring the Next Generation

William T. Davidson
Chief Engineer, TSGB
Ballast Facility Director
bdavidson@csum.edu

Richard S. Muller
Maritime Vocational Lecturer / Waterfront Coordinator
Ballast Facility Manager
rmuller@csum.edu

Kevin J. Reynolds, P.E.
Marine Engineer, Glosten Associates
kjreynolds@glosten.com

Abstract. Ballast water from ships has been recognized as a vector for Aquatic Invasive Species (AIS). During 2006 key personnel from the California Maritime Academy were approached by the Maritime Administration, researchers from the University of Washington, and a marine engineering firm about a concept to develop facilities for testing ballast treatment systems on a U.S. training ship. The partnership formed sought grant funding from various federal agencies to design and construct the facility. As a result of these collaborative efforts for funding and partnerships, a unique facility was built onboard the *Training Ship Golden Bear*. Four years and much effort later the *Golden Bear* is now operating as a "Plug & Play" ballast treatment testing facility capable of performing scientific biological efficacy testing through to national and international standards through our partnership with Moss Landing Marine Laboratories.

The Golden Bear Facility (GBF) has been active testing commercial ballast water treatment systems to international standards. An enormous construction and retrofit effort took place during the winter of 2009 and extended through the spring of 2010 where the ballast system was tested and our first commercial treatment system was installed for International Maritime Organization (IMO) testing for type approval for a shipboard facility.

While bringing a ballast treatment testing facility to fruition has been satisfying and rewarding, the authors have realized a perhaps greater potential with broader appeal. By creating the space in which a wide array of environmental technologies can be

developed and tested, the GBF, a Research, Development, Testing and Evaluation (RDTE) facility exists in a location where future industry participants live, train and learn their craft. Early experiences indicate that students are interested and engaged in learning about new issues and regulations that affect our industry, certainly as they relate to Ballast water and AIS.
It is our hope and belief that other technologies relating to exhaust emissions, solid waste stream, oil pollution, hull fouling and other potential risks to the marine environment will draw equal interest and engagement of our students and faculty providing impetus for discussion and a launching point for further study. We believe that by making green technologies a part of the experience and knowledge base of our future graduates we can affect the future of our industry. This development effort provides lessons learned that can benefit other maritime institutions that might develop a similar effort. This paper outlines the cooperative partnerships required, engineering and construction efforts, development of science team capacity and protocols, and the set-up of an administration structure to sustain operations.

1. INTRODUCTION

While shipping moves over 80% of the world's commodities each year, it simultaneously moves an estimated 3 to 5 billion tons of ballast water internationally. It is estimated that a similar volume may also be transferred domestically within countries and between regions. Ballast water for stability is considered essential to the safe and efficient operation of modern shipping, yet untreated or unregulated ballast may also pose a serious ecological, economic and health threat when discharged in a new location. [1]

Harmful aquatic organisms and pathogens (often non-native or non-indigenous species - NIS) that are released from ship's ballast water and sediment are recognized as a serious threat to global biological diversity and human health. Studies carried out in several countries have shown that many species of bacteria, plants, and animals can survive in a viable form in the ballast water and sediment carried in ships, even after journeys of several months' duration. Subsequent discharge of ballast water or sediment into the waters of port states may result in the establishment of these harmful organisms creating a detriment to the marine environment. The International Maritime Organization (IMO), as well as several port state authorities, has recognized the potential harm created by the transportation of non-indigenous species through ballast water. [2]

Ballast water has long been a major source for introducing non-native species into aquatic ecosystems where they would not otherwise be present. A species is defined as an invasive species when it is non-native to the ecosystem under consideration and when introduction of that species causes or is likely to cause economic or environmental harm or harm to human, animal or plant health. [3]

Aquatic invasive species present a significant threat to biodiversity in the world's coastal waters because they often have no natural predators and may out-compete native species for food in their new environment. Once established, invasive species can cause major environmental and economic harm as they multiply and spread. They can be very difficult, if not impossible, to control or eradicate following introduction into the receiving waters. Not all introduced organisms will become invasive species and harm native ecosystems. An example would be species taken onboard from a freshwater environment and discharged into saltwater. Due to the variability in organisms and complex environmental interactions affecting their establishment, it is not yet possible to accurately predict whether an introduced species will become an invasive species in a new location. [4]

In November 1997, the International Maritime Organization (IMO) issued voluntary guidelines, addressing ballast water management, which it recommended all maritime nations adopt. In January 2004 the IMO and the International Convention for the Control and Management of Ships' Ballast Water and Sediment established regulation D-2 that, once implemented aims to prevent, minimize and ultimately eliminate the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments. This Convention and associated IMO Marine Environmental Protection Committee (MEPC) Guidelines have been the impetus for Ballast Water Treatment System (BWTS) Type approval.

The U.S. Coast Guard, the primary U.S. federal agency charged with establishing controls on ballast water discharges, is working closely with the United States Environmental Protection Agency and other federal agencies to improve ballast water management by ships and to reduce the potential for introduction of invasive species by ships. Individual states which have been affected by invasive species from ballast water are also working to address the issue for their waters.

These issues and the desire for establishing environmental stewardship for our world's oceans through undergraduate education have prompted the Maritime Administration (MARAD) and California State University's California Maritime Academy and partners, to build the Golden Bear Facility (GBF).

2. PROBLEM DEFINITION AND BACKGROUND

The lead time required to develop and manufacture reliable, approved ballast water treatment systems is a limitation to rapidly phasing-in those units. It is only recently that ballast water treatment systems in any quantity are being prototyped, tested, and evaluated on board ships. Prototype ballast water treatment systems are critical to proving that these systems can perform reliably under the rough conditions at sea, constant wear and tear of vibration, extreme temperature and humidity, and salt air.

Testing protocol, such as that detailed in IMO G8 (see Fig. 1), must be used as an accepted standard to validate manufacturers' reliability and performance claims of any new treatment systems. These systems are required to pass through a rigorous Type Approval process, which certify that they will operate safely and properly in shipboard conditions, meet efficacy requirements according to the Convention, and meet toxicity discharge standards and review according to a special science panel at the IMO. Challenges exist; facilities equipped for performing the needed testing for these treatment systems are generally booked through 2012 or beyond, reducing the number of candidate systems available for approval. Availability is also delayed by new and developing standards, such as those from California and the United States, which are causing treatment systems to be further reevaluated.

The problem that invariably arises in scaling up to shipboard level studies is that effective scientific and controlled investigations are usually difficult to conduct on ships. It takes a great deal of negotiation to receive permission for shipboard research. Even after a ship is found, problems with tight and varying ship schedules, access to ship's tanks and plumbing, and lack of room for conducting laboratory analyses often make completing experiments time-consuming, technically difficult, and highly costly. The central goal of this project has been to provide a ship-based ballast technology testing facility that minimizes the problems described. [5]

	IMO Criteria		Proposed Modifications		
			Vessel	IMO Comparison	
	Shipboard	Land-based	Capability	Shipboard	Land-based
Ballast Tanks					
Control capacity (m^3)	1:1 scale	200	432/441	☑	☑
Test capacity (m^3)	1:1 scale	200	432/441	☑	☑
Holding time	N/A	5 days	5 days	N/A	☑
Treatment Rate Capacity (TRC)					
Less than 200 m^3/hour	1:1 scale	1:1 scale	349	200	200
200 to 1000 m^3/hour	1:1 scale	1:5 scale	349	349	1,000
Greater than 1000 m^3/hour	1:1 scale	1:100 scale	349	N/A	34,900
Sampling Collection > 50 µm					
Influent test pre-treatment	Three x 1 m^3	Three x 1 m^3	Three x 1 m^3	☑	☑
Influent test post-treatment	N/A	Three x 1 m^3	Three x 1 m^3	Exceeds	☑
Influent control	N/A	Three x 1 m^3	Three x 1 m^3	Exceeds	☑
Discharge test pre-treatment	Three x 1 m^3	Three x 1 m^3	Three x 1 m^3	☑	☑
Discharge test post-treatment	N/A	N/A	Three x 1 m^3	Exceeds	Exceeds
Discharge control	Three x 1 m^3	Three x 1 m^3	Three x 1 m^3	☑	☑
In tank test	N/A	N/A	Three x 1 m^3	Exceeds	Exceeds
In tank control	N/A	N/A	Three x 1 m^3	Exceeds	Exceeds
Measurements, Physical					
Temperature	Required	Required	In-line	☑	☑
Ballast water flow rate	N/A	Required	In-line	Exceeds	☑
Ballast water pressure	N/A	N/A	In-line	Exceeds	Exceeds
Treatment power consumption	N/A	Required	Portable	Exceeds	☑
Salinity	Required	Required	Sample	☑	☑
pH	N/A	Required	Sample	Exceeds	☑
Total suspended solids	Required	Required	Sample	☑	☑
Turbidity (NTU)[3]	N/A	Required	Sample	Exceeds	☑
Particulate organic carbon	Required	Required	Sample	☑	☑
Dissolved organic carbon	N/A	Required	Sample	Exceeds	☑
Dissolved oxygen	N/A	Required	Sample	Exceeds	☑

Figure 1. Comparison with Shipboard and Land-based IMO Guidelines [6]

3. BACKGROUND AND FUNDING HISTORY OF GOLDEN BEAR FACILITY

In the summer of 2006 during the *Training Ship Golden Bear (Golden Bear)* annual training cruise, a contingent from the University of Washington and the Glosten Associates (author) visited the vessel's Captain and Chief Engineer (author). The group was working on a U.S. Fish and Wildlife supported Phase I feasibility study that in turn had evolved from discussions between MARAD, concerned scientists and other interested parties seeking to speed up the development of ballast water treatment solutions. The concept on which the feasibility study was focused involved developing a facility to support research, development, testing and evaluation of multiple ballast treatment systems aboard a federal government owned vessel. MARAD manages a significant number of ships located in coastal regions around the U.S. The Maritime Academy Training Ships, part of the MARAD fleet, were proposed as an asset given their predictable schedules, association with educational institutions, and local distribution. Given the U.S. Pacific Coast focus of the study, California Maritime Academy was considered a prime candidate and a proposal for funding pursued.

The proposed *Facility* would help to combat the problems outlined above by serving as a shipboard ballast water treatment testing facility that would:

- Provide access to an operational ship with purpose-built laboratories to researchers working on ballast water treatment solutions.
- Reduce the high costs associated with current shipboard testing.
- Increases the standardization and quality control of shipboard experiments. [7]

The early agreement lead to stakeholder meetings and discussions with the principal investigators, vessel owner, the university, and various sponsors and matching fund contributors to seek grant funding for the proposed facility. In 2008 a successful proposal to the U.S. National Oceanographic and Aeronautic Administration (NOAA) – Sea Grant Ballast Water Demonstration Management Program was able to provide funding. This NOAA – Sea Grant proposal requested funding of $500,000 with $200,000 matching funds provided by MARAD and the California State Lands Commission (CSLC) to perform modifications to the *Golden Bear* required to support the dock-side shipboard research, development, testing and evaluation of multiple ballast treatment systems. The stated goal was to achieve modifications designed such that the resulting facility would meet or exceed the IMO Guidelines for shipboard and full-scale land-based ballast treatment test facilities. The funding was also requested to foster the education and outreach opportunities associated with the proposed project.

This initial grant was focused on designing and building a very basic facility capable of ballast treatment system integration. Laboratory capabilities, automation, and at-sea capabilities were engineered but not installed with the thought of expansion as funding and need dictated. Flexibility was a key component of designing to service rapidly developing technologies.

Funding became available late enough in the 2008/9 fiscal year that installation was impractical prior to summer 2009 cruise periods, so plans were shifted to purchasing of long lead and specialized elements for the facility construction. Construction contracts were ratified late 2009 and the basic facility was built from November 2009 through April 2010.

As these initial efforts took hold and plans began to gel for a late 2010 target for initial testing, two fortuitous events occurred to accelerate development: 1) MARAD funding had increased at the federal level to support environmental technology development, and CMA became a recipient of additional funding. The Pacific Ship's Initiative (PSI) agreement between MARAD and CMA provided funding to complete construction of the full facility. 2) CMA and partners were approached by a U.S. ballast water treatment vendor eager to perform IMO shipboard testing. This industry partnership was leveraged into rapidly completing the necessary construction to enable shipboard testing starting in May 2010, a full 6 months earlier than planned.

This rapid development of the facility and emergence into a very small U.S. and worldwide community of treatment testing facilities caught the attention of US Coast Guard and Environmental Protection Agency (EPA) sponsors to the program developing U.S. type-approval protocols. A USCG-EPA Environmental Technology Verification (ETV), request for proposal had been released seeking facilities who could attempt to test to these developing protocols. The Golden Bear Facility proposal was accepted and the additional modifications required to meet the protocol were funded by MARAD and the ETV contract itself.

The MARAD – PSI grant funding and additional, testing contracts, and the ETV project have encouraged and allowed continued construction and completion of the original concept facility as well as expanded capabilities in order to meet international and pending U.S. and Environmental Protection Agency type-approval protocols. The Golden Bear

Facility is now a fully operational ballast treatment RDTE facility, with room for additional development and studies.

4. THE GOLDEN BEAR BALLAST RDTE FACILITY

The Golden Bear Facility (Facility) is located on the 500-foot long *Training Ship Golden Bear* with 7141 cubic meters in total ballast water capacity. The ship generally spends eight-months docked in Vallejo, California, taking occasional and short trips in the Bay Area. The ship also takes two cruises for a total of four-months each year, often to remote locations such as the Far East or Australia. The ship is owned by the U.S. Maritime Administration and is operated by Cal Maritime as part of the California State University (CSU) system.

The Facility has a lead science team from Moss Landing Marine Laboratory (MLML), also part of the CSU system and has been outfitted to integrate containerized ballast water treatment systems with routine ship ballasting operations. Two ballast tanks, each with capacities of 432 cubic meters, and associated piping are outfitted to aid in conducting controlled biological efficacy testing. The pumping system can be varied between 90 and more than 400 cubic meters per hour at heads of two-bar. In this manner, the treatment system can perform routine operations under the stresses of ship operations during trans-oceanic voyages, and perform efficacy testing cycles under controlled conditions. The Facility physical plant meets the IMO G8 Guidelines for shipboard and the ETV requirements for land-based testing. [7]

Training Ship Golden Bear —Vallejo, California

The Facility was developed to conduct research, development, testing, and evaluation (RDTE) of technologies and operational practices that show promise for limiting the impact of marine vessel operations on the environment. Specifically, the Facility provides:

- Dedicated onboard laboratory to enable rapid biological and chemical analysis to support RDTE activities.
- Access to all ship equipment; including the ballast water system, hull and apertures, bilge water and de-oiling equipment, sanitation system, and diesel engine exhaust systems.

- Specialized equipment to support ballast water treatment system evaluation, including a dedicated pump and piping system, means of installing and integrating a treatment system, an automation system, and a water sampling system.

The Facility functions as a "plug and play" platform for research teams, regardless of how they approach the treatment challenge. Researchers can install their system in a standard 20-foot shipping container, using connection specifications provided by the facility to access ballast water tanks, electricity, and ancillaries. This enables them to set up their platform at their home location, and then easily transport it to Vallejo, California for loading aboard the facility without having to install their treatment system below deck.

Container-mounted treatment systems are supported by new below deck structure, and fasteners to secure up to two containers. A support services station is positioned nearby with compressed air, fresh water, electrical power receptacles, ballast water supply and sampling lines, and instrumentation.

Researchers have access to two existing ship ballast tanks (one treatment and/or one control), (see fig. 2), each with a capacity of 432 cubic meters and with large hatches for plankton net sampling. The pumping system can vary the flow capacity of the system and permits treatment on uptake and/or discharge, with variable and control tanks filled simultaneously. An onboard marine biology laboratory is outfitted with equipment to analyze samples.

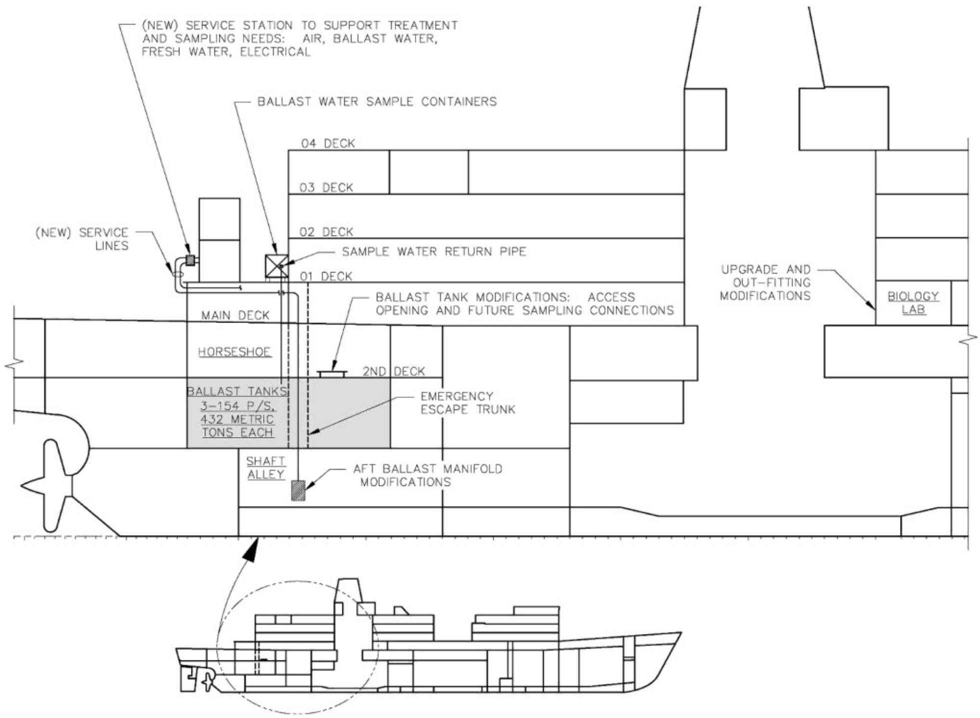

Figure 2. Profile view of keying testing facilities

4.1 Container Mounting System

The treatment systems to be tested are temporarily fastened to the ship's deck within the confines of standard ISO containers. Container mounted treatment systems are fastened to the 01 Deck level behind the aft house. The containers are positioned starboard of the centerline to avoid interference issues with the 30 ton crane immediately aft of the mounting area.

4.2 Support Services

A support services station is positioned near the ISO container mounts. Services include compressed air, fresh water, and 120 VAC and 440 VAC electrical power. Ballast water supply and sample tanks are also located at or near this station.

The Service Station on the 01 Deck level connects to treatment containers by means of hoses and cables. This provides a plug and play capability that allows treatment systems to be exchanged quickly and easily.

Electrical Power

The ballast water treatment systems can be provided with 440VAC and 120VAC power. The 440VAC receptacles for the treatment system have 100 amp & 50 amp circuits available, while the 120VAC receptacle utilizes a 30 amp breaker. For safety, all are provided with break-before-make contact pins.

Compressed Air

Ship Service Air, maintained around 100 psi with a 120 psi maximum pressure, is supplied to the Service Station on the 01 Deck. This compressed air source is available at all times, even when the ship is on shore power with the power plant secured.

Fresh Water

Potable water is supplied to the 01 Deck Service Station from on-deck wash-down spigot.

Automation

Connection and I/O for the treatment testing system to the Integrated Monitoring and Control (IMAC) system is provided adjacent to the ISO mounts

4.3 Pumping System

Piping modifications and additions to the ballast system allow ballast water to flow between the Shaft Alley seachest and the container mounted treatment system(s) on the 01 Deck. This Ballast Test System specifically utilizes a ballast tank pair directly above the Shaft Alley space. Other ballast tanks throughout the ship may be used for testing by means of a system crossover pipe.

The original sea chest in Shaft Alley is connected to a new ballast water treatment pump since the original fire/ballast pump was insufficient for test purposes. New manifolds and piping have been added to the original ballast system in Shaft Alley to provide a variety of ballast treatment modes including standard modes such as:

- Control Tank Fill – Filling one test tank with untreated ballast water.
- Treatment Tank Fill – Filling one test tank with treated ballast water.
- Control / Treatment Tank Discharge – Discharging either test tank overboard.
- Ballast Treatment on Discharge – Treating ballast water while pumping overboard.

Original piping was tapped in three places in order to provide suction to the new pump, overboard discharge from the Ballast Test System, and crossover to the majority of ballast tanks. All other piping for the Ballast Test System is new, including piping internal to the main test tank pair.

Ballast water is pumped to the 01 Deck by means of an independent treatment system pump. The pump is located in Shaft Alley on the port side of the space. The treatment pump is a double suction centrifugal pump, Goulds model 3410-17, 75 hp motor. The pump operates at a maximum speed of 1180 rpm with a shut-off head of 138 feet H_2O. The pump is also fitted with an ITT PumpSmart PS200 VFD drive that allows the pump to operate between 90 m^3/hr to 450 m^3/hr, depending on test conditions and requirements.

4.4 Tank Arrangement and Capacities

The seawater ballast tanks selected for use in this project are tanks 3-154-1 and 3-154-2, (see Fig. 3). Both tanks are similar in construction and mirrored about the ship's centerline, each with a capacity of about 114,210 gallons. These port and starboard ballast tanks have a 441 and 432 metric ton capacity respectively. The tank tops reside on the 2nd deck, approximately 33 feet above the keel. Both tanks are easily accessible through their tank tops. Both tanks extend down to the overhead of Shaft Alley, approximately 16 feet off the keel, and aft to frame 174, the forward most frame in the 3-174 aft peak ballast tank pair.

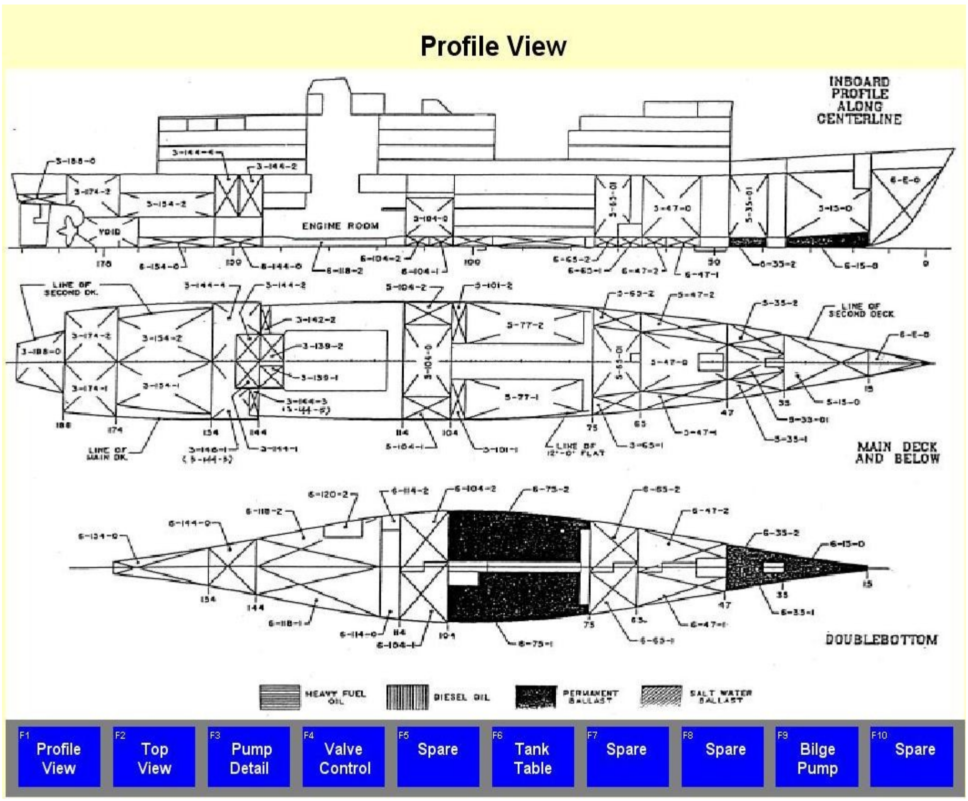

Figure 3. Ballast System Control Screen (Tank Arrangement)

4.5 Sampling System

The ballast test facility has adequate sampling to test the effectiveness of any ballast treatment systems installed on the 01 Deck.

Slip Stream Sampling System

The testing facility is equipped to take samples from one of three slip stream ports located on the Main Deck before and after treatment, which are used to collect samples in up to six (6) sample tanks located near the Main Deck slip stream ports. These ports allow testing of ballast water on uptake before treatment, uptake after treatment, and ballast discharge. Each of these six tanks uses a “flow through” design that allows continuous zooplankton sampling throughout the ballast test.

Ballast Tank Net Casting

Biological sampling access through the control and treatment tank-tops are possible by utilizing raised, quick acting watertight hatches. 24 x 24 inch clear opening provide ideal access for plankton net casting.

Figure 4. Slip Stream Sampling System

Ballast Tank Sample Collection

8 inch flanged pipe penetrations are installed in the ballast tank tops for discreet sampling connections. Flexible tubes can be installed throughout the ballast tanks and penetrate the tank tops through the flanged connections to provide information about treatment effectiveness at various locations within the tanks.

The sample tube system for each tank may consist of 3/8 inch or 1/2 inch plastic tubing connected to permanent fixtures, such as ladders and beams within the tanks, for support. A single diaphragm pump for each of the two manifolds can be used to draw seawater from the tanks through each sample tube.

4.6 Laboratory Facilities

The Facility's marine laboratory is located onboard the ship to provide researchers with the ability to rapidly assess the biological efficacy of tested BWTS. Additional facilities are located at Moss Landing Marine Laboratory (MLML), a two-hour drive from the Facility.

The ship's lab is outfitted with all equipment required to serve as the primary space for the majority of the sample processing/analysis required. The ship's lab (130 ft^2) is dedicated solely to work related to ballast water testing and provides bench space, fume hood, refrigerator/freezer space, and a wet sink area.

Figure 5. Marine Biology Laboratory

4.7 Automation Plant

An Integrated Monitoring and Control (IMAC) system with online data logging is installed in order to provide reliable monitoring and record keeping of data as well as visual cues to aid operators in system timing and operational modes. The IMAC system is comprised of a computer network which monitors and securely records a wide array of field sensors such as valve position indicators, sample flow meters, and water quality instruments. User interfaces are located throughout the Facility to provide visual indicators piping system, Ballast Water Treatment System (BWTS), and sampling system status to the Facility team. Further, the automation system facilitates the generation of reports based on the stored data.

IMAC includes an online information system consisting of a computer network for handling Facility documentation. Access is enabled for personnel to view standard and test specific procedures, access secure collected data, and manipulate data into useful information for reports. User forms allow online entry of data directly into the information system.

The system includes the following features:

- Passive automatic monitoring and logging of most system parameters, such as valve positions, ballasting flow rates, pressures, temperatures, water chemistry characteristics, tank levels and sampling flow rates.
- Active control of certain system devices, such as BWTS start and stop, Facility pumping rate, and key valve operators.
- User interface screens providing pictorial representation of system current operation; visual cues to Facility staff indicating details such as remaining time until tank will be full and pumping rates.
- Information access to procedures and protocols at any of the user terminals located through-out the Facility.
- Data entry forms, for on-line entry of various records and forms.
- Automatic generation of predesigned data reports, based on collected data. For example, system flow rate over time.

5. FACILITY USE AND STUDENT INTERFACE

The Golden Bear ballast facility has now completed operational testing work on two major projects and is proving to be a shipboard facility capable of both land-based and shipboard testing cycles. We expect in the near future to partner with principle investigators working in more of the development stages of technology as well as compliance testing.

The installation and construction project occurred during the vessel's in port period as it functioned as a campus lab and presented a great opportunity for training on methods and ship's structure. It is the actual testing and operations of the various ballast treatment systems that have proved truly outstanding training opportunities.

The shipboard testing that occurred during the 2010 cruise engaged students working side-by-side with faculty and staff operating the system in a unique way. Some of the positive feedback included:

- Faculty utilized the clear and well laid out system with a pump station located in a fairly quiet area in the shaft alley as a great platform for teaching systems design and operational logic.
- The Chief Mates on both cruises had significant tanker experience and utilized the ballasting ops to describe those processes.
- The modern variable-frequency drive and interface was a great means of teaching speed to load relationships and pump theory.
- The significant ballast operations required to perform biological efficacy testing required interesting stability and counter ballasting operations for training.
- Anecdotally, most students were positively motivated by the timely integration of testing and training to the latest regulatory requirements and new technologies.
- Having a marine biology team aboard, several of whom were CSU graduate students, provided our students and community a different perspective on maritime issues.
- The marine biology team also illuminated another potential career path for CMA graduates as they discussed research vessels.
- Well attended opportunity seminars were provided to give the participating students background on the science, operations and technology being tested.

Subsequent operations and testing while the ship is located on campus have shown additional interest and opportunity for integration with existing shipboard lab courses, work-study opportunity for interested students, and integration with the living and learning environment.

6. THE FUTURE

With growing support of State and Federal Agencies as well as a keen interest by CMA in developing a research institute associated with the *Golden Bear*, we are in process with CMA administration to develop a Golden Bear Research Institute (GBRI). Creating the GBRI would allow CMA to have an established grant and industry funded cost-center flexible enough to attract and manage a broad array of subjects our facilities and principal investigators could support.

Our hope is that the early success we've experienced with building and operating a ballast test facility could be leveraged into a center with a focus on lessening the environmental footprint of vessels. As part of the GBRI we have proposed the development of the Marine Vessel Sustainability Center. This Center will be focused around the following:

Mission Statement – Marine Vessel Sustainability Center

- Provide an effective platform, for the research, development, testing and evaluation of technologies and practices which reduce marine vessel environmental impacts.
- Advance United States merchant shipping and environmental technology business interests.
- Develop stewards of the environment through Cal Maritime student education, community involvement, and maritime business outreach.

Our vision now of what was originally a Ballast research facility taking a lead on promoting ballast treatment technology is expanding as per our mission statement above. This vision will allow us to branch out and provide a place to review and evaluate potential platform testing of many new "Green Ship" technologies, but also other related technologies that are not primarily shipboard or environmental. There are countless possibilities with some prime examples below:

- Ballast water treatment device testing for IMO G8 type approval.
- The use of biodiesel on the TSGB
- Reduction of, SOx, NOx and particulate matter (exhaust scrubbers)
- Exhaust Gas Recirculation (EGR) systems
- OWS technologies
- Electrical efficiencies: lighting, LED technology, etc.
- Recycling and reduction of shipboard waste
- Processing of shipboard waste and stowage of recycled products (aluminum, plastic)
- Local scientific institution partnership (shared resources)
- Engineering Technology faculty grants for combined plants for "steady" power production (wind turbine backed by gas turbine).

- Proposals to develop Green Ship "rating" system similar to LEEDS for the construction industry.

Working in these areas will provide dynamic educational opportunities for our various programs and also create opportunity to develop industry partnerships.

Our outreach and partnerships are already and will likely continue to include participation and networking at and with the following organizations as well as others to be determined:

- US Maritime Administration
- North Sea Ballast – Globallast – IMO
- International and US Ballast testing and research facilities.
- Maritime Events – Green Ship Technologies
- IMO – MEPC
- Local CA government offices, BAAQMD, CARB, State Lands, Fish & Game, etc.
- COAST (CSU Council on Ocean Affairs, Science and Technology)
- USCG, EPA
- Local Scientific institution partnership (shared resources) - MLML

It is our hope and belief that these efforts towards greening vessels will enhance the industry while providing opportunities to expose our students to the latest technologies, career opportunities and the nexus of regulation, science, and industry. The favorable juncture of circumstances that lead our team to take on ballast testing issues, has provided an opening to further possibilities. Our wish is that this exposure will inspire the next generation of mariners towards a better understanding of their relationship to the planet.

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Novel Phase Change Material Icephobic Coating for Ice Mitigation in Marine Environments

Brian Dixon
Assistant Professor, Massachusetts Maritime Academy, Buzzards Bay, Massachusetts, USA
bdixon@maritime.edu

Alex Walsh
President, ePaint Company, East Falmouth, Massachusetts, USA
alex@epaint.com

Brett Gall
Senior Research Scientist, Versatile Dynamics, Inc., Falmouth, Massachusetts, USA
bgall@versatiledynamicsinc.com

Michael Goodwin
Senior Scientis,ePaint Company, East Falmouth, Massachusetts, USA
mike@epaint.com

Abstract: Novel ice-phobic coatings were developed that employ organophosphorous phase change materials (PCMs). PCMs exist in a passive or dormant state under most environmental conditions, but PCMs undergo solid-solid phase changes over a narrow temperature range slightly below at which ice formation occurs. As ice forms on the surface, some of the latent heat of freezing passes to PCMs. This heat is absorbed by the PCMs and causes local strain on the coating surface and results in removal of the ice. Minimal force (<1psi) is required to remove ice from test surfaces treated with PCM ice-phobic coating technology.

Key words: Icephobic, anti-icing, de-icing, marine coating

1. INTRODUCTION

Ice build-up is a serious concern for industries such as aerospace, maritime, power transmission, telecommunication, and ground transportation with far reaching economic and safety impacts. Icing also reduces military preparedness and rescue response in times of emergency. Icing reduces ship stability, adversely affects aerodynamic performance of aircraft, and disrupts vital communication signals. The effects of icing are not limited solely to damage to machinery and equipment, but also cause injury and loss of life. Conventional methods for controlling icing are limited to toxic deicing fluids, sacrificial coatings that need to be frequently reapplied, or removal by costly thermal and mechanical systems.

The adhesion of ice to structures, e.g. naval and fishing vessels, ice breakers, communication and radar equipment, etc., can have serious safety consequences [1]. Currently, the removal of ice build up on shipboard structures is done through the use of deicing materials and the use of brute force by means of baseball bats, mallets, shovels and heat guns. De-icing materials such as ethylene glycol, calcium chloride and urea are in use but have drawbacks such as limited temperature use and unwanted side effects (irritation with skin, harmful dust, corrosive to metals, and creation of slippery surfaces) [2]. This research demonstrates the feasibility of designing a surface that stresses the ice-surface interface as the ice forms without interfering with normal shipboard operating procedures. A novel coating containing phase change materials (PCMs) encapsulated within a flexible, film-forming hydrophobic polymer was developed.

PCM based ice-phobic coatings use a combination of low surface energy materials with heat driven motions of the surface coating to inhibit ice attachment on surfaces. Prior efforts by other researchers have relied entirely on low surface energy materials [3,4,5]. Like previous approaches, PCM-based coatings yield low surface energy films that minimize ice accretion. Unlike other approaches to the icing problem, the proposed experimental coating relies on the thermodynamic properties of the PCM. When a PCM-based coating is cooled below 0°C, adjacent regions within the polymer coating expand and contract due to the solid-solid phase changes, stressing the ice-coating interface. Stressing at the ice-PCM coating interface effectively de-ices the surface observed by the ice detaching, or by reducing the force required to remove ice. A depiction of PCM icephobic coating technology is presented in Figure 1.

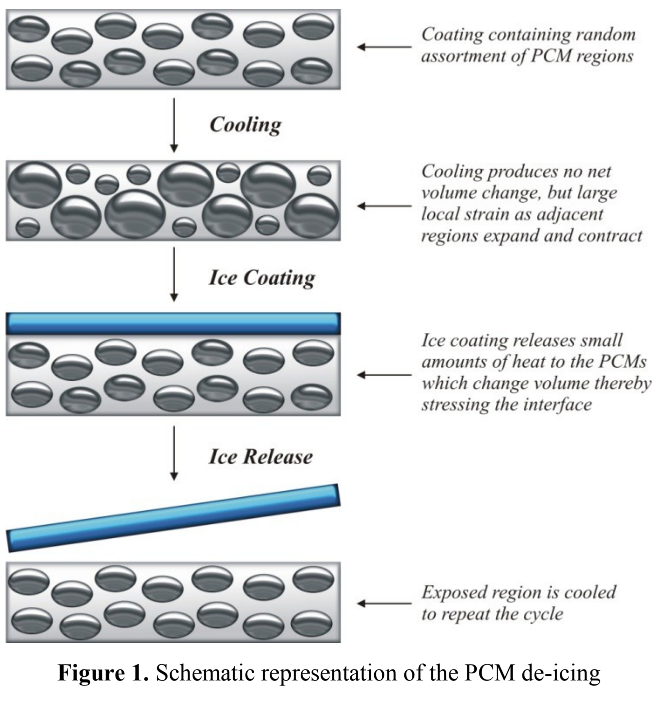


Figure 1. Schematic representation of the PCM de-icing

What happens during icing events is illustrated in Figure 1. The steps that lead to the cycle for mechanical rejection of ice are: 1) Micro-phase PCM regions near the coating surface undergo *solid-solid* phase changes over a narrow temperature range, slightly below where ice formation occurs. Cooling below 0°C by the air flow results in local contraction of the polysiloxane carrier resin and simultaneous expansion or stretching of the PCM such that the composite bulk film, on the average, contracts relatively little if at all. 2) Super-cooled water droplets coat the coating surface and freeze. As ice forms on the surface, some of the latent heat of freezing of ice passes to these PCMs near the surface. 3) This heat is absorbed by the PCMs and causes solid-solid phase changes. Surface regions of the coating expand and adjacent regions contract. Uniform distribution of micro-spherical PCMs facilitates this process. The ice-coating interface experiences local shear stress of alternating sign. This causes local failure of the ice-coating bond, and de-icing. The actual lateral local displacements of the surface are on the order of one tenth the diameter of the particles. These displacements produce a local linear strain parallel to the coating surface of about 0.1, more than enough to locally break the ice-surface bond.

2. PHASE CHANGE TEMPERATURE DETERMINATION BY DSC

The temperature range where phase change occurs in PCM-base coatings was determined by differential scanning calorimetry (DSC). DSC is a thermoanalytical technique in which the difference in the amount of heat required to increase the temperature of a sample and reference are measured as a function of temperature. DSC is used in studying phase transitions involving energy or heat capacity changes. By measuring the difference in heat flow between the sample and reference, differential scanning calorimeters measure the amount of heat absorbed or released during these transitions. Two scans were performed per sample cooling to -40°C and heating to 60°C. Films of fully formulated coatings were used for testing. Results from DSC show that PCM-based coatings undergo phase change from -11 to -5°C. Peak adsorption was observed at -5°C. The broad transitions observed (Figure 2) overall are suggestive of polymeric or complex mixture systems.

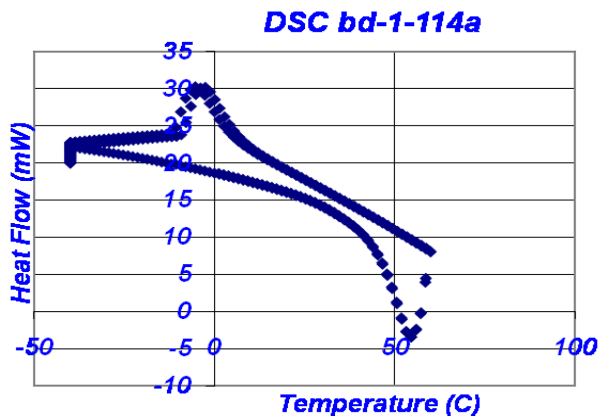


Figure 2. Phase change temperature determination by DSC

3. CRYO-CLEAVE SEM IMAGING OF PCM -BASED ICEPHOBIC COATING

PCM size and dispersion in polymeric matrix was imaged by Cryo-cleave SEM imaging. In Cryo-cleave SEM, images can be made of the fracture surfaces below the coating surface (side view). The PCM-based coating applied to an aluminum panel was rapidly frozen in liquid nitrogen. The cryo-chamber is equipped with a knife that can be handled from outside by means of a level to fracture the sample for applications in which imaging of the surface of inner structures is aimed. Imaging from Cryo-cleave SEM (10,000XMagnification) is presented in Figures 3. The image shows that PCMs uniformly dispersed in the coating matrix as 2-3µm diameter spheres.

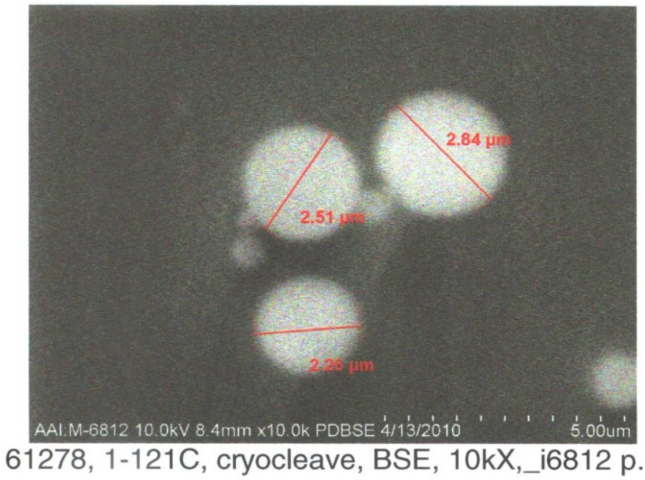


Figure 3. SEM Image of PCM 3000 (formula 1-121C), 10kX magnification

4. ICE-ADHESION TESTING

Ice adhesion testing by double lapshear pull tests (ASTM D3528) and by Centrifuge Ice Adhesion Test (CAT) demonstrate de-icing properties of PCM-based coatings. Ice adhesion testing following ASTM (2002) D3528-96 was developed by the US Army Corps of Engineers CRREL in Hanover, NH. The Centrifuge Ice Adhesion Test (CAT) was developed at the Anti-Icing Materials International Laboratory (AMIL) of the University of Quebec at Chicoutimi.

4.1 Ice-adhesion Testing by Double Lap Shear (ASTM D3528-96)

Ice adhesion testing by double lapshear involved the removal of aluminum test coupons coated with candidate PCM-based icephobic coatings from an iced test fixture. This test method was employed to qualify PCM chemistries as icephobic.

Aluminum (3.175mm thick, 2024) test coupons, 25.4mm wide by 101.5mm long, with a hole drilled in the top are used for testing. Three coupons are coated with each prospective formulation. Each sample coupon is coated with the material to be tested and then placed into the groove in the test fixture. It is held centered by a small groove in the bottom of the base piece. The top is held centered by a wrap of tape which also forms a watertight seal around the coupon. The space between the coupon and base piece is filled with de-ionized and de-gassed water and frozen at -10^{0}C. The test fixture is mounted in a United Test Systems UTM, model # SFM-50kN with environmental chamber and Datum 3.0 analytical data acquisition software is used for conducting the test. The chamber is connected to a LN2 cryogenic tank to maintain sub-zero temperatures in the chamber. The test is conducted at -4^{0}C, and the force required to pull the sample coupon out of ice measured. The test coupon is pulled at a rate of 0.127mm/min for the first 10 minutes and then at a rate of 12.7mn/min until a total distance of 25.4mm is reached.

Ice adhesion to hundreds of prospective PCM-based coatings was measured following ASTM D D3528 in attempts to optimize de-icing properties of PCM coating chemistry. Results are summarized in Figure 4. Minimal force is required to remove test coupons coated with the optimized PCM-based coating, less than 1psi (5.5±3.9 kPa). By contrast, the force required to remove ice from polyurethane (MIL-PRF-85285D) coated test surfaces is 324.1±35.3 kPa.

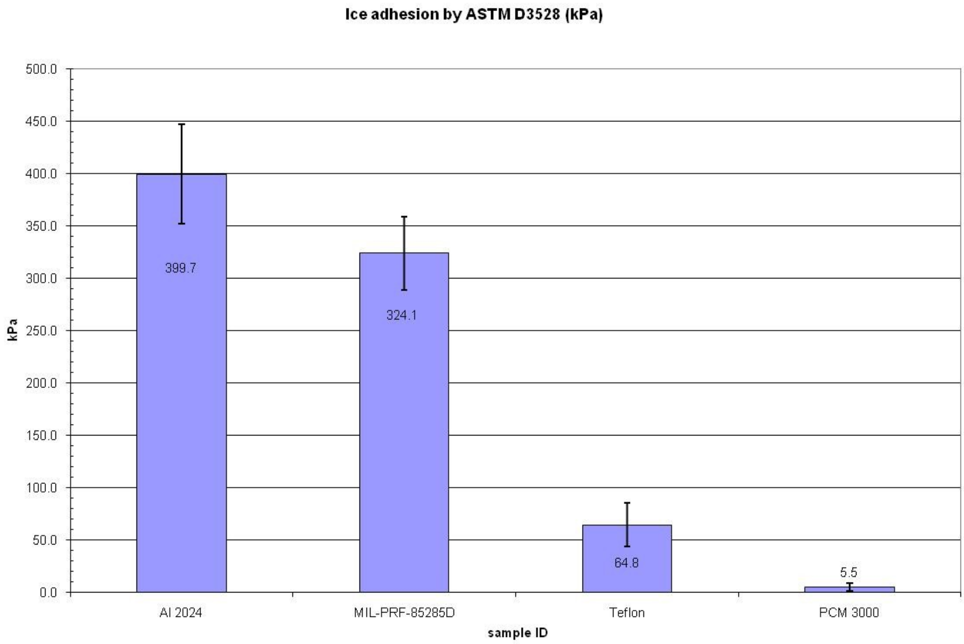


Figure 4. Double lap shear test fixtures

4.2 Ice Adhesion by Centrifuge Ice Adhesion Test (CAT)

Testing at AMIL was performed to measure the adhesion reduction of candidate ice-phobic coatings compared to uncoated (control) surfaces. Aluminum beams are iced in a cold room and then ice adhesion tested as a function of centrifugal force (F). The test beam dimensions are shown in Figure 5.

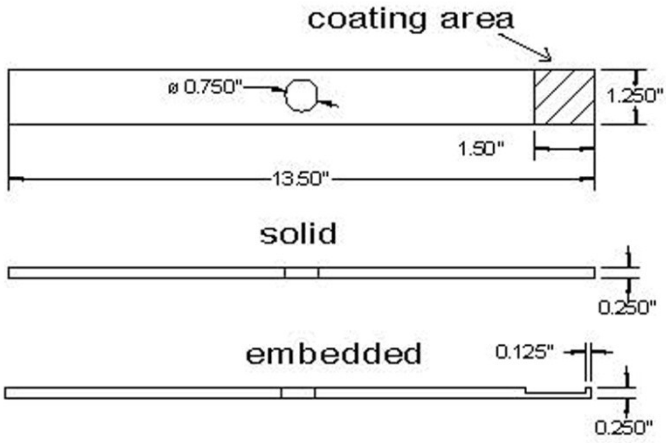


Figure 5. Test Beam Dimensions

The beam is rotated at an accelerated speed until ice detaches due to centrifugal force. Sensors detect ice detachment in real time and the time to detachment and rotation speed recorded. Three aluminum beams were coated with the PCM-based formula optimized through ice adhesion by double lapshear testing, PCM 3000. PCM 3000 was sprayed to a masked area ($12cm^2$) on one end of the solid bar. The coating was cured 48 hours at 25°C, the masking removed, and test surfaces shipped to AMIL. Ice was frozen to the test surfaces in 32 minutes at -8.0±0.1°C. The test was conducted at -10.0±0.1°C. Bare aluminum bars were used as controls.

Results from CAT testing at AMIL confirm that PCM 3000 is icephobic. AMIL reported an Adhesion Reduction Factor (ARF) of 39.0 for PCM 3000. The ARF is calculated by comparing average shear stress to remove ice by centrifugal force measured using three coated aluminum test surfaces to the average stress measured on three bare aluminum controls, the higher the ARF, the more ice-phobic the coating. The ARF of Teflon is roughly 7.0. Only sacrificial coatings, such as lithium and silicone greases, achieve greater than 30.0. Based on results from AMIL, ice shedding properties of PCM-based ice-phobic coatings exceed that of all other commercially available products. PCM-based ice-phobic coatings yield a durable more permanent solution to the icing problem than soft silicone or grease-based sacrificial coatings.

5. ICE ACCRETION TESTING

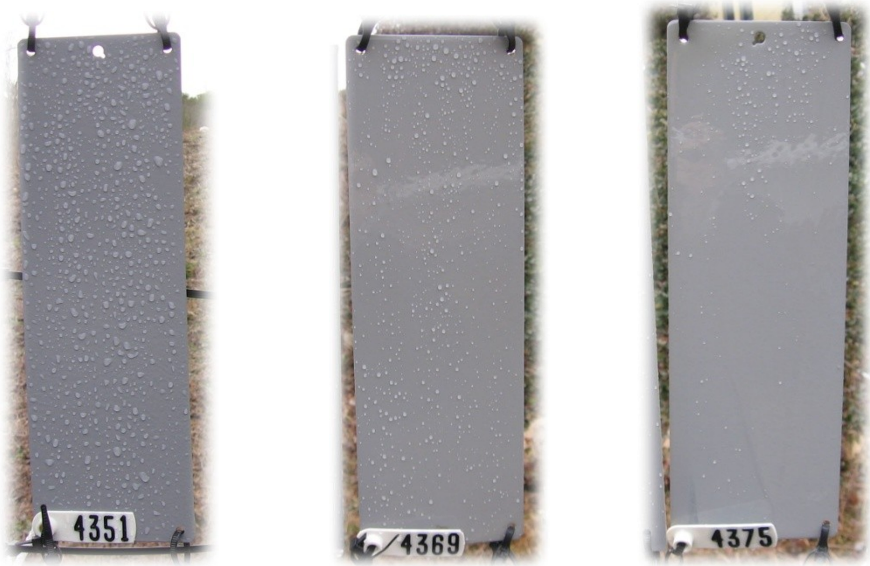
PCM-based coatings and controls were weathered for about six months outside research facilities in East Falmouth, MA. Steel and composite test panels were coated with MIL-P-24635 and over coated with PCM-based coating formulas. Test panels were fixed to test racks for a southerly facing exposure. Test panels were exposed to a total of 21.5 inches of precipitation during the test period between January 13 and June 27, 2006.

Test panels were monitored and documented after snow-ice events and using pictures and the aid of a computer graphics program, the formulations were then evaluated by measuring the average size and frequency of ice formation and giving it a rating. ASTM D714, *Standard Test Method for Evaluating Degree of Blistering of Paints*, has been modified for this test by substituting the size and frequency of paint blistering with the size and frequency ice bead formation. The results are rated based on their performance, bead size 10 being the best and 0 being the worst. The frequency of the beads is rated as none being the best case and dense being the worst. The results are presented in Table 1 and Figure 6. The type of substrate did not seem to have any influence on the rating results. For the most part, ice formation was the same for a given formulation, regardless of the underlying substrate.

Table 1. Vertical Angle Panel Outdoor Weather Testing Observations and Results

Start Date: 1/13/06		Date: Time: Temp: Condition:	1/23/06 8:00 am 33°F After rain-freeze event	Date: Time: Temp: Condition:	2/1/06 8:00 am 32°F After rain-freeze event	Date: Time: Temp: Condition:	2/13/06 10:00 am 27°F During snow event
Formulation	Substrate Type	Ice Bead Size*	λ**	Ice Bead Size*	λ**	Ice Bead Size*	λ**
MIL-P-24635 Silicone-Alkyd Enamel Control	Steel	4	Medium-Dense	4	Medium-Dense	10	Dry
MIL-P-24635 Silicone-Alkyd Enamel Control	Alum 5052	4	Medium-Dense	4	Medium-Dense	10	Dry
MIL-P-24635 Silicone-Alkyd Enamel Control	GFVE	4	Medium-Dense	4	Medium-Dense	10	Dry
0% PCM,	Steel	7	Medium	7	Medium	10	Dry
0% PCM	Alum 5052	7	Medium	7	Medium	10	Dry
0% PCM	GFVE	7	Medium	7	Medium	10	Dry
10% PCM	Steel	8	Few	7	Few	10	Dry
10% PCM	Alum 5052	8	Few	8	Few	10	Dry
10% PCM	GFVE	8	Few	8	Few	10	Dry

* Ice Bead Size: Scale from 0-10 (0 = >12mm, 2 = 6mm, 4 = 3mm, 6 = 2mm, 8 = 1mm, 10 = 0mm)
** Frequency (ASTM D714): Dense (D), Medium Dense (MD), Medium (M), Few (F)



MIL-P-24635 Silicone-Alkyd Enamel Control | 0% PCM, Polysiloxane Carrier Resin | 10% PCM, Polysiloxane Carrier Resin

Figure 6. Vertical Angle Steel Substrate Test Panels After Rain-Freeze Event

6. DEMONSTRATION ON RADOME

The FAA has concluded icing on radar and communications equipment to be a serious hazard to people and equipment on the ground and detrimental to system performance. Ice normally does not de-bond from the radome structures until buildup is extremely heavy, ice masses exceeding 200lb in weight before de-bonding occurs. Ice thrown through the air at this weight and velocity is enough to kill or severely injure a person and damage equipment on the ground. The FAA has charged the Volpe National Transportation Systems Center (Cambridge, MA) with finding a solution to the icing problem.

Volpe Center engineers Mr. Thomas Seliga and Mr. Allen Mackey arranged a demonstration project to prove the efficacy of incorporating ePaint's PCM-based ice-phobic coating technology onto radome and communication equipment. The demonstration project involved painting a candidate PCM-based formula onto a 20' EASAT radome, placing the radome into service, and blasting the radome with snow and ice. This demonstration project was a cooperative effort between ePaint, The Volpe Center, Sensis Corp., and the FAA.

PCM-based ice-phobic coating was applied to an EASAT radome at Sensis Corporation facility in Syracuse, NY. On March 9, 2009, the radome was transferred and installed on a tower at Sensis Corp. testing facility located at Syracuse Hancock International Airport. The EASAT radome is 20' long and operates by spinning one revolution per second. Radio frequency testing performed by Sensis Corp. determined there were no issues with the coating interfering with signal transmission or reception.

Figure 7. Application of PCM **Figure 8.** EASAT Radome

Testing commenced the morning of March 13, 2009. Temperature and relative humidity on the tower ranged from 26-30°F during testing, humidity was low. According to Greek Peak Summit representative JR Hill, environmental conditions were perfect for making snow and ice. The ice-phobic painted radome was blasted with wet snow and ice from snow making equipment operated by Greek Peak Summit. The radome was blasted for approximately three hours with wet snow and ice, stopping periodically to evaluate effectiveness of the coating.

Figure 9. Blasting the EASAT Radome with Wet Snow and Ice

Within several minutes of resuming the operation of the radome and snow making equipment, a large section of ice shed and landed about 100' from the tower. The shed ice was about 12-20mm in thickness, released from the coating surface. Testing was continued for approximately another two hours and during that time, ice continued to shed off the radome structure at 5-10 minute intervals.

7. CONCLUSION

A novel ice-phobic coating was discovered that yields passive anti-icing and dynamic de-icing properties to prevent ice accretion on metallic and composite surfaces. The shear induced stress from local expansion-contraction regions results in stressing of the ice-coating interface. The research was significant as the coatings based on PCMs potentially offer more effective, less costly and more durable replacements for the existing icephobic coatings.

PCM-based icephobic coatings are transparent, flexible and offer a highly hydrophobic surface. Surfaces coated with PCM 3000 have high contact angles, so water just beads and runs off the surface. Ice accretion measurements showed very little ice accumulation on the surfaces coated with our icephobic coatings. Ice that does accumulated on these coating surfaces can be easily removed. Ice adhesion measurements indicate that minimal (<1psi) force is required to remove accreted ice.

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New Roles and Responsibilities of Flag States and Port States in the Context of the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009

Onur Sabri Durak
Ph. D. Candidate, Shanghai Maritime University
onursabri@hotmail.com

Abstract: The ship-recycling activity is a friendly way of disposing obsolete ships at the end of ship's life cycle for a long time. In this context this article briefly outlines the features of ship recycling industry. However, the international legal framework for the ship recycling industry goes back to 1980's and it is to say, the legal framework is in its infancy. In this regard, this article firstly outlines historical background of legal framework related to ship recycling and, then introduces the Hong Kong Convention. Subsequently, the article discusses new roles and responsibilities of Flag States and Ports States in the context of the Hong Kong Convention from a legal viewpoint. Finally, this article states for conclusion remarks.
Keywords: Hong Kong Convention, Flag Stats, Port State.

1. INTRODUCTION

A vessel may stay with one owner or may change ownership several times during its whole life, however that life has unavoidable finite and at the final stage, generally there is only one voyage left which is to the ship recycler. Even though ship recycling process is not the only option for obsolete ships at the end of their life cycle [5], [6], [19] disposal of ships at the end of their economic life via ship-recycling has great significance for the continual renewal of the merchant marine fleet [15], [21] and for sustainable development [20]. However, ship-recycling activities have adverse effects on environment [11], occupational health and safety [1], [12], [17]. On one hand, ship recycling activities contribute to sustainable development and is the environmentally way of disposing obsolete ships [15] and economically integrated to life chain of them [2]. On the other hand, unfortunately, ship recycling activities impose adverse impacts on marine environment and some social, occupational, health disadvantages [1], [2], [11], [12].

Ship recycling costs are comparatively higher in developed countries such as in European Union member States (EU) or in United States of America (USA) than less developed countries due to strict regulations related to environment, occupational health and safety concerns. Thus, ship recycling activities in developed countries are not economically viable and in connection with cost concerns in developed countries, ship recycling activities are transferred from developed countries to less developed countries, particularly to five of them; India, Pakistan, Bangladesh, China and Turkey [7].

At the final stage of obsolete ship's life cycle, subject matter ship contains a range of hazardous, noxious and toxic substances [11], [12], [21]. In EU, USA and Member States of the Organization for Economic Co-operation and Development (OECD), materials generating from ships that contain hazardous, noxious and toxic substances are subject to monitoring and their disposal is strictly regulated under the international/domestic legal instruments [13]. Most of the hazardous, noxious and toxic substances generating from ships are strictly limited or banned under the existing regime of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989 (the Basel Convention). Persistent Organic Pollutants (POPs) are kinds of hazardous substances that persist in the atmosphere, and then bio-accumulate in human beings as well as in fauna and flora. In this regard, the Stockholm Convention on Persistent Organic Pollutants was promulgated in 2001 to protect human health and environment from any adverse effects of POPs. The Stockholm Convention lists Polychlorinated Biphenyl (PCB) as one of the POPs stated under the Stockholm Convention. The Stockholm Convention limits the scope of exporting the POPs including PCB without the prior informed consent of the importing country. Moreover, the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade entered into force in 2004. The Convention lists a number of chemicals and requires for informed consent from the importing country prior to export.

Accordingly the IMO has adopted Guidelines on Ship Recycling in 2003. The ultimate purpose of the Guidelines is to promote ship recycling as the best option for the disposal of obsolete ships. In this regard, the Guidelines provide guidance on how to prepare ships for recycling and minimize the possible adverse effects of hazardous materials [8], [9].

Furthermore, the ship recycling industry imposes occupational accident and health threats to workers in ship recycling/breaking yards. Workers in ship recycling/breaking industry located in less developed countries generally do not have proper occupational trainings; do not wear protective dresses and equipments to avoid any possible accidents and; there are no warning signs referring to danger at ship recycling/breaking yards. One of the main reason for occupational accidents and health threats to workers arising out of ship recycling/breaking industry is that, most of the States are lack of appropriate and adequate domestic labour law, social security and occupational safety and health law framework [12]. In addition to that, ship recycling locations around the world make the enforcement of laws and regulations very difficult or even impossible [2].

Accordingly, the International Labour Organization adopted guidelines called as 'Safety and Health in Shipbreaking: Guidelines for Asian Countries and Turkey'. The ultimate purpose of the Guidelines is to improve the occupational safety and health of workers in ship recycling yards. The ILO Guidelines urge ship recycling countries to promulgate a national legal framework to ensure the occupational safety and health of workers employed in ship recycling activities [7].

Even though there is a number of international legislative documents regulating the environmental and occupational issues for ship recycling industry, the truth in the global world is that; shipping industry relies on less developed/developing countries to dispose of obsolete ships through the ship recycling/ship breaking process [2], [10]. As a result, currently, the shipping industry in developed countries avoids the burden of complying with the high cost standards in order to manage hazardous, noxious, dangerous wastes generating from ship-recycling activities and occupational safety and health measures.

Taking into account rise of environmentalism [4], economical, social and occupational considerations [2], the International Maritime developed and adopted the Hong Kong Convention. The Hong Kong Convention's enforcement requires flag states', port states' and coastal states' joint efforts and works. In this regard this article, initially, introduces background of the Hong Convention and outlines the framework in the second chapter. While the chapter three addresses the Flag States' roles and responsibilities, the chapter focuses on Port States' roles and responsibilities under the Hong Kong Convention. Finally, chapter five states remarks for conclusion.

2. THE HONG KONG CONVENTION

The Hong Kong Convention was developed under the joint efforts of International Maritime Organization, International Labour Organization and the Basel Convention Working Group on Ship Scrapping. During the drafting process of the Convention it was consulted to the all relevant shipping industry parties and so, the Hong Kong Convention reflects considerations of all those parties. The Hong Kong Convention intends to be legally binding, globally applicable and easily enforceable.

The Hong Kong Convention comprises twenty one articles that cover the general obligations of Party States, definitions, application of the Hong Kong Convention, controls related to ship recycling, survey and certification of ships, authorization of ship recycling facilities, exchange of information, inspection of ships, detections of violations, violations, undue delay or detention of ships, communication of information, technical assistance and co-operation, dispute settlement, relationship with international law and other international agreements, signature, ratification, acceptance and accession procedures, entry into force conditions, amendments procedure, denunciation, depositing procedures and official languages of the Hong Kong Convention.

The Annex to the Hong Kong Convention comprises four chapters. Chapter 1 is dedicated to the "General Provisions" of Regulations 1-3. Chapter 2 outlines Requirements for Ships in Regulations 4-14. Chapter 3 of the Annex elaborates "Requirements for Ship Recycling Facilities" of Regulations 15-23. And, finally Chapter 4 of the Annex outlines "Reporting Requirements" in Regulations 24-45.

In addition to the Annex, the Hong Kong Convention comprises seven appendices. Appendix 1 outlines "the Control of Hazardous Materials". The Appendix 1, initially lists the types/names of the hazardous materials, then defines them in details and finally applies the control measures. The "Minimum Lists of Items for the Inventory of Hazardous Material" is introduced under the Appendix 2. The Appendix 3 denotes "Form of the International Certificate on Inventory of Hazardous Materials", "Endorsement to Extend the Certificate if Valid for Less Than Five Years Where Regulation 11.6 Applies", "Endorsement Where the Renewal Survey Has Been Completed and Regulation 11.7 Applies", "Endorsement to Extend the Validity of the Certificate Until Reaching the Port of Survey or for a Period of Grace Where Regulation 11.8 or 11.9 Applies" and Endorsement for Additional Survey. In dealing with ship-recycling facilities, Appendix 4 outlines the "Form of the International Ready for Recycling Certificate" and "Endorsement to Extend the Validity of the Certificate until Reaching the Port of Ship-Recycling Facility for a Period of Grace Where Regulation 14.5 Applies". Consequently, the "Form of the Authorization of Ship Recycling Facilities" is adopted under the Appendix 5. The Appendix 6 outlines the "Form of Report of Planned Start of Ship Recycling". And, finally, the Appendix 7 goes through the "Form of the Statement of Completion of Ship Recycling".

The Hong Kong Convention creates an integrated system. By virtue of Article 1.5, unless expressly provided otherwise, a reference to this Convention constitutes at the same time a reference to its Annex. In this respect, Parties to the Hong Kong Convention have no right to raise reservations or objections to the Annex.

3. FLAG STATES' ROLES AND RESPONSIBILITIES IN THE CONTEXT OF THE HONG KONG CONVENTION

3.1 Terminology Problem

The phrase of "Flag States" is a well known and established concept in International Customary Law and International Law. Historically, this concept has been transferred from customary law into legislative documents under international law. It is to say, the concept of Flag States was initially stipulated under the Convention on the High Seas, 1958 and codified the primacy of Flag State jurisdiction, consequently, the concept was transferred into newly international legislative documents.

The Convention on High Seas, 1958 Article 5.1 stipulates that, "each State shall fix the conditions for the grant of its nationality to ships, for the registration of ships in its territory, and for the right to fly its flag". The corresponding Article 91 of the United Nations Conventions on the Law of the Sea, 1982 (UNCLOS) deals with the grant of nationality by a State to a ship. The Article 94 of the UNCLOS imposes duties on the Flag States

The Hong Kong Convention refers to the concept of Flag State; however, the Hong Kong Convention prefers to stipulate "… ships entitled to fly the flag of a Party or operating under its authority" in Article 3.1.1, "sovereignty or jurisdiction of the State whose flag the ship is entitled to fly" in Article 3.3, "ships flying its flag or operating under its authority" in Article 5, "ships flying the flag of that Party" in Article 12.4, instead of explicit term of "Flag State". Different terminology stipulated under the Hong Kong Convention relating to Flag State concept brings legal questions and ambiguities.

Do terms stipulated under the Hong Kong Convention have differences rather than the "Flag State"? Even though Article2 of the Hong Kong Convention prescribes the definitions, the Article is in a silence for the definition of Flag State. Moreover, while the Hong Kong Convention is describing the "administration", the Convention consistently stipulates "…of the State whose flag the ship is entitled to fly…". Since the Hong Kong Convention does not describe the Flag State and stipulates different terminology, the meaning should be investigated under the International Law.

By virtue of Article 15.1 of the Hong Kong Convention, nothing in the Convention shall prejudice the rights and obligations of any State under the UNCLOS, 1982 and the customary international law of the sea. In this context meaning of Flag Stated should be particularly investigated in accordance with UNCLOS, 1982.

Article 91 of the UNCLOS, 1982 outlines the nationality of ships and stipulates that, every State shall fix the conditions for the grant of its nationality to ships, for the registration of ships in its territory, and for the right to fly its flag. While Article 92 of the UNCLOS, 1982 is addressing the status of ships, it refers to the flag of one State, in other words “Flag State”. The term of “Flag State” has been explicitly prescribed under the Article 94 of the UNCLOS, 1982, as “Duties of the Flag State”. In accordance with Article 94, every State shall effectively exercise its jurisdiction and control in administrative, technical and social matters over ships flying its flag.

This limited analysis in the Hong Kong Convention and the UNCLOS, 1982 indicates that, terminology stipulated for the Flag State has not been unified yet under the international legislative documents and instruments. This may lead lack of coordination and inconsistencies for the simultaneous enforcement of international legislative documents.

The second fault related to Flag State concept arises out of Article 3.1.1, that stipulates “ships entitled to fly flag of a Party or operating under its authority”. The first part of the sub-article “ships entitled to fly flag of a Party” is discussed and investigated above. It is to say first part of the sub-article may conform to Flag State concept under the International Law. However, what is the meaning of “operating under its authority? The definitions of the Hong Kong Convention do not answer for this question. Literally it might be thought that, the phrase “operating under its authority” refers to ships operating under the Party’s authority; in other words, ships owned or operated by a Party and used for only on government non-commercial service. However, since Article 3.2 of the Hong Kong Convention excludes the government ships for non-commercial service for the application the Convention, abovementioned idea is legally groundless.

Another idea might be discussed that, this phrase refers to the ships that do not fly the Flag of a State but operate under the State’s authority. Every State has the right to regulate its domestic law and the State may not require its ships to fly a Flag. This possibility might be acceptable under very limited conditions, if the ship solely sails through the inland and territorial waters of the State. However, Article 3.3 of the Hong Kong Convention has already excluded these types of ships from the enforcement of the Convention. Moreover, recently, for any State in the global world, it is impossible not to impose flying the Flag of the State even in its inland and territorial waters, in connection with the safety and security matters.

As a sum up, it is to say, drafting methodology of the Hong Kong Convention may lead further discussions in the context of Flag State concept.

3.2 Roles and Responsibilities of the Flag States

Article 1 of the Hong Kong Convention imposes general obligations on State Parties as Port State, Flag State and Coastal State. In connection with the general obligations stipulated under the Article 1.1, each Party to the Hong Kong Convention undertakes to give full and complete effects to Convention’s provisions in order to prevent, reduce, minimize and, to the extent practicable, eliminate accidents, injuries and other adverse effects on human health and environment as a result of ship recycling. The purpose of the Article is to enhance ship safety, protection of human health and the environment throughout a ship’s operating life. By virtue of Article 1.4 State Parties undertake to encourage the continued development of technologies and practices which contribute to safe and environmentally sound ship recycling. In accordance with Article 1.3 Party States shall endeavour to cooperate for the purpose of effective implementation of, compliance with and enforcement of the Hong Kong Convention. Furthermore, in accordance with Article 9.1, each Party State shall cooperate in the detection of violations and the enforcement of the provisions stipulated under the Hong Kong Convention. By virtue of Article 10.1, State Parties are obliged to regulate its national law and adopt appropriate legislative instruments to avoid any violations of the requirements of the Hong Kong Convention

By virtue of Article 4.1 each Party State shall require that ships entitled to fly its flag or operating under its authority comply with the requirements set forth under the Hong Kong Convention and shall take to the extent effective measures to ensure such compliance.

Flag States are imposed to survey and certify the ships entitled to fly its Flag. In this context, Article 5 prescribes that, each Flag State shall ensure that ships flying its flag and subject to survey and certification are surveyed and certified in accordance with the regulations in the Annex of the Hong Kong Convention.

In accordance with Article 10.1.1, Flag State has the authority and jurisdiction over the ship wherever the violation occurs. If the Flag State administration is informed of such kind of a violation by a Party State, the Flag State administration shall investigate the matter and may request the reporting Party State to furnish additional evidence of the alleged violation. If the Flag State is satisfied with the submitted evidence(s), the Flag State administration shall take appropriate proceedings as soon as possible, in accordance with its national law. The Flag State administration, then, shall promptly inform the Party State that reported the alleged violation of any action taken. If the Flag State administration has not taken any action within one year after receiving the information, the Flag State shall inform the Party that reported the alleged violation, of the reasons why no action has been taken.

By virtue of Article 12 of the Hong Kong Convention the Flag State shall report to the International Maritime Organization the below information:

- annual list of ships flying the flag of that State Party which an International Ready for Recycling Certificate has been issued;
- an annual list of ships recycled within the jurisdiction of that Party;
- information concerning violations of the Convention; and
- actions taken towards ships under the jurisdiction of that Party.

4. PORT STATES' ROLES AND RESPONSIBILITIES IN THE CONTEXT OF THE HONG KONG CONVENTION

4.1 The Evolution of International Law Instruments in the Context of the Port States' Roles and Responsibilities

Traditionally, the establishment of the maintenance of good order on high seas has based upon the concept of nationality of the ship and consequent jurisdiction of the Flag State over the ship. The Flag State responsibility has been in an evolution since the medieval ages and well established in the international law and international customary law [14], [18]. However, as a regulatory system, the Flag State responsibility has been developed by the Member States of the IMO over the past fifty years in a global legal manner [14]. In an ideal world, the Flag States would command and enforce upon their shipowners, standards of design, maintenance, operation and manning which would ensure a very high standard of safety at sea. Coastal States, along whose coasts ships sail through and Port States, at whose ports for shipping calls, would have no cause and involvement to concern themselves with the control and enforcement of such standards. Unfortunately, in the current world of shipping industry, this demonstration is beyond the realities [14].

The principal concern for an effective Flag State responsibility and regime is the will, capacity and ability of the Flag State to provide appropriate and adequate infrastructure and legal capability for the administration and the enforcement of applicable legal instruments for maritime industry [14]. Even though, the Flag State regime is well established in the customary law and incorporated into international Conventions, it is realized that the Flag State responsibility system does not work properly and ineffective cause of many reasons as follows:

- Due to economic and financial considerations, creation of flags of convenience [16],
- Ineffective national maritime administrations for monitoring ships under its control [14],
- Lack of financial resources and technical infrastructure to register and administer the ships flying its flag on a global basis and to monitor the registered ships under its national registration system [14], [16]
- Inappropriate and unqualified maritime administration personnel for inspections,
- Lack of political will and legal capacity to incorporate international legal instruments into national legal system [14],
- Delegation of Flag State's responsibilities for inspection, survey and certificate to private organizations that often do not have the capacity to carry out and conclude such kind of technical and administrative duties on behalf of the Flag State [14], [16],
- Lack of any mandatory regime for the international law-making institutions to enforce effective implementation of their legal instruments [3], [14].

All those problems have put intense pressure on the international law-making institutions to draw up a new international legal instrument for the achievement of a globally applicable and enforceable regime. In this connection, international cooperation and joint works have concluded and introduced a new legal instrument, so called *'Port State responsibility'* to achieve the ultimate purpose of international maritime safety and security regime [16].

4.2 Roles and Responsibilities of the Port States

Port State concept and Port States' responsibilities has been transferred into the Hong Kong Convention taking into account faults arising out of Flag State concept. Even though, the Port State and Coastal State maybe the same Country in some cases, a study on the Coastal State and its responsibilities is beyond the limits of this research. In this context, the coming paragraphs firstly outline the general obligations and responsibilities the Port States, then focuses on particular obligations and responsibilities of the Port States in connection with the Hong Kong Convention.

In this regard, every Port State that is Party to the Hong Kong Convention, is obliged to give full and complete effect to provisions of the Convention in order to prevent, reduce, minimize and, to the extent practicable, eliminate accidents, injuries and other adverse effects on human health and the environment as a result of ship recycling activities. By virtue of Article 1.3, Port State shall endeavour to cooperate for the purpose of effective implementation of, compliance with and enforcement of the Hong Kong Convention. Article 9.1 of the Hong Kong Convention stipulates that, Party States, including the Port State, shall cooperate in the detection of violations and the enforcement of the provisions of the Convention.

Article 8 of the Hong Kong Convention stipulates for the inspection of ships. In this context, 1st paragraph of the Article prescribes that, Port State that is a Party to the Convention is entitled to inspect a ship which the Hong Kong Convention applies, in any port or offshore terminal of that Party for the purpose of determining whether the ship is in compliance with the Convention. Such an inspection is limited to verifying that there is on board either a valid International Certificate on Inventory of Hazardous Materials or an International Ready for Recycling Certificate. However, where a ship does not carry a valid certificate or there are clear grounds for believing that:

- the condition of the ship or its equipment does not correspond substantially with the particulars of the certificate, and/or Part I of the Inventory of Hazardous Materials listed in the Appendices 1 and 2; or
- there is no procedure implemented on board the ship for the maintenance of Part I of the Inventory of Hazardous Materials listed in the Appendices 1 and 2

Port State may carry out a detailed inspection taking into account guidelines developed by the International Maritime Organization.

By virtue of Article 9.3, the Port State may take steps to warn, detain, dismiss, or exclude the ship from its port if the ship is detected to be in violation of the Hong Kong Convention. Port State shall immediately inform the Administration of the ship concerned and the International Maritime Organization about such actions.

In accordance with Article 10.2, the Port State is entitled to prohibit and establish sanctions under its law if there is any violation of the requirement of the Hong Kong Convention within the jurisdiction of the Port State. Whenever such a violation occurs, the Port State shall either:

- cause proceedings to be taken in accordance with its law; or
- furnish to the Administration of the ship such information and evidence as may be in its possession that a violation has occurred.

The sanctions provided for by the laws of the Port State shall be adequate in severity to discourage violations of the Hong Kong Convention.

Article 11.1 of the Hong Kong Convention stipulates that, Port State shall make all possible efforts to avoid a ship being unduly detained or delayed under the Article 8, 9 and 10 of the Convention. And, if the ship is unduly detained or delayed under the above-mentioned Articles of the Hong Kong Convention, it shall be entitled to compensation for any loss or damage suffered.

5. CONCLUSION REMARKS

Even though ship recycling is an integrated tier of shipping industry for such a long time, legal framework is far beyond to correspond with the expectations of industry and interested parties. The Hong Kong Convention is the very first significant step to integrate ship recycling industry into international maritime law regime. The Hong Kong Convention introduces new legal instruments for ship recycling industry to achieve an integrated management and legal system for the global shipping industry in a vertical scheme.

Together with the traditional Flag State responsibilities, the Hong Kong Convention introduces Port State's responsibilities in details as legal instrument in order to prevent, reduce, minimize and, to the extent practicable, eliminate accidents, injuries and other adverse effects on human health and the environment caused by ship recycling activities. In this context, Port State controls are expected to prevent deficiencies arising out of Flag States control, particularly of Flag of Convenience.

Although the very new Hong Kong Convention is a significant development for the maritime safety, marine protection and occupational safety and health regimes, the Convention still has deficiencies. These deficiencies arise out of the structure of the Convention, as it lacks an integrated management system after all ship recycling process. Furthermore, the success of the Hong Kong Convention depends on the signatures of five leading ship recycling States; Bangladesh, China, India, Pakistan and Turkey. Amongst five leading ship recycling States, only Turkey has signed the Convention on 27.08.2010; however, ratification documents have not been deposited yet to the International Maritime Organization by the Turkish authorities [9]. Furthermore, aside China and Turkey, remaining Countries are either lack of national legal framework and have reservations on signing the new Convention. These issues may affect the future viability of the Hong Kong Convention; even so, it is important to note that the Hong Kong Convention will offer a significant improvement in the global maritime safety, marine environment and occupational safety and health regimes upon its coming into force.

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Analysis and Trends of MET System in Croatia – Challenges for the 21st Century

Vlado Frančić
M.Sc., Faculty of Maritime Studies, University of Rijeka, Croatia, vfrancic@pfri.hr

Damir Zec
Ph.D., Faculty of Maritime Studies, University of Rijeka, Croatia, zec@pfri.hr

Igor Rudan
Ph.D., Faculty of Maritime Studies, University of Rijeka, Croatia, rudan@pfri.hr

Abstract: The paper deals with present status and recent trends and challenges in the MET system in Croatia. The standards of the present MET system, as it has been implemented in Croatia up to now, are more demanding than those prescribed in the STCW Convention and at the same time student-oriented. Consequently, the MET system offers more career opportunities to graduate students, particularly to those seeking employments on highly sophisticated vessels or similar shore installations. However, more than sixty years after introduction of mandatory higher education for top-level positions on board, the Croatian Government approved a new maritime career path. The adopted amendments introduced the so called "the alternative MET system", developed as a purely vocational system. It is expected that both systems will be running in parallel.
In the light of the aforementioned changes, the main objective of the paper is to assess and present possible impacts these changes will exert on the existing higher MET institutions in Croatia as well as to assess challenges to be faced by other stakeholders. In addition, possible consequences to the public image of the seafaring as a profession and its attractiveness among young people will be analysed.
Keywords: MET system, alternative maritime educational system, quality, comparison

1. INTRODUCTION

Education is one of the most important pillars in developing shipping industry. The shipping industry actively promotes maritime education activities and crew management represents very significant component of any shipping company policy. For this reason, education of seafarers as well as education for shore based personnel in shipping industry have large importance, and vary from professional and vocational training to specialized maritime education and training on various levels, from secondary schools to university degree education. Additionally, due to globalization in shipping business maritime education follows international standards which tend to be equal worldwide.

As a maritime-oriented state, Croatia has had a Maritime Education and Training (MET) system operating for a quite long period. Today, the majority of Croatian seafarers are employed on foreign companies resulting in education standards fully complying with international requirements, primarily laid down in the IMO STCW convention as well as with requirements of the EU educational framework. Current demands for seafarers include those serving on highly sophisticated, technologically advanced and very expensive ships, such as LNGs, cruising or container ships. Additional requirements on safety and environmental protection which is in force on these types of ships require high educational standards and continuous improvement. In many segments the Croatian MET system is beyond minimum STCW standards, particularly when offered at the university education stage.

Finally, the MET system in Croatia has recently undergone significant transformations and improvement following institutional requirements placed by the EU (Bologna declaration) for university level education in general. However, recent amendments in MET system implemented by the end of 2010 tend to minimise seafarers' education standards. Such a step, unquestionably, provides educational flexibility but could also jeopardize the already achieved quality of Croatian MET system and put additional challenge for the future.

2. AN OVERVIEW OF THE CROATIAN MET SYSTEM

Throughout history, as well as today, the people of Croatia had a strong connection with the sea and with all activities related to the maritime industry. Such developments in the shipping industry and navigation gave rise to creating organized maritime education and training (MET) system. The first education for seafarers began in the 16th century in the Republic of Dubrovnik and other free towns on the eastern coast of the Adriatic Sea. As an example, the year 2009 marked 160 years of the establishment of the first nautical school in Croatia in Bakar.

The development of the Croatian MET system could be divided into several stages which basically rely on secondary education nautical schools [1]. After the 2nd world war, the first higher education MET institution was established in 1949 in Rijeka followed with another two institutions in Split and Dubrovnik. They were expanding parallel with secondary education maritime training schools. The quality of education in addition to continuous improvement which followed the latest technology developments and the need for highly educated seafarers made it possible in 1978 to transform the Rijeka College of Maritime Studies into a university college offering degree studies. This was the first MET institution in Croatia to become a member of a university.

Today, MET institutions follow international standards and requirements laid down in the IMO STCW convention as well as in the EU educational legislation. The institutions operate under the umbrella of the Ministry of the Sea, Transport and Infrastructure (Maritime administration) parallel with Ministry of Science, Education and Sport.

The process of maritime education in Croatia is divided into two stages. The first stage includes vocational education within secondary education nautical schools, followed by the second stage - MET institutions of higher education (maritime faculties). Along the Croatian coast there are 6 secondary education nautical schools (in 2010 there were 327 graduated students) and 4 maritime faculties: in Rijeka, Zadar, Split and Dubrovnik with 281 graduated students in 2010. All MET programs and curricula are in accordance with STCW requirements, approved by the Administration and the functionality of the system is under constant control. Basically, secondary nautical schools have the task of preparing students for watchkeeping duties on ocean-going ships and for top-level positions on board ships in limited trades, while maritime faculties educate students for top-level positions on ships in international trade and for jobs ashore at the operational and management level.

In the recent period there have been two significant changes in the national MET system. The first was on harmonization with the IMO STCW convention in 1998. The second and the most important one was the implementation of the Bologna processes in higher education, which started in 2005. Afterwards, maritime higher education institutions fully adopted the structural reforms imposed on the national higher education system. It is, fundamentally, a three-tier system of studies (3+2+3), i.e. three years of undergraduate study for the bachelor degree, two years of graduate study for the master's degree and three years of postgraduate studies for the academic title of Doctor of Science. All studies are based on the standardized credit system[1] organization. In order to promote the principles of the Bologna declaration, such as wider cooperation and mobility among universities, harmonized development of MET curricula, as well as reducing the diversity of the education systems, the Croatian maritime institutions of higher education (Rijeka, Zadar, Split and Dubrovnik) harmonized their respective MET programmes of study. Such an organization enables both students and the teaching staff mobility and comparability of curricula, diplomas and qualifications, which also were imperatives of the Bologna declaration.

The following graph presents the higher maritime education system currently in force in Croatia.

[1] ECTS (European Credit Transfer System) - European Credit Transfer System which is a student-centred system based on the student workload required to achieve the objectives of a programme, objectives preferably specified in terms of the learning outcomes and competences to be acquired [6].

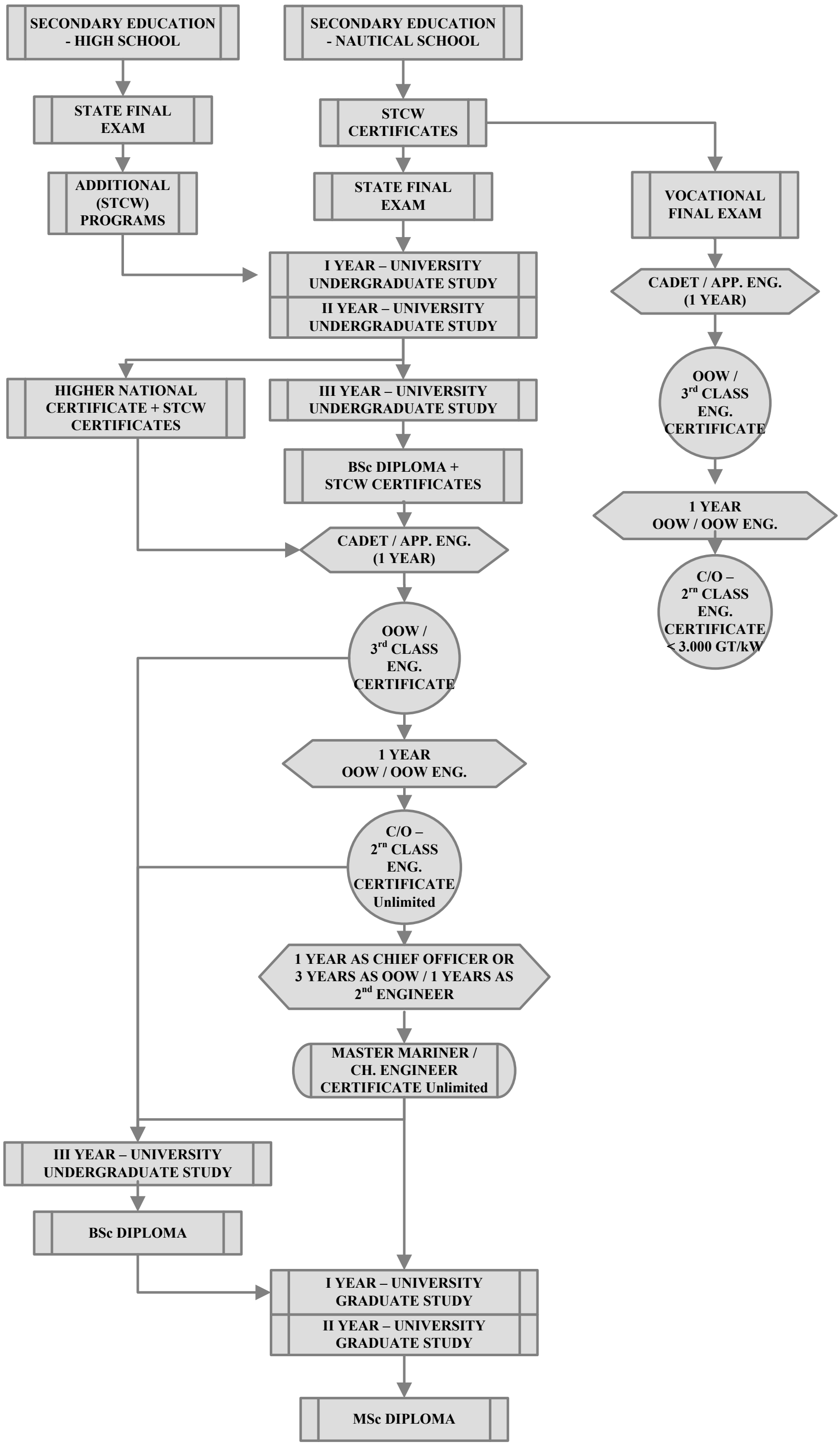

Figure 1. Croatian MET system

The specific feature of the new MET system was that the three-year BSc degree study can be conducted as a 2+1 programme, where the first two years cover the requirements of the STCW convention, sufficient for obtaining top-level positions on board, while the third year gives the student the possibility to gain the degree level education. It should be noted that such system represents a prolongation of education if compared to time before the Bologna changes in that the degree level education could be achieved in two years. However, with three years degree education, students can receive additional knowledge enabling them better competitiveness for shore-based employment possibilities. Also, the level of education is fully comparable with the education of other professions in Croatia. Furthermore, the second and the third educational tier are entirely designed for jobs and duties ashore. They are completely designed for creating high-level professionals in the maritime administration, R&D institutions as well as for top-level management in shipping and other related maritime companies.

Throughout all education levels special attention is given to quality of the curriculum which is a prerequisite for international recognition of the system and involvement of graduates in the global maritime market. In this way teaching is carried out using the latest teaching aids, including highly sophisticated simulators which are upgraded continuously.

3. “ALTERNATIVE” MARITIME EDUCATION SYSTEM

For the last several years an initiative was started for introducing changes to the existing, well known and established MET system in Croatia. Basically, the initiative started to build up as a consequence of the continuous threats on shortage of qualified and licensed officers, mostly engineering officers. At the beginning, the idea came from shipping companies, operated ships under Croatian flag. It followed by crewing agencies, particularly those representing low-to-medium level foreign shipping companies operating with technologically low-level ships. Towards the end, the strong initiative came from the seafarers organized in the association and from the Seafarers’ union of Croatia.

The main objective of the proposal was the implementation of the so called “Alternative maritime education system”. It is based on minimizing educational standards for top-level positions on board. Alternative maritime education system enables seafarers without higher education to attain the highest maritime ranks and certificates (Master Mariner and Chief Engineer certificates) through additional training which will meet the minimum STCW convention standards. The system, basically, represents a special instance of vocational system. This is why the initiative raised a great deal of disagreement followed by severe criticism coming from the higher education institutions and their graduates.

After more than one year of negotiation and the process of harmonization between maritime faculties, secondary education nautical schools, seafarers associations, companies, the competent administrations, and seafarers union at the end of 2010 the maritime administration put into force a new regulation on Special MET system, popularly referred to as Alternative System of MET. The system will goes parallel with the existing one.

The basic characteristic of the alternative system could be summarized as a specialized education for experienced officers in their professional advancement. The opportunity to attend the alternative system is given to those officers and engineers who have graduated from the nautical secondary school and have more than 36 months of sea service as officer. The education will be provided exclusively by higher education institutions as a part of lifelong education and credits in accordance with the European Credit Transfer System will be granted to all participants. Accreditation of the educational programme at the university level will give possibility for all participants to join and continue their studies within the existing higher educational system later on. The program comprises of 800 teaching hours[2] in total, divided in courses according IMO Model Courses 7.01 and 7.02. Exams are compulsory for each course. Due to the complexity of the seafarer profession, the programme is planned to be carried out in two or more modules (3 months or less per module), which enables seafarers an almost uninterrupted sea service. Participants' mobility will make possible to join the alternative programmes at any Croatian maritime faculty. However, participants will be obliged to take relative exams at the college were they attended that particular course. Participants who successfully complete this kind of education, i.e. who have successfully passed exams for each study course, will get the opportunity to take Master Mariner/Chief Engineer exam with the Harbour Master Office representing the competent Ministry of Transport. The following figure is a diagram representation of the new education system.

It may be concluded that the alternative MET system is introduced in addition to the existing, while at the same time retaining the existing maritime certification system. In addition, it should be noted that the new system follows the minimum STCW requirements. Mostly, the alternative system promotes and evaluates seafarer's practical knowledge, skills and experience. In relation to the regular higher education system, which involves higher educational standards and additional theoretical as well as practical knowledge, unquestionably above STCW requirements, this alternative MET system presents a minimalist STCW-based approach. It is expected that the alternative system will persist on condition that it is conducted under constant review by the maritime administration.

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[2] 750 hours of education for Master Mariner certificate and 795 hours for Chief Engineer certificate.

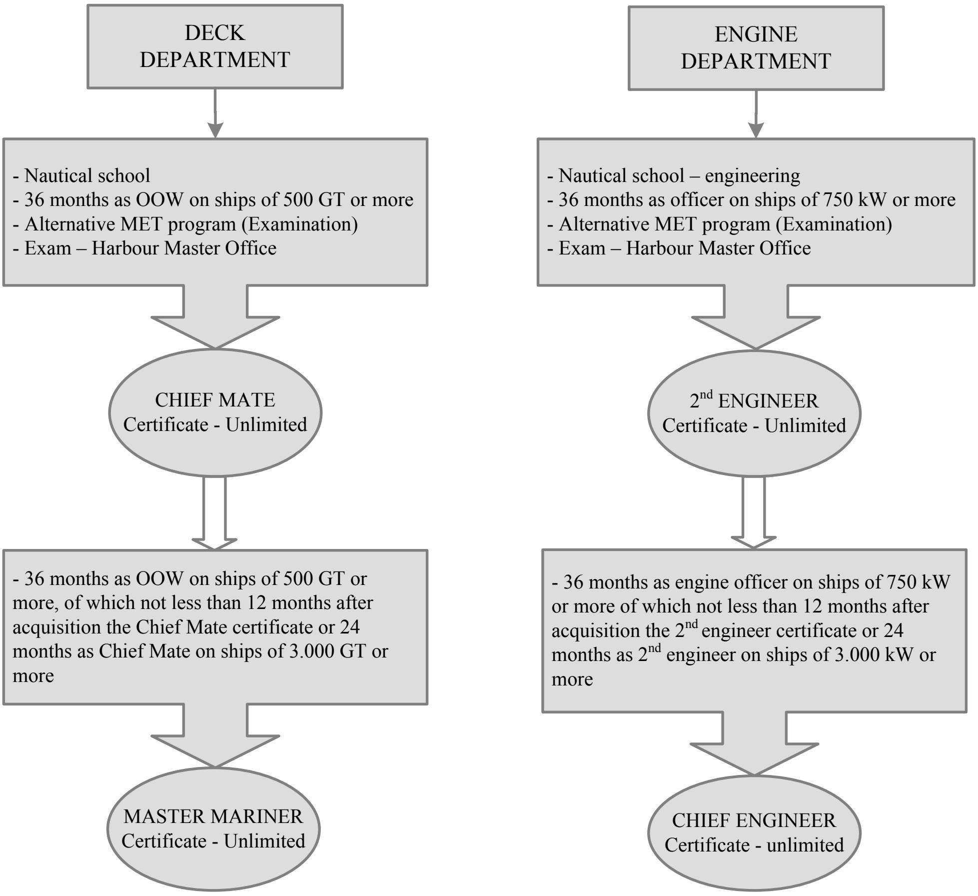

Figure 2. Alternative MET system organization

4. CROATIAN MET SYSTEM IN THE FUTURE - STRENGTHS AND WEAKNESSES

By introducing an alternative MET system the new era in Croatian MET system undoubtedly began. More than half century of well established and recognized education system has been changed. The policy of keeping degree programmes on the way to obtain Master/Chief Engineer certificates of competency has been apparently abandoned reducing the level of educational standards. The past Croatian MET system could be compared to the EU "3E" concept[3] which advocates systematic approach in much more higher level than approach placed in alternative system [1].

[3] Additionally, "4E" system lead to MSc and PhD programmes which is already included in Croatian MET system.

Having introduced the Bologna declaration principles into regular higher maritime education, five years ago, the Croatian MET system opted to follow the very high educational requirements of the 21st century. It satisfies almost all needs of a modern officer such as academic degree, computer science capabilities, maritime English proficiency, and leadership discipline to satisfy modern and expanded safety and environmental protection requirements.

A totally opposite system has been developed by introducing the low-level requirements which will inevitably cause negative consequences for the development of the Croatian MET system. Accordingly, in the future, we may expect an inevitable "battle" between demands of shipping industry for seafarers, mainly oriented to satisfying minimum education standards, and very high requirements of international and national maritime administration in respect to safety at sea and environmental protection connected with operation of highly sophisticated and technologically advanced ships.

Generally, the required standard of quality for seafarers depends on the shipping company's employment policy. Some of them claim that the seafarers graduated from the degree programmes are "over-qualified" for on board duties. Consequently, there is a fear of diminishing the number of new seafarers and decrease in the attractiveness of the seafarer profession. On the other hand, experienced officers holding a B.Sc degree could satisfy demands for shore-based management level jobs inside shipping industry, which enables more professional career opportunities for former seafarers willing to continue working ashore.

In order to analyze the possible consequences on Croatian MET system, in the light of recent changes, a questionnaire was prepared and disseminated among experienced seafarers[4]. The questions in the questionnaire were the following:

- Do you think that higher education level is necessary for the highest ranks on board ships (master, chief engineer, first mate, second engineer)?
- Do you think that, in the long term period, the quality and consequently reputation and recognition of Croatian officers in the global shipping industry, will be reduced?
- Do you think that existing officers holding degree education get unfair competition?

The results shows that more than three quarters of the examinees think that higher education level is necessary for the highest ranks on board ships as well as that in the long term period the reputation, and wages, of the Croatian seafarers could be reduced. As for competition "only" 71% of the examinees answered positively. It should be emphasized that between the tested officers without degree education (totally 18), 39% of them are of the opinion that higher education is necessary.

Before the implementation of the new system another survey had been made by the maritime administration with the following questions[5]:

- Will you continue your education at higher education institution after completing the alternative MET programme?

[4] Total number of examinees was 117.

[5] Some of the questions and results are omitted because it is not relevant for analyzing alternative MET system.

- Do you intend to spend a whole career on board?
- Are you ready to continue your career in the maritime administration?

The answers show that 57% of the seafarers will try to continue education on higher institution later on, 70% do not want to spend a whole career on board and even 81% are ready to look for job ashore in the maritime administration.

Summing up the results of the questionnaires several important points can be stated. First above all, the Croatian MET system should continue promoting higher education because any further reducing of education requirements could jeopardize Croatian seafarer's excellence and reputation. In addition, among the seafarers there are strong tendencies to carry on professional careers ashore, during their lifetime. Undoubtedly, MET system, as a part of higher education system, leads to better competitiveness and more professional opportunities for seafarers.

In the future, MET system should prepare seafarers to operate modern, expensive and technologically advanced ships in the first place and additionally for managing level positions within shipping and other maritime related companies. According to the presented results and in view of authors' knowledge and experience, here are the most prominent strengths and weaknesses that the Croatian MET system will be faced with in upcoming years (Figure 3).

Strengths	**Weaknesses**
- Long tradition and good organization - More career-oriented - Higher and highest degree education system (BSc, MSc, PhD) - Preparing students for shore based jobs	- Reducing educational standards – alternative MET system - Frequent changes - Shortage of seafarers - Theoretically oriented teachers
Opportunities	**Threats**
- Keeping existing educational level - Part of the EU educational framework - Supports from the shipping companies - Financial independence	- Low entry standards - Weak attractiveness for seafarers - Minimizing educational standards worldwide - Lack of financial support from the Government - Lack of teaching staff

Figure 3 SWOT analysis of the Croatian MET system

Additionally, as a possible consequence of the minimizing educational requirements another important issue could be emphasized. During the last decade in Western Europe, but also in Croatia, attractiveness of the seafarer profession was decreased. Therefore, the number of students enrolled in maritime educational institutions, secondary education maritime training schools and maritime faculties were decreasing, particularly among marine engineers[6]. On the other hand, higher education becomes almost mandatory as a rule for many other professionals and persons without degree education are not sufficiently competitive on the labour market. Therefore, there is a risk that minimising the existing values of MET system parallel with enhanced requirements of education standards in general. This will produce a negative influence on young people in their profession selection and will continue to decrease the attractiveness of the maritime profession in the general public.

It is obvious that the Croatian MET system has many positive attributes and could be considered as one providing excellence in international maritime education. However, internal weaknesses and demands imposed by the shipping industry worldwide require from all stakeholders, i.e. higher education institutions and nautical schools, teachers, as well as the administration, additional efforts to maintain existing standards. Furthermore, MET system shall adapt and follow updates in educational standards satisfying industry demands for highly skilled seafarers. This means they should take further actions for increasing the attractiveness of the seafarer profession and, at the same time, for improving MET quality to standards much more above minimum of STCW convention.

5. CONCLUSION

During the recent history the MET system in Croatia has been constantly adapting to all significant changes in shipping. Educating well trained seafarers meeting advancements in modern technology has been first issue for the national MET system. On the other hand, the process of constant diminishing the number of seafarers put the system under the pressure by the shipping companies willing to satisfy demands for seafarers.

Under such circumstances the Croatian MET system is placed between the need for education of seafarers at high standards for those intending to sail on highly sophisticated vessels and the industry requirements for filling the gap for officer’s in short period with minimum education standards. In this respect, the implementation of Bologna process was the step forward in increasing education level at the university standards with added value for seafarers willing to continue work on shore once they finish sea career. On the other hand the alternative MET system based on minimum STCW standards mostly suits low-to-medium level shipping companies in their desire, at a short term, to solve the shortage of seafarers.

The future of Croatian MET system can be seen as dual and flexible, offering both approaches to education. However, the tendency among the seafarers to carry on professional careers ashore, will most probably promote education at the higher education institutions as an imperative. Nevertheless, MET system should create a motivating environment for the seafarer profession, maintain highest standards in education, training and certification and be side by side with the education systems in other professions.

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[6] In last five years, total number of students graduated from all faculties in engineer department not exceeds 100 and is double less from the number of students in nautical department.

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EMSA CLEANSEANET System in its Practical Implementation

Avtandil Gegenava
Professor, Batumi State Maritime Academy,
a.gegenava@maradgeorgia.org

Abdul Kakhiddze
Professor, Batumi State Maritime Academy
a.kakhidze@bsma.edu.ge

Abstract: The paper deals with the collaboration of EMSA CLEANSEANET System and MRCC (Maritime Rescue Coordination Centre) Georgia. MRCC Georgia is regularly provided by data to avoid the responsibility region pollution as well as to rapidly react to the existed facts of illegal discharges.

The European Maritime Safety Agency (EMSA) is tasked to contribute to the enhancement of the overall maritime safety system within the European Union. One of its goals is to reduce the risk of marine pollution and to assist sea using satellite monitoring

To develop a common sustainable European system, EMSA transfers expertise from regions with experience in satellite surveillance to regions with no operational experience in this field.

The EMSA satellite service offers extensive surveillance of European waters for oil spills by using radar images acquired by Synthetic Aperture Radar (SAR) sensors on polar orbiting satellites. SAR sensors have the capability to detect oil slicks on the sea surface in darkness as well as daylight hours and to see through clouds.

The service provides a range of information including:

1. Oil spill alerts to Member States and rapid delivery of all available satellite images over the area of interest,
2. Slick position/extent/pattern/shape,
3. Assimilated meteorological wind and wave data,
4. Local wind and wave data derived from the SAR image.

The practical implementation of the EMSA CLEANSEANET-MRCC Georgia partnership is presented in the case study concerning with the illegal discharges in MRCC Georgia responsibility region.

1. INTRODUCTION

The European Maritime Safety Agency (EMSA) is tasked to contribute to the enhancement of the overall maritime safety system within the European Union. One of its goals is to reduce the risk of marine pollution and to assist Member States in tracing illegal discharges at sea using satellite monitoring.

The European Directive 2005/35/EC of the European Parliament and of the Council on ship-source pollution and on the introduction of penalties for infringements, which entered into force in September 2005, elaborated the Agency's task with respect to supporting Member States activities in the field of monitoring marine oil spills. Specifically the Directive requires the Agency to "work with the Member States in developing technical solutions and providing technical assistance in relation to the implementation of this Directive, in actions such as tracing discharges by satellite monitoring and surveillance".

Accordingly, EMSA has developed the CLEANSEANET service, a satellite based monitoring system for marine oil spill detection and surveillance in European waters. The service provides a range of detailed information including oil spill alerts to Member States, rapid delivery of available satellite images and oil slick position.

Coastal States have defined the areas to be monitored by the CleanSeaNet service, together with the required number of satellite scenes. The basis of the definitions has been the knowledge of the national hot spots, i.e. areas where the illegal oil discharges are known to take place, areas of high traffic density etc.

The satellite images are downloaded using antennae in Norway, Italy and Portugal (from 2008 onwards). The data is processed and analyzed to detect possible oil slicks. An alert report is produced for every planned image to inform the Coastal States on the results of the analysis, i.e. whether possible oil slicks are detected or not. In case slicks are detected, the affected Coastal State immediately receives an alert to enable the Coastal State to take quick actions in order to verify and quantify the slick and to identify the potential source. The complete process, from satellite overpass to the alert, takes a maximum of 30 minutes (See Fig.1.).

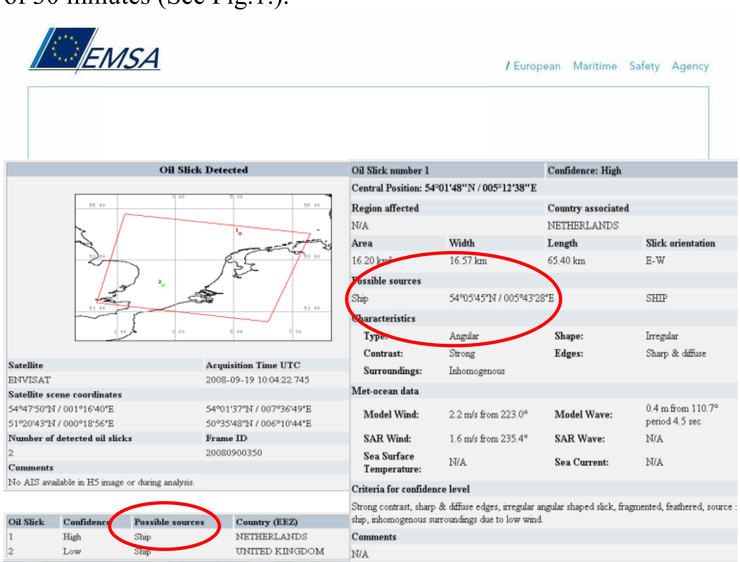


Figure 1. E-mail alert report.

This article contains information about this service CleanSeaNet, to identify and satellite monitoring of oil spills and transfer this information to the national MRSS for rapid response in areas of their responsibility.

2. PRACTICAL USE OF EMSA CLEANSEANET IN MRCC GEORGIA

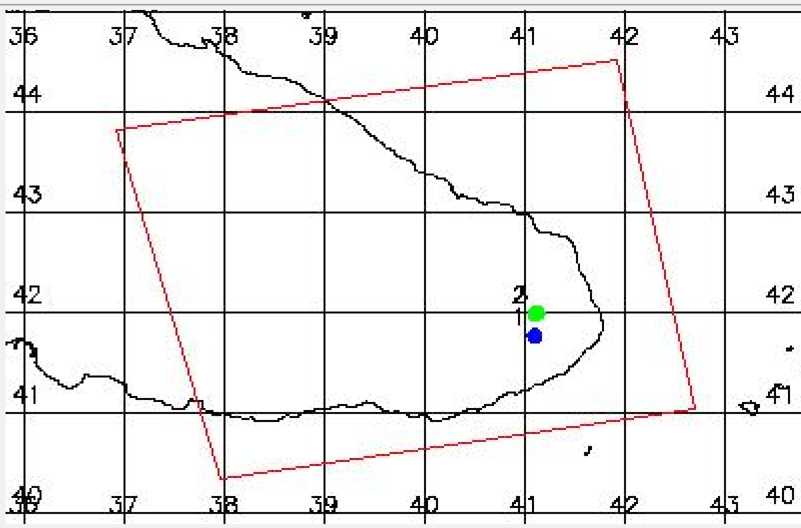
Alert e-mail will be sent for to MRCC in case if oil slick is located in responsibility zone of MRCC Georgia. MRCC will call the alert contact point if potential oil spill is detected in the national alert zone. A short description of the detection will be provided. Alert image and further e-mail ("Oil Service Desk") consists of (See Fig.2.):

- Position of the possible oil pollution,
- Date and time of observation,
- Estimated size of the polluted area,
- Wind speed and direction,
- Polluter category e.g. Ship, platform, industry,
- If available, the name of the platform or the geographical name in the case of release from onshore sites,
- Probability level (low, medium or high).

After receiving Alert e-mail from CleanSeaNet when a potential source detected in satellite images MRCC should identify a vessel which is potentsilnym contaminant. Further rapid action is essential to ensure that at the time to identify sites of pollution and the vessel. Need to use all available means (AIS, VTS, RADAR) to identify and track suspected pollutant - in this case, if the potential polluter is a ship). If a potential source of the ship, which was determined by its delay in the sea to investigate, and if it fails to send a request to port State control to be checked at the next port of call. Proofs sent via e-mail at the next port of call. If the ship continues on his way, messages are transmitted MRCCs neighboring countries

OIL SERVICE REPORT

Possible Oil Slick Detected



Satellite	Acquisition Time UTC
ENVISAT	2011-02-18 19:11:15.174

Satellite scene coordinates	
43°48'49"N / 036°55'15"E	44°31'28"N / 041°55'23"E
40°19'51"N / 037°58'34"E	41°02'13"N / 042°42'25"E
Number of detected oil slicks 2	**Frame ID 20110220005**

Possible Oil Slick number	Confidence	Possible sources	Country (EEZ)	
1	MEDIUM	N/A	Georgia	Details
2	LOW	N/A	Georgia	Details

Figure 2. A concrete example of the report oil slick in the area of responsibility MRCC.

Possible Oil Slick number 1		**Confidence: MEDIUM**	
Central Position: 41°45'49"N / 041°06'01"E			
Region affected		**Country associated**	
Georgia		Georgia	
Area	**Width**	**Length**	**Slick orientation**
1.92 km²	0.41 km	4.67 km	E-W
Possible sources			**AIS MMSI**
Characteristics			
Type:	Tail	**Shape:**	Irregular
Contrast:	Medium	**Edges:**	Sharp and Diffuse
Surroundings:	Homogenous		
Met-ocean data:			
Model Wind:	1.6 m/s from 88.7°	**Model Wave:**	0.2 m towards 49.9°
SAR Wind:	7.7 m/s from 99.8°	**SAR Swell:**	0.1 m towards 260.0°
Sea Surface Temperature:	N/A	**Sea Current:**	N/A
Criteria for confidence level			
Medium contrast, sharp and diffuse edges, irregular tail shaped slick, source: N/A, homogenous surrounding.			

Figure 2. continued. A concrete example of the report oil slick in the area of responsibility MRCC.

Possible Oil Slick number 2		**Confidence: LOW**	
Central Position: 41°59'10"N / 041°06'18"E			
Region affected		**Country associated**	
Georgia		Georgia	
Area	**Width**	**Length**	**Slick orientation**
1.68 km²	0.49 km	3.46 km	S-N
Possible sources			**AIS MMSI**
Characteristics			

Type:	Linear	**Shape:**	Irregular
Contrast:	Weak	**Edges:**	Sharp and Diffuse
Surroundings:	Homogenous		
Met-ocean data:			
Model Wind:	2.2 m/s from 81.4°	**Model Wave:**	0.2 m towards 63.0°
SAR Wind:	7.9 m/s from 102.0°	**SAR Swell:**	0.1 m towards 210.0°
Sea Surface Temperature:	N/A	**Sea Current:**	N/A
Criteria for confidence level			
Weak contrast, sharp and diffuse edges, irregular linear shaped slick, source: N/A, homogenous surrounding.			

Figure 2 continued. A concrete example of the report oil slick in the area of responsibility MRCC.

Coastal States have defined the areas to be monitored by the CleanSeaNet service, together with the required number of satellite scenes. The basis of the definitions has been the knowledge of the national hot spots, i.e. areas where the illegal oil discharges are known to take place, areas of high traffic density etc.

The satellite images are downloaded using antennae in Norway, Italy and Portugal (from 2008 onwards). The data is processed and analyzed to detect possible oil slicks. An alert report is produced for every planned image to inform the Coastal States on the results of the analysis, i.e. whether possible oil slicks are detected or not. In case slicks are detected, the affected Coastal State immediately receives an alert to enable the Coastal State to take quick actions in order to verify and quantify the slick and to identify the potential source. The complete process, from satellite overpass to the alert, takes a maximum of 30 minutes.

AUTHORIZED LICENSEE: This End user licence conditions apply to governmental organization(s) of a Coastal State, located at single or multiple facilities within a single country, which have been notified to EMSA. The Products shall be used for the sole purpose of oil spill monitoring (illegal discharges and accidental spills).

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- to make an unlimited number of soft and hard copies for the internal use of the LICENSEE and internal backup purposes only;
- to transfer, via either a physical delivery protocol or a secured and encrypted network protocol, a full resolution product to LICENSEE's employees and/or contractors or consultants who are under a duty of confidentiality no less restrictive than LICENSEE'S duty hereunder. The contractors or consultants must not retain the Product or copies thereof after completion of the Licensee's internal project;

- to store, post or process the Product (including full resolution product) in a system that is not accessible by an open or non-restricted network;
- to release hardcopy prints of the Product, to publish the Product in research reports, journals, trade papers or similar publications, and to post the Product to Internet web sites provided that such Product is in a secure format that allows only printing and viewing and prohibits manipulating the Product's pixel or metadata; all providing that such release, publishing or posting is solely for non-commercial uses and that the copyright notice of the satellite owner and EMSA is conspicuously displayed alongside the Product.; and
- to develop, reproduce and distribute any Value-Added Product (as defined in these conditions) generated from the Product.

3. CONCLUSIONS

How to use the system CLEANSEANET shows that:

- EMSA played an operational role in monitoring marine oil spill and detection in Europe.
- Ensures fast and efficient delivery of all relevant satellite imagery and information products.
- In the event of a major oil spill disaster in European seas and adjacent waters, EMSA will act as a focal point with its own resources, to quickly download information to ground stations in Europe for further processing and analysis.
- Coastal States will more quickly locate oil spills and will take the agreed timetable for satellite monitoring of the planning of national or regional measures.

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Degradability of Different Packaging Polymeric Materials in Sea Water

Aleksandra Heimowska
Department of Chemistry and Industrial Commodity Science
Faculty of Business Administration and Commodity Science
halex@am.gdynia.pl

Katarzyna Krasowska
Department of Chemistry and Industrial Commodity Science
Faculty of Business Administration and Commodity Science
kraska@am.gdynia.pl

Maria Rutkowska
Department of Chemistry and Industrial Commodity Science
Faculty of Business Administration and Commodity Science
rutmaria@am.gdynia.pl

Abstract: The comparison of environmental degradability of different packaging polymeric materials in the Baltic Sea water was the subject of this paper. The experiment was also performed in laboratory at ambient temperature in a liquid medium containing sea water with sodium azide to evaluate the resistance of polymers against hydrolysis. The characteristic parameters of environment were measured during the period of degradation and their influence on degradation of polymers was discussed. The degradation processes of packaging polymers: polyethylene terephthalate, polyethylene, poly(ε-caprolactone), their modification with starch and natural poly(3-hydroxybutyrate-co-3-hydroxyvalerate) were studied by microscopic observations of polymer surfaces, changes of weight and tensile strength during the incubation under natural and laboratory conditions.

The obtained results confirm good resistance of pure polyethylene to sea water and indicate that the modification of polyethylene with starch improves degradability of this blend in natural aqueous biological environment.

Degradation of poly(3-hydroxybutyrate-co-3-hydroxyvalerate) and poly(ε-caprolactone) in natural marine environment occurs very fast. And after 6 weeks incubation the poly(ε-caprolactone) samples were completely disintegrated.

Keywords*:* environmental degradation, sea water polyethylene, poly(ε-caprolactone), starch, polyethylene terephthalate, natural poly(3-hydroxybutyrate-co-3-hydroxyvalerate)

1. INTRODUCTION

Several hundreds of thousands tons of plastics have been reported to be discarded into the marine environment every year. It has been estimated that one million marine animals are killed every year either by chocking of floating plastic items or by becoming entangled in plastic debris. The development of biodegradable plastics is the key to solving the problems caused by marine plastic debris.

Sea water is a very complicated environment for degradation because microorganisms, animals, salt, sunlight, fluctuation of water, rain etc. all play a part in degradation in nature. The sea water is an example of environment where all kinds of micro- and macroorganisms, which could be involved in the degradation of polymers, are present.

According to the literature the first degradation step for nondegradable material such as polyethylene is oxidation. Photooxidation increases the amount of low molecular weight material by breaking bonds and increasing the surface area. In the second degradation step, microorganisms may utilize the abiotic degradation products and low molecular weight of polymer [1-2].

Biodegradation is the natural process in which the degradation of materials results from the action of naturally - occurring microorganisms such as bacteria, fungi or algae [3]. Biodegradable plastics break down completely into nonplastic and nontoxic constituents-substances like water, CO_2, CH_4 and biological materials [4].

Among degradable polymers poly(ε-caprolactone) is known as material susceptible to microbial degradation which could be a result of simple chemical hydrolysis of ester bonds or enzymatic attack or both [5-6].

The physical blending of degradable and nondegradable polymers with natural polymers such as starch is a way to prepare degradable polymers.

Starch is an inexpensive product available annually from corn and other crops. It is totally biodegradable in a wide variety of environments [7-9].

The aim of the present work was the comparison of the environmental degradability of packaging polymeric materials such as: polyethylene terephthalate, poly(ε-caprolactone) [10-12], polyethylene, their modification with starch [11,13] and natural poly(3-hydroxybutyrate-co-3-hydroxyvalerate) [14] in the Baltic Sea water.

2. EXPERIMENTAL

2.1 Materials

The following materials has been studied and are presented:
- pure polyethylene terephthalate (PET) received from Melinex Process Research, Section ICI Polyester in Cliveland in England
- pure polyethylene (PE) received from “Petrochemia Płock S.A” in Poland,
- modified polyethylene containing 8% starch (PE/starch), received from “Starch and Potato Products Research Laboratory” in Poland,
- modified polyethylene containing pro-degradant additive in the form of a master batch (MB) in the amounts of 20% (PE+MB). The MB consisted mainly of corn starch, linear low-density polyethylene as the carrier resin, styrene-butadiene copolymer and manganese stearate; the last two are referred to as the pro-oxidant systems. The samples were prepared

in collaboration with EPRON Industries Ltd. and received from the Royal Institute of Technology in Stockholm, Sweden,
- pure poly(ε-caprolactone) (PCL) from Solvay, trademark CAPA 680 with reported MW=80.000,
- modified poly(ε-caprolactone) containing 60% (PCL/starch) from Novamont S.P.A. in Italy, trademark Mater-Bi Grade ZI01U made of starch and PCL,
- natural poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) was supplied by Aldrich.

2.2 Environment

The environmental degradation of different packaging polymeric materials was carried out in the Baltic Sea water under natural weather depending conditions [10-16].

The incubation of polymer samples took place in the Baltic Sea water, in Gdynia Harbour. The samples were located in a special perforated basket at a depth of 2 meters in the sea.

The characteristic parameters of the Baltic Sea water such as: temperature, pH, salinity, oxygen content were monitored by The Institute of Meteorology and Water Management Maritime Branch in Gdynia, Poland (Tab. 1).

The experiment was also performed in laboratory in a liquid medium containing sea water with sodium azide (NaN_3 ~ 0,195g/1l) to eliminate the influence of microorganisms on the degradation of the polymer samples. This experiment allowed evaluation of resistance of polymers to hydrolysis. Parameters of the Baltic sea water with NaN_3 are presented in Tab.2.

2.3 Investigation of polymer samples

After incubation the samples were taken out from environment and washed with distilled water and dried at room temperature to a constant weight.

The weight, surface morphology and mechanical properties of polymer samples were tested before and after degradation in environment.

2.3.1 The weight changes

The weight of polymer samples was estimated using Gibertini E 42s electronic balance. The percentage weight changes [%] were calculated from the weight data.

2.3.2 The tensile strength changes

The maximum tensile strength (MPa) was measured at room temperature using The Tensile Testing Machine Type Fu 1000e made by VEB Thuringer Industriewerk Rauenstein, according to PN-EN ISO 527-1, 2, 3: 1998 Standard.

2.3.3 Microscopic observations

The surface of the of polymer samples was observed in micro scale (microscopic observation). Microscopic observations were analyzed with the optical microscope ALPHAPHOT-2YS2-H linked to a Nikon F90X camera at magnification 1:270. The surface was analyzed before and after biodegradation.

The changes in the whole samples of the polymer blends were performed with the optical transmission microscope „Boetius", equipped with a polarizer, at a magnification of 1:250.

The pictures were taken before and after degradation.

3. RESULTS AND DISCUSSION

3.1 Characterization of environment

The characteristic parameters of sea water in natural environment presented in Tab. 1 indicate that the temperature of the Baltic Sea water was lower than that preferred for enzymatic degradation which is in the range of 20-60^{0}C [17].

Table. 1 The characteristic parameters of the Baltic Sea water

Parameter	Month							
	Aug	Nov	Feb	Jun	Jul	Aug	Nov	Apr
Temperature [^{o}C]	21,6	7,9	5,6	17,6	20,3	19,3	8,6	3,2
pH	8,5	8,3	8,2	8,5	8,2	8,9	8,1	-
Cl content [g/kg]	3,2	3,9	4,0	2,9	3,3	3,2	4,0	4,0
Oxygen content [cm^3/dm^3]	7,5	8,3	10,8	7,5	7,6	7,4	6,4	-
Salt content [ppt]	5,8	7,0	7,3	5,4	5,6	6,0	7,2	7,3

Table. 2 The parameters of the sea water with NaN_3

Parameter	Month					
	Apr	Jun	Jul	Aug	Nov	Apr
Temperature [^{o}C]	20	22	21	19	19	20
pH	7,8	7,1	7,8	7,6	6,8	7,9

In laboratory, the temperature was stabilized at a higher level (~20^{o}C). The pH values were similar in both environments. The average pH was alkaline (8,2) in the sea water in the natural environment and 7,8 in the laboratory test, which is appropriate for enzymatic degradation (pH 5-8) [17]. The rather low temperature and slight alkalinity of Baltic Sea water had an influence on development of psychrotropic and mesophilic bacteria.

The salinity and Cl^- content are higher in winter months than in summer months, but oxygen content is from 7,4-10,8 cm^3/dm^3.

The variety of micro- and macroorganisms in south Baltic Sea water and abiotic parameters (temperature, salinity) have an influence on microbiological activity of marine environment and consequently on degradation process of polymer samples.

3.2 The changes in polymeric materials during environmental degradation

The results of weight changes of polymer samples after incubation in Baltic Sea water are presented in Fig.1.

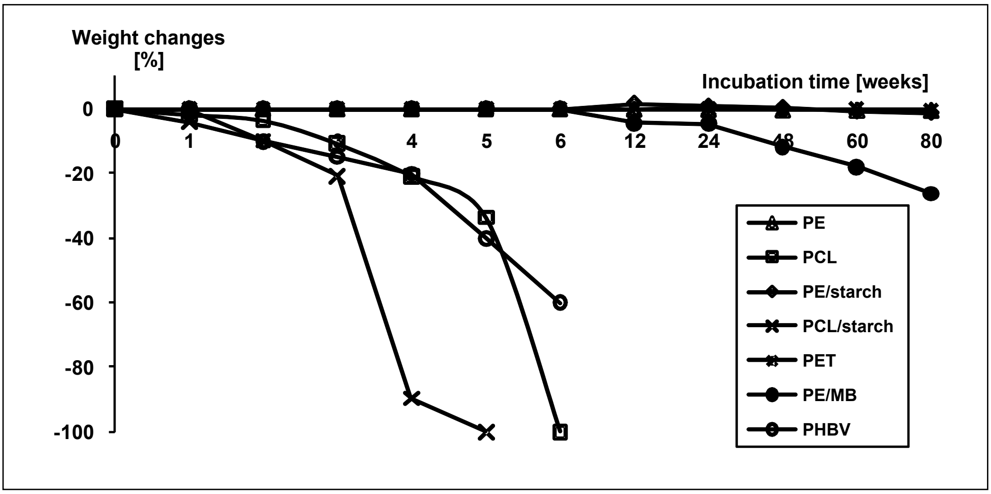


Figure. 1 Weight changes of polymer samples after incubation in the Baltic Sea water

Looking at the results we can observed that pure PET is the most resistant to sea water because we have not noticed any changes for 48 weeks of incubation in natural environment. This is because PET is aromatic polyester which is not susceptible for biodegradation.

There were no visible weight changes of pure PE. The degradation of polyethylene should be attributed primarily to photodegradation [1-2]. Low amount of solar radiation reaching the film under water surface can be one of the factors responsible for the low extent of oxidation process of PE.

We could expect the degradation process should be speeded up through microbiological consumption of the starch particles, producing a greater surface/volume ratio of the PE matrix.

It has been demonstrated that polyethylene with 8% starch is also not very susceptible to microbial degradation in sea water in natural environment, although it has been known that starch is readily degraded by a wide variety of yeast, fungi and bacteria. The samples PE/starch were even swollen at the beginning of the experiment (August-November) up to 1%, because starch was reversibly swollen [18].

The small weight losses were observed for the system with pro-oxidant (polyethylene with MB) in the first period of experiment (August-February). Then the degradation process speeded up. The starch removal was much greater from films containing the pro-oxidant components than from those without them. The degradation of polyethylene with MB is due to hydroperoxide - catalyzed autooxidation of the prooxidant in synergistic combination with biodegradation of the starch particles. Because of the synergistic process, the loss weight was much higher than the amount of the starch in added MB [18].
Analysis of the results shows that the temperature of the sea water has an influence on the rate of degradation. During winter (November-February) no weight loss was observed for blends of PE/starch.

At the first week (June) of incubation of natural PHBV, PCL and PCL/starch in Baltic Sea water small changes of weight were observed because of the low temperature for biodegradation process (17,6^{o}C). In the next few weeks (July-August) the weight changes were much higher and after 5-6 weeks the sample of natural PHBV lost 60% of weight, but both PCL samples were completely assimilated. The additive of starch speeded up a deterioration of PCL samples.

The results of weight changes of the polymer samples after incubation in sea water with NaN_3 are presented in Fig.2.

The weight changes of the samples incubated in sea water with NaN_3 were not significant, however, the temperature was higher than in the Baltic Sea.

The weight losses of pure PET, PE and PE/starch were lower than 0,6% after 48 weeks. The sterile samples show an overall slower autooxidation rate. The addition of sodium azide to keep the samples sterile might also interfere with the autooxidation.

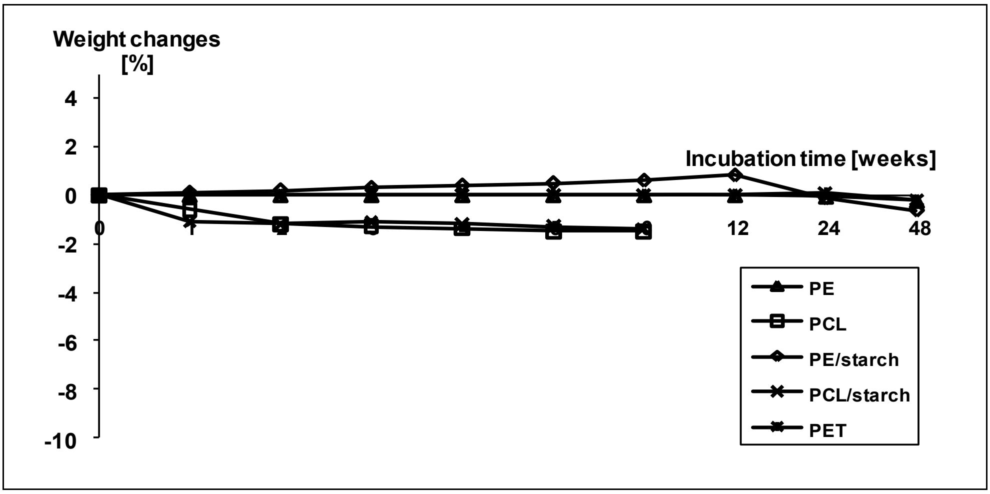


Figure. 2 Weight changes of polymer samples after incubation in the sea water with NaN_3

Azide compounds are known to undergo several reactions such as 1,3-dipolar addition to double bounds [19] or reaction with carboxylic acid [20]. The small weight changes were observed for PE/starch. At the beginning of the experiment (till 12 weeks) this sample was very little swollen (~1%). This swollen degree was comparable with results for PE/starch sample in the Baltic Sea water in natural environment. With the time of incubation small weight losses were noted. This is because starch was reversibly swollen at first up to a certain point (~1%) and after that the swelling become irreversible causing disruption of granules [18]. However the process was responsible for weight loss not more than 0,6%. The obtained results confirm that these packaging polymeric materials are resistant to the chemical hydrolysis.

The weight losses of the pure PCL and PCL/starch samples incubated in sea water with sodium azide were not significant (~1,5%). These changes might be explained by nonenzymatic hydrolytic ester cleavage.

The tensile strength of polymer samples after incubation in the Baltic Sea water is presented in Fig. 3.

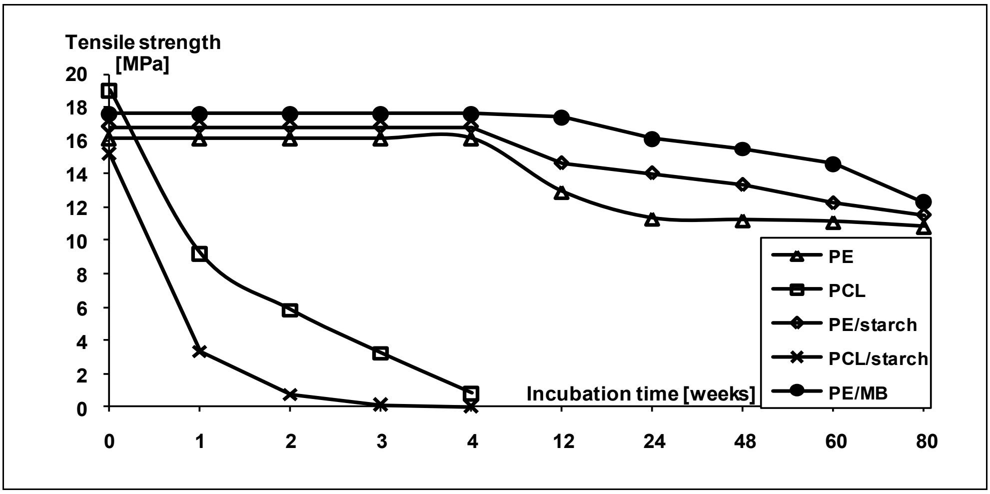


Figure. 3 The tensile strength of polymer samples after incubation in the Baltic Sea water

There were no special changes of tensile strength for PET during all incubation time (the tensile strength changed from 147MPa to 134MPa after incubation), what confirmed the results of weight changes.

There was no correlation between weight losses and tensile strength for PE samples but the changes of tensile strength after incubation in the Baltic Sea water were more visible than the changes of weight of pure PE, PE/starch and PE/MB. We can observed that the tensile strength decreases continuously for all PE samples incubated in the natural marine environment, which could be explained by some shear stresses (the fluctuation of water). Mechanical damage of the PE macrochains may be also caused by the swelling and bursting of growing cells of the invading microorganisms or by macroorganisms in sea water. Owing to mechanical damage of macrochains of PE, the value of the tensile strength of modified PE decreased about 30% although the weight decreased about 0,6%. We can also noticed no changes of weight for pure PE but the tensile strength decreased about ~30%.

The decrease of tensile strength of PCL and PCL/starch samples after incubation in sea water was observed explicitly and was associated with weight changes. The tensile strength was reduced as weight loss increased. The results of tensile strength confirmed faster biodegradation of PCL/starch, than pure PCL samples. During incubation of samples in the Baltic Sea water enzymatic degradation caused the surface erosion. Swelling and bursting of growing cells of the invading macro - and microorganisms might cause the mechanical damage to the surface of PCL. This was a reason of the dramatic decrease in tensile strength after incubation in the Baltic Sea water. The tensile strength of PCL samples incubated three weeks in sea water was very low ($\delta_B = 3$ MPa).

The tensile strength of polymer samples after incubation in the sea water with NaN_3 is presented in Fig. 4.

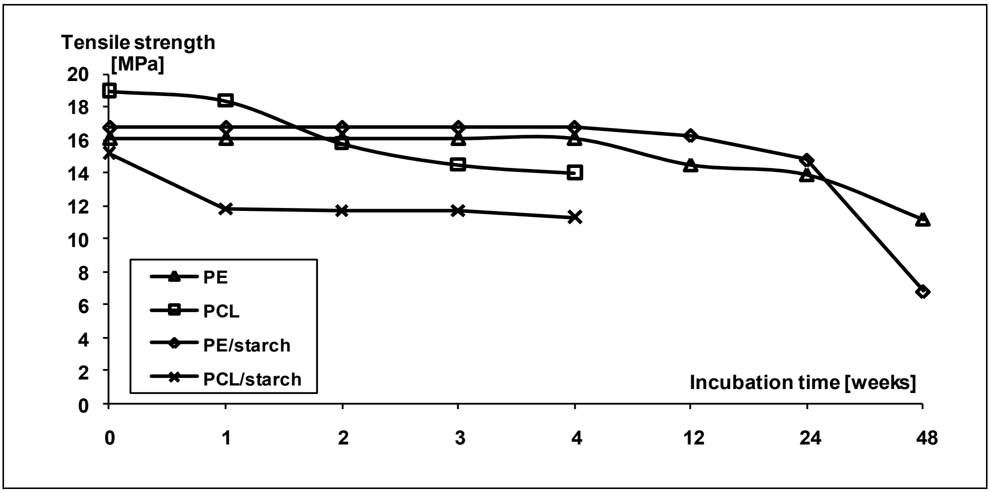


Figure. 4 The tensile strength of polymer samples after incubation in the sea water with NaN_3

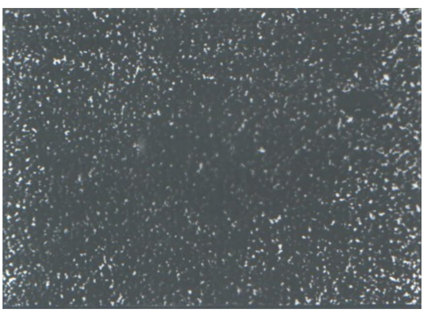
Similar changes of tensile strength for all PE samples were observed during 24 weeks of incubation in the sea water with NaN_3. Here, the changes of tensile strength of PE samples are more visible after 24 weeks of the experiment. For PE/starch after 48 weeks of incubation in sea water with NaN_3 the tensile strength decreased from 16,8 MPa to 6,8 MPa (when the changes in weight are not more than - 0,8% after the same time). The unusual change of tensile strength after 48 weeks of the experiment for PE/starch is probably caused by some release of starch (from the sample). Reduction of starch weakens polymer sample by creating wholes on the polymer surface after starch removal.

The results of tensile strength of both PCL samples after incubation in abiotic environment confirmed the results of weight changes. There were not visible changes in mechanical properties for PCL samples during all incubation time.

The degradation process of polymeric materials was described by changes in the morphology of the sample surface too.

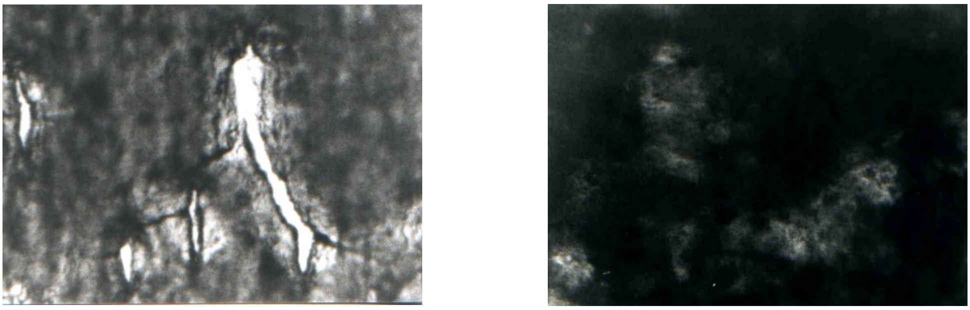
There were no changes on photomicrographs surface of PET and PE samples during the all incubation time.

The microscopic observations of PCL samples are presented in Figure 5. After incubation in natural sea water the samples were not homogeusly destroyed and there were different images depending on where the picture was taken.



a) blank sample

b) after 2 weeks of degradation



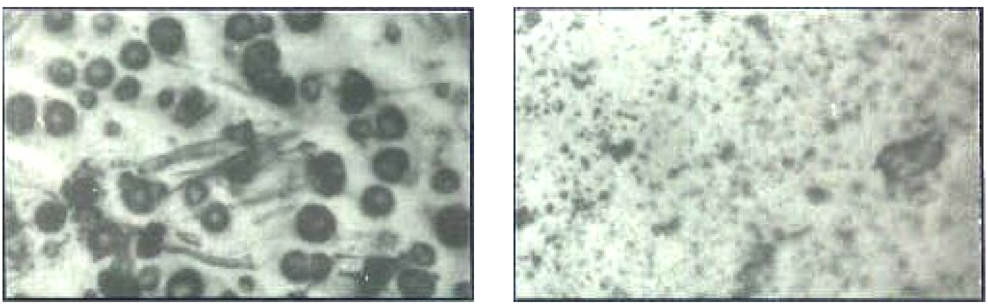
c) after 4 weeks of d) after 5 weeks of degradation

Figure 5. Photomicrographs surface of PCL sample under optical microscope at a magnification of 1:270 without polarisers, before and after incubation in sea water

The surface of blank sample of PCL observed under optical microscope (Fig.5a) consisted of two phases (bright – crystalline and dark – amorphous). After 2 weeks of incubation in sea water we observed an increase of orientated birefringence elements which might be an evidence of an increase in crystallinity (Fig.5b). According to literature semicrystallinity of PCL plays a critical role in degradation phenomena, because the amorphous phase is degraded first and as a result an increase in crystallinity of polymers occurs, when most of the amorphous phase is degraded, subsequently the crystalline phase is degraded [21-23]. The microscopic observations could confirm that the amorphous phase was degraded first. After 4 weeks of experiment the decay of birefringent element was observed, crystalline phase began to degrade (less orientated birefringence elements) (Fig.5c). At the end of the experiment we could see very distinctly the black area on the surface of film studied, which represented an agglomeration of microorganisms (Fig.5d), and observation of PCL film morphology was unable to follow.

The surface of PE/MB after 24 weeks of incubation in sea water which is observed under the optical transmission microscope consisted still of the matrix (PE) and the dispersed phase (globules of starch).The image of starch globules were clearly destroyed after 80 weeks of incubation (Fig.6).

The microscopic observations are in agreement with the changes of weight and tensile strength of polyethylene with MB.



a) after 6 months incubation in sea water b) after 20 months incubation in sea water

Figure 6. Microscopic structure of polyethylene with MB under the optical microscope „Boetius" at a magnification of 1:250 without polarizer

4. CONCLUSIONS

The obtained results confirmed good resistance of pure polyethylene and polyethylene terephthalate to sea water. Very little microbial degradation was observed for polyethylene/starch blend in the sea water, which was caused by low sea water temperatures, moderate biological activity of microorganisms and low amounts of solar radiation reaching the films. Globules of starch in modified polyethylene were destroyed first in marine environment. Than the oxidation process of polyethylene was speeded up because of a greater surface/volume ratio in the polyethylene matrix after removal of starch.

The degradation of polyethylene starch blends in sea water requires a long period of incubation and the special conditions of environment.

Biodegradation of natural poly(3-hydroxybutyrate-co-3-hydroxyvalerate), poly(ε-caprolactone) and poly(ε-caprolactone) with starch in sea water was very fast. The films of poly(ε-caprolactone) were completely assimilated over the period of 5-6 weeks. The obtained results indicate that poly(ε-caprolactone) was very sensitive to enzymatic attack of microorganisms in living environment and was rather resistant to chemical hydrolysis in abiotic environment. The addition of starch speeded up the deterioration of poly(ε-caprolactone) samples.

Biodegradation of poly(ε-caprolactone) in a microbially active environment occurred in two stages. The first stage consisted of the degradation of amorphous phase, resulting in an increase in crystallinity of the polymer. The second stage started when most of the amorphous regions were degraded. The polymer prone to fragmentation and enzymatic surface erosion proceeded.

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The MarEng and the MarEng Plus Projects New Online Teaching and Learning Maritime English Materials

Barbara Katarzyńska
Gdynia Maritime University
bakat@am.gdynia.pl

Abstract: This paper is based on the multimedia teaching and learning Maritime English materials aimed not only at the distance learners on board ship but also at the teachers and students of nautical colleges and maritime universities in Europe and other parts of the world.

The MarEng project, which was partly funded by the EU Leonardo da Vinci Agency, started in November 2004 and finished in April 2007. It resulted in the production of a CD-rom and online teaching and learning Maritime English materials which have been freely accessible on the Internet since May 2007.

The MarEng Plus project, which is also partly funded by the EU Leonardo da Vinci Agency, started on October 1st 2007 and was completed by the end of December 2010. It encompasses two new topics the Maritime Security and the Marine Environment.

Key words: Maritime English, Multimedia format, Online teaching and learning materials Inter-active exercises, Marine Environment

1. INTRODUCTION

In recent years a number of new English teaching and learning materials appeared and are available for the students of maritime colleges and universities. Among them the MarEng project stands out as an innovative multimedia Maritime English programme which is accompanied by a variety of inter-active exercises.

The material making partners included:

- University of Antwerp, Institute of Transport and Maritime Management in Belgium
- University of Antwerp, Department of Business Communication in Belgium
- University of Helsinki, Department of Translation Studies in Finland
- Gdynia Maritime University in Poland
- Latvian Maritime Academy in Riga in Latvia
- University of Turku in Finland
- Universidad de La Laguna, School of Nautical and Sea-related Studies, English and German Linguistic Studies in Santa Cruz de Tenerife in Spain

- Sydvast Polytechnic, School of Maritime Studies in Turku in Finland
- Aland Polytechnic, The Aland Maritime Institute in Mariehamn in Finland.

2. MARENG PROJECT

Centre for Maritime Studies in Turku in Finland was the co-ordinator of the MarEng Project and the multimedia company Lingonet Oy was responsible for the task of putting the teaching and learning material and the exercises into a multimedia format.

The materials cover two levels of Maritime English: intermediate and advanced. All the materials at an intermediate level are based on the language used during a voyage of a virtual ship, the m/s "Marina" from the port of Santander in Spain to the port of Kotka in Finland, the language used in real situations at sea and in ports.

The materials at an intermediate level cover the following topics:

- Introduction
- Welcome to a Modern Port
- Loading the m/s "Marina"
- The Ship
- Leaving Port
- In the Fairway
- Heavy Weather
- Mayday Mayday
- The Crew and its Tasks
- At Sea – Changing the watch
- Survival in an Emergency
- Helicopter Rescue
- An Encounter with the Coast Guard

All the materials at an advanced level cover the following topics:

- Port Operations
- Shipping and Maritime Management
- Cargo handling
- Cargo Space
- Vessel Types
- The Engine Room
- Port State Control
- SMCP
- Vessel Traffic Services (VTS)
- Ice Navigation
- The Weather
- Radio Communication
- Radio Medical.

The materials have been evaluated and tested by Advisory Partners including:

- APEC Antwerp/Flanders Port Training Centre in Belgium
- Antwerp Maritime College in Belgium

- National Board of Education in Finland
- Oy Rettig AB Bore in Finland
- Maritime Administration in Latvia

Most of the texts have been recorded and students can listen to them as many times as they like. The texts are also available in the PDF format for printing so it is possible to see the texts if there is such a need.

There are many types of inter-active exercises in each of the sections at both levels.

3. MARENG ONLINE

The MarEng online teaching materials can be used in the college classroom, in distance learning and for self-study purposes.

The MarEng materials can be downloaded free of charge from the website at http://mareng.utu.fi.

As the MarEng project materials have been successfully used for teaching Maritime English in various nautical schools and colleges in Europe since May 2007, many of its users stressed the need for filling in the gap and creating elementary level materials for the students because the knowledge of English varies in different countries, even in Europe.

So the MarEng Plus project was approved by the EU Leonardo da Vinci Agency and started in October 2008 and continued till the end of December 2010 resulting in the production of elementary level materials for both teaching and learning Maritime English.

The material making partners remained very much the same as in the case of the previous MarEng project but they have been joined by

- The National Maritime College of Ireland in Cork in Ireland
- Kymenlaakso University of Applied Sciences in Finland
- Antwerp Maritime Academy (University of Antwerp Association) in Belgium
- STC Group in the Netherlands
- Aland University of Applied Sciences in Mariehamn in Finland.

The materials were evaluated and tested by Advisory Partners and zero partners including

- The Lithuanian Maritime College in Klaipeda, Lithuania,
- The Ceronav Training Centre in Constanta, Romania

The topics for the elementary level materials cover:

- Cargo handling in ro-ro vessels (prepared by Antwerp Maritime Academy in Belgium)
- Cargo handling of Dangerous Goods (prepared by Universidad de La Laguna in Santa Cruz de Tenerife in Spain)
- Cargo handling of liquids (prepared by Kymenlaakso University of Applied Sciences in Finland)
- Cargo space in container terminals and bulk terminals (prepared by Gdynia Maritime University in Poland)
- Engine Room (prepared by Gdynia Maritime University in Poland)

- Navigation Bridge (prepared by the Latvian Maritime Academy in Riga in Latvia)
- Charts (prepared by Aland University of Applied Sciences in Finland)
- Radio communication (to be prepared by Universidad de La Laguna in Santa Cruz de Tenerife in Spain)
- Weather (prepared by Gdynia Maritime University in Poland)
- First Aid (prepared by Aland University of Applied Sciences)
- Severe weather conditions (prepared by Kymenlaakso University of Applied Sciences in Finland)
- The Marine Environment (prepared by University of Antwerp and ITTMA
- Maritime Security (prepared by University of Antwerp and ITTMA)

The materials are aimed at the operational level and are available on the internet at www.lingonet.com/marengplus, password: marengplus, user name: marengplus

They include a number of inter-active exercises and are in a multimedia format. The teacher's manual is also available in the pdf form. The MarEngPlus materials can also be used on line and are available in a CD form.

The last two topics that is The Marine Environment and Maritime Security have been prepared at all three levels that is elementary, intermediate and advanced and in my power point presentation I would like to concentrate on the materials related to the Marine Environment protection.

At an elementary level, the section on Marine Environment includes short recorded texts on Man-made Pollution, Oil Spills and Oil Clearance Operations which are accompanied by a variety of exercises.

At an intermediate level, the section on Marine Environment includes Marine Environment Protection, Prevention of Oil Pollution, SMCP Environmental Protection Communications, Reporting Pollution Incidents, Methods and Devices for Oil Clearance Operations and Fuel Emissions. Again short recorded texts are accompanied by inter-active exercises.

At an advanced level, the section on Marine Environment includes sources of Man-Made Pollution, Hazardous and Noxious Goods, Anti-fouling and Shipboard Marine Pollution Emergency Plans.

4. CONCLUSION

To conclude, the Mareng Plus materials dealing with Marine Environment can be used as complementary materials in teaching terminology in inter-active exercises or can form part of a separate course on Marine Environment Protection.

Influence of Human Factor on Marine Casualties

Saori Kiriyama
Graduate school of Maritime Sciences, Kobe University

Shintaro Nishimura
Graduate school of Maritime Sciences, Kobe University

Kenji Ishida
Ph.D, Professor, Graduate school of Maritime Sciences, Kobe University

Abstract: According to the reports of the Japan Coast Guard, recently the number of marine casualties has not changed so much and major cause of marine casualties is human factor. Human factor is analyzed by case studies, even using the case studies can not prevent all marine casualties. In this study, we introduce a new simulation model to prevent marine casualties or minimize damages caused by human factor.
This model simulates a navigation of ships while predicting dangerous situation such as collisions using information of ships such as position, speed and course. The model uses System Dynamics Computer Simulation combined m-SHELL model analysis.
Inputting data of past marine casualties into this simulation model, each ship will avoid dangerous situation in the simulation. Therefore, this simulation model makes judgment of safety navigation and it is the notable features. It will be possible to prevent marine casualties caused by human factor which making judgment of this simulation model not by watch keepers. When we simulated by using the situation of past collision, this simulation model showed information to navigate safely and to avoid collision.
In the future, it will be possible to navigate safely by assisting judgment by this simulation model.
Keyword: Human Factor, System Dynamics Computer Simulation, m-SHELL Model Analysis

1. INTRODUCTION

Equipments for navigation and performance of ship have been advanced. We can navigate more safely with these advances and expect decrease in marine casualties. However, the actual situation is different from it. According to the reports of the Japan Coast Guard, the number of marine casualties has not changed so much and the percentage of marine casualties caused by human factor to total is about eighty percent (80%). We can say that the major cause of marine casualties is human factor. There is the close relationship between human factor and marine casualties and we have to prevent marine casualties caused by human factor.

Human factor is mainly analyzed by the case study such as verifications of past accidents and investigations of mistakes. However, it is not enough from the perspective of prevention because there is some possibility of not preventing marine casualties without past accidents having similar circumstances. In other words, a method of preventing marine casualties under any circumstance is necessary.

According to the reports from the Japan Coast Guard, marine casualties caused by human factor are mainly human error such as improper navigations and insufficient lookout. Human error happens in spite of various measures to prevent it, because human factor certainly happens under systems related human. We consider that it is possible to prevent marine casualties caused human factor by decreasing navigator's judgment and propose the simulation model. Using this simulation model, we can analyze human factor more quantitatively with simulating circumstances of past marine casualties and assessing effect of human factor too. Therefore, the objective for this study is constructing the simulation model to prevent marine casualties or minimize damages under any circumstance. Also, we will report the effect of applying to this simulation model to prevent marine casualties or minimize damages.

2. SIMULATION MODEL

2.1 Outline of simulation model

In this study, we constructed the simulation model for navigating two ships using the System Dynamics Computer Simulation combining m-SHELL model analysis. This simulation model can consider human factor by combining m-SHELL model analysis. Also, we can simulate collisions which are the most in marine casualties. Inputting position, target course and target speed of ships, subjects of simulation, into this simulation model, the model shows necessary information to navigate safely.

2.2 System Dynamics Computer Simulation

The System Dynamics Computer Simulation (hereafter SD) interacts in the models and computes about dynamic systems changing as the time passed. Features of the SD are as follows.

- Advanced to analyzing feedback loops
- Advanced to analyzing complex dynamic systems
- Advanced to simulating for a long term
- Applicable to optimize
- Applicable to capture causal relations of system visually

Navigating condition is complex dynamic system as the situation including the parties concerned such as ships and navigators changes as the time passed. Especially, human factor is influenced each other by various factors. Therefore, we applied the SD.

2.3 m-SHELL model analysis

When the accidents caused by human error occurred, in general the parties concerned should be responsible personally and they were punished. But we have found that human error doesn't decrease. In fact, human error happens in the situation including the parties concerned not only by the parties concerned. The next step is to consider the situations which humans hardly make errors. The effective method of considering the situation is m-SHELL model analysis. It is the way to classify the situation into five factors such as Software, Hardware, Environment, Liveware(the parties concerned) and Liveware(others) and consider influences each other. Software is information and supporting systems such as manuals, regulations and training. Hardware is facilities and machines. Environment is situations to work such as weather, temperature, visibility and lights. Liveware is humans. In Figure1, management is emphasized. This shows that the management is considered bases of everything. And Table1 shows relation between m-SHELL model analysis and the factor in the model.

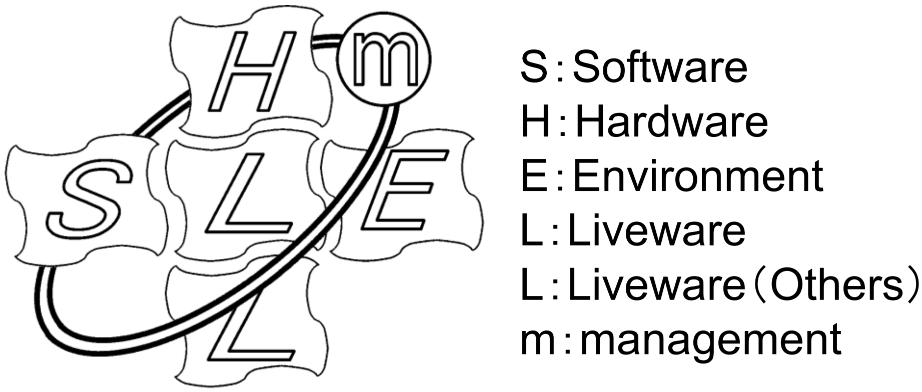

Figure1. m-SHELL model analysis

Table1. Relation between m-SHELL model analysis and human factor in simulation model

SHELL	Factor	Factor in the simulation model
Software	Regulation	Behavior based on COLREGS
Hardware	Performance of ship	Performance of turning and adjustment
Environment	Visibility	Visible distance of light
	Weather	Change of speed and course
Liveware	Navigator's judgment	Position of ship to other ship
Liveware (Others)	Information of other ship	Position and course of other ship

2.4 Concept of simulation model

This simulation model consists of the main model and the two sub models. The main model is judgment of collision. The sub model is controlling navigation environment of each ship, subjects of simulation, and divided into four sections which are position of the ship, control speed and course, judgment of navigation and control of avoiding collision. Position of ship is the model to control position as latitude and longitude and influences calculating distance between the ships and judgment of navigation. Control of speed and course is the model to keep the target speed and course and influences position of ship. Judgment of navigation is the model to judge whether or not to avoid and influences control of avoiding. Control of avoiding is the model to control speed and course for avoiding and influences position of ship. Figure 2 shows relations between the models.

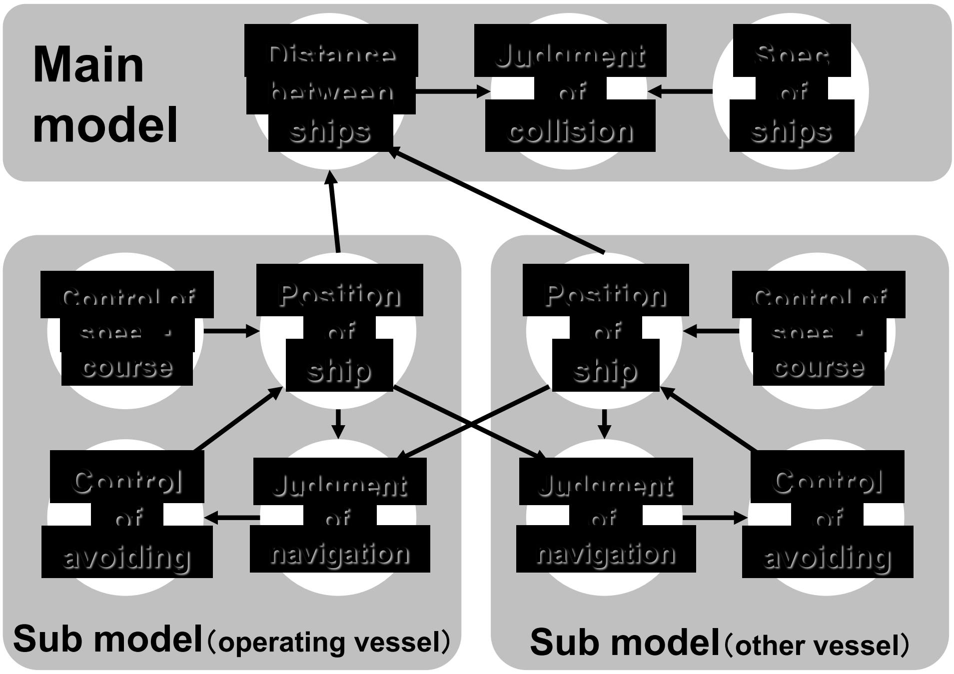

Figure2. Concept of simulation model

2.5 Simulation model of navigation

Figure3 shows the simulation model. The main model is judging of collisions from distances between the ships and specifications of the ships. Inputting the data of position as latitude and longitude at start of simulation into the sub model, position of ship, real-time position of ship in simulation is calculated automatically. Inputting the target speed and course into the sub model, control of speed and course, the model controls to keep it. The sub model for *judgment of navigation* judges whether or not to avoid from relation between two ships obeying Act on Preventing Collisions at Sea. The sub model for *control of avoiding* controls speed and course for avoiding separately from control speed and course when the sub model for *judgment of navigation* judges that a ship has to avoid. Each ship avoids dangerous circumstances in simulation and these simulation models shows necessary information for the safety navigation.

Also, the combined m-SHELL model analysis is effective when we analyze human factor by simulating situations of the past accidents.

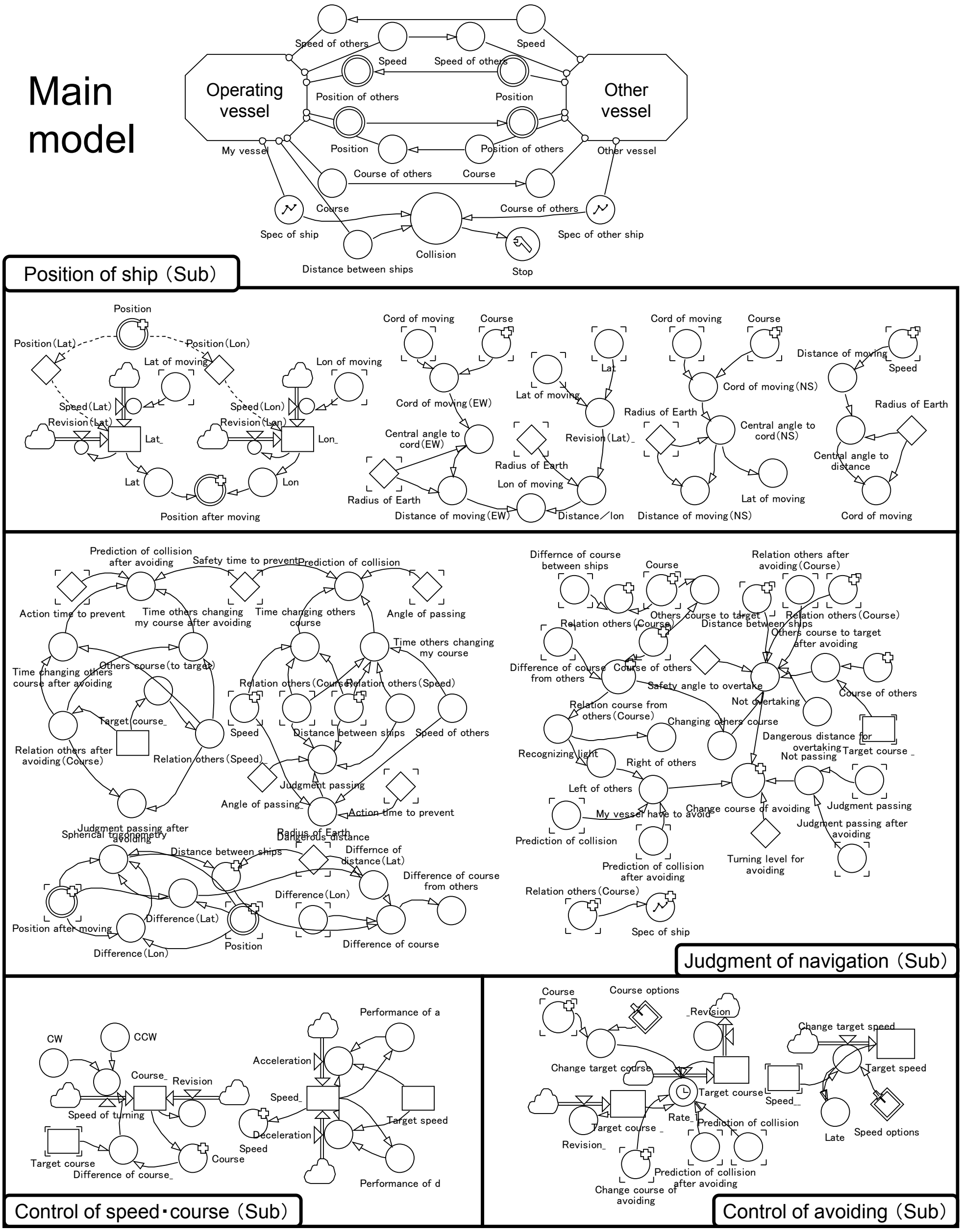

Figure3. Simulation model of navigation

3. VERIFICATION OF THE MODELS

We simulated using the circumstance of the past collision to show validity of the simulation model. There are two objectives for verification. First, we show the accuracy of the simulation model. Second, we show that it is possible to propose effective ways to prevent collisions or minimize damages. The circumstance we used is the collision between the ship E and the ship I. This collision occurred because the ship E took avoiding operation at 1:37 in Figure 4. We simulated premising that *"Operating vessel"* in the simulation model(1) as the ship E, *"Other vessel"* in it as the ship I, and the ship E avoids dangerous circumstances as necessary.

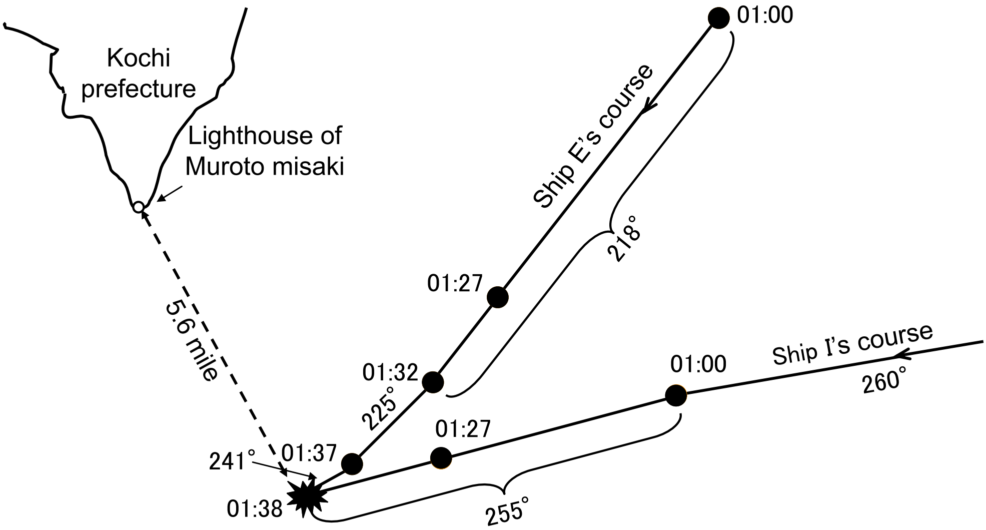

Figure4. Circumstances of the collision

First, we simulated under the same circumstances of the real collision to show the accuracy of the simulation model. Table 2 shows the results of simulation. From Table 2, the results of simulation (1) and actual circumstance are almost the same. Therefore, the simulation model (1) is accurate enough to simulate.

Table2. The results of simulation (1)

	Results of simulation	Actual circumstances
Collision	Happening	Happening
Time of collision	1:37:59	About 1:38
Position of collision	(33˚11'54.15"N, 134˚16'30.20"E)	(33˚11'54"N, 134˚16'30"E)

Second, we simulated under judgments of the simulation model to show that it is possible to propose effective ways to prevent collisions or minimize damages. In consequence, the collision did not happen. Figure 5 shows the circumstances in simulation (2). From Figure 5, the ship E changed course to 255 degrees for avoiding at 1:33. This judgment prevented the collision. This is judges from time until *operating vessel's* course crosses *other vessel's* course, time until *other vessel's* course crosses *operating vessel's* course and action time to prevent collision. Table 3 shows the results of simulation. From Table 3, there are great differences on avoiding between results of simulation (2) and actual circumstances. In other words, avoiding action of the ship E was too late to prevent the collision. Therefore, if the ship E navigated as the simulation model (2) shows, it was possible to prevent the collision.

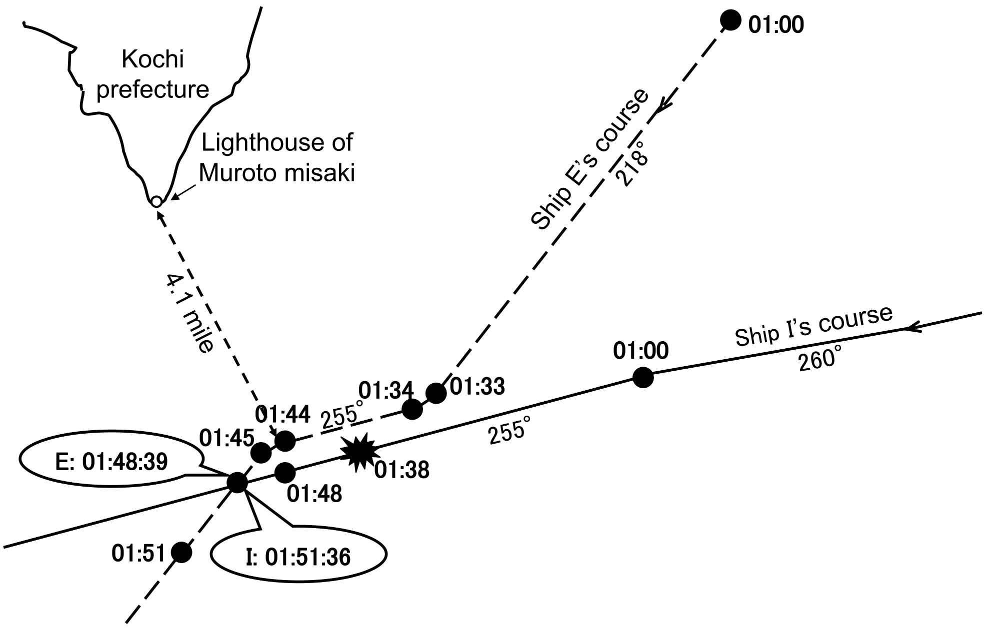

Figure5. Circumstances in simulation

Table 3. The results of simulation (2)

	Results of simulation	Actual circumstances
Collision	Not happening	Happening
Time of avoiding	1:33:48	About 1:37
Position of ship in time of avoiding	1.10 km	0.1 km

4. CONCLUSION

We found when and how to avoid for safety navigation. In other words, the simulation model showed necessary information to navigate safely. Therefore, the System Dynamics Computer Simulation combined m-SHELL model analysis is effective method of proposing any way to prevent marine casualties.

In the future, it will be possible to prevent human error and navigate safely by judging navigation in this simulation model not by the watch keepers in the bridge. Also, the results of simulation showed that the ship E had to avoid at 1:33 etc. In other words, the simulation model showed what the watch keepers should be attention to prevent the collision. Though we simulated using the circumstance of only the past collision between the ship E and the ship I in this study, this simulation model shows what the watch keepers should be conscious of to prevent marine casualties by simulating many circumstances of the past accidents.

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The Impact of the "European Union's 'Zero-waste, Zero-emission' Maritime Transport Policy" (and its related Transport/Environment regulations-*Acquis*) on the development of Environment Friendly Maritime Transportation in the World

Levent Kirval
Asst. Prof. Dr., Istanbul Technical University-Maritime Faculty
lkirval@itu.edu.tr

Alper Kilic
Res. Asst., Istanbul Technical University-Maritime Faculty
enviromarineacademic@yahoo.com

Abstract: With its 27 member states and 4 candidate countries, the European Union is the most ambitious political and economic integration movement, which also developed a binding supranational legal framework (Acquis Communautaire) in its geography. Particularly, the EU has generated an extensive legal framework for its member and candidate countries in the Environment and Transportation related areas.

For environmental friendly maritime transportation, the EU has been trying to reduce the greenhouse gas emissions from shipping, improve the environmental quality of its marine waters, manage ship-generated waste and ship dismantling, reduce sulphur oxides and nitrogen oxides emissions from ships, and promote more ecological shipping for quite a long time. The EU has gradually developed a detailed regulatory framework in these areas and it started to screen their implementation in the member and candidate countries. The environment friendly maritime transportation policies and the regulations of the EU are briefly summarized as "Zero-waste, Zero-emission Maritime Transport Policy for Europe".

In this context, this paper will analyse this Zero-waste, Zero-emission policy of the European Union and the relevant legal framework (acquis), which can function as catalyst for the development of similar regimes at the global level (possibly, under the framework of International Maritime Organisation (IMO), or with the extension of the UN-FCCC's Kyoto protocol, or similar international agreements/treaties). It will also focus on the current success level of the EU policy making with regards to green shipping and environmental protection in the maritime related industries.

Keywords: EU Environment Policy, EU Maritime Policy, Green Shipping, Environment Friendly Maritime Transportation, IMO Environment Regulations

1. INTRODUCTION

The mankind has been trying to keep a balance between industrial development and environmental protection for centuries. The gradual growth of the national economies and the interconnected global economy has greatly increased the pressures on the environment. Particularly, the pollution of the world's atmosphere and its oceans has been a major concern for all during the last decades. Furthermore, the global warming has been quite alarming for the intellectual circles around the world due to the possible ending of the circumstances which permit most human beings (and living organisms) to remain on Earth.

As a result, local authorities, national level administrations, regional integration movements' institutions and international organizations (as well as the non-governmental organizations) have started preparing (or lobbying for) binding legislations that monitor the firms (and all other polluting actors) functioning in their respective geographies. By means of such binding legislations and the monitoring of the activities of the industrial producers and the service sector companies (as well as similar polluting actors), the policy makers have been trying to find ways for protecting the natural resources of the earth and preventing environmental pollution at local, national, regional, and global levels.

In this context, the environment friendly transportation has also been on the agenda of the policy makers for quite a long time as the global economy (industry) and the individuals are served by this important service sector (by means of different transportation modes; rail, road, air and sea-waterways). Particularly, in today's rapidly globalizing world economy, the importance of the maritime (waterways) transportation (and the environmental risks arising from this sector) has been increasing. Today, approximately 90% of the global transportation services are done by the seas with a huge fleet of ships, which are important polluting actors (due to their gas emissions to the atmosphere, waste disposal to the seas, enormous energy/hydrocarbon consumption, possible disastrous effects of ship construction-dismantling, oil discharge, ballast water discharge, etc.) and therefore, environment friendly maritime transportation (also, environmental friendly production of 'services and goods' in maritime related sectors) is very important for keeping our planet clean and safe.

In this context, the European Union (as the most developed political and economic integration movement) has also been developing a legislative framework for the EU seas for quite a long time. The binding nature of the relevant *acquis communautaire* has played a key role in the EU member states and candidate countries to implement environment friendly maritime transportation policies. Indeed, this legislative framework and particularly the policy agenda of the EU with regards to green shipping can also function as a catalyst for the development of similar binding rules and regulations at the global level. In that regard, in the following section, firstly, the history of the EU integration process and the binding nature of the EU law will be briefly summarized. Subsequently, the EU's "Zero Waste and Zero Emission Maritime Transport Policy" and its potential impact on the global maritime community (with regards to development of binding legislation and monitoring methods at the global level) will be examined.

2. THE HISTORICAL BACKGROUND OF THE EU AND THE EU LAW

In the post Second World War period, the Western European states took the first steps for integration in the continent. In this context, the European decision makers concentrated on the energy sources (the most valuable one being coal during those days) and raw materials (iron and steel being at the top of the list). [1] European leaders, which came to conclusion that the political integration would only be realized through technical steps and prior economic integration, thought that the single market and the integrated European economy would be the catalyst for the solutions of political problems of Europe. [2]

This integration plan was announced by the Schumann Declaration on 9 May 1950, and the European Coal and Steel Community (ECSC), the first organization of the European integration was established in 1952. Germany, France, Italy, Belgium, Luxemburg and Netherlands were the first six signatories of the Treaty. The establishment of the European Economic Community (EEC) and European Atomic Energy Community (EAEC) by Treaties of Rome took the integration idea further and expanded it to other areas. Following the economic integration theories of the period, the free movement of the goods, services, capital and labor were seen as the main tools of establishment of single market in Europe and this was clearly expressed in the EEC Treaty. [3] The Single European Act (SEA), signed in 1986, finalized the steps of forming a single market by assigning a schedule, and finally, the single market has been established in 1993. Maastricht Treaty (Treaty of European Union (TEU), signed in 1992, had played a key role in transforming EEC into EU, and additionally has founded the three important pillars – European Communities (EC), Common Foreign and Security Policy (CFSP), Justice and Home Affairs (JHA) – on which the EU is built on. By Maastricht Treaty, an economic and monetary union (transition to Euro) policy has also been established. Amsterdam Treaty, signed in 1997, merged the existing legal texts and formed a legal framework for the union. Subsequently, Nice Treaty, came to force in 2003, replaced Amsterdam Treaty as the highest legal text of the EU. A probable constitution would play a key role for the EU integration to gain a legal identity. However, because of the lacking consensus on the matter (especially due to vetoes of the France and Netherlands), it was greatly simplified and has come to life with the Lisbon Treaty in 2007. This treaty has come to force in the end of the 2009 after several referendums and debates in member states.

During this historical integration process, one sees a transformation from intergovernmental nation states relationship to the multi-level governance (local, national, supra-national levels jointly producing common policies). Today, the political power of the EU organs has greatly increased and this situation can be seen when highly developed legal framework of the EU – *acquis communautaire* – is examined.

In addition to the sui-generis "deepening axis" towards political and economic integration, the European integration has also "widened" in time. The number of the EU members reached to 9 by the memberships of United Kingdom, Ireland and Denmark in 1973 and by the full membership of Greece, the total number of the integration movement reached to 10, starting the expansion to the south-eastern Europe. The number of the EU members reached to 12 by the memberships of Spain and Portugal in 1986, and it reached to 15 by the memberships of the Finland, Sweden and Austria in 1995. After the end of the Cold War and the collapse of the Berlin Wall, the probability of the expansion of the Union towards east including Central and East European countries, and also unification of West and East Germany became a hot issue. After the unification of West and East

Germany, by the fifth enlargement wave, Poland, Check Republic, Slovenia, Slovakia, Hungary, Estonia, Latvia, Latonia, Cyprus (de facto: South Cyprus) and Malta became the members of the EU in 2004 and the number of the members reached to 25. By the memberships of the Bulgaria and Romania in 2007, the number of the EU members has reached to 27. By the future membership of the current candidate countries; Turkey, Croatia, Macedonia, Iceland and Montenegro, the number of the EU members will reach to 32 and the remaining Balkan states will be the potential candidates of the future enlargement waves.

During the above summarized deepening and widening processes, the European Union has developed a continuously evolving sui-generis supranational legal framework. [4] Briefly, the EU Law (developed on the Law of Causality, different from the Case Law) is the summation of the pieces of Community legislation published within the in the Official Journal of European Communities, which today is composed of more than 100.000 pages (forming the binding supranational regulations for the member states). The EU regulations have also started to affect the maritime industry and the maritime transportation sectors in time. For example, the single cabotage regime for EU and its related regulations has greatly influenced the maritime transportation in Europe. Also, the EU has gradually developed an extensive environmental legislative framework (for the earth, the seas and the atmosphere) which is also of binding nature for the member states and the candidate countries. As a result, particularly the maritime transportation sector has been greatly affected by these steps taken by the EU institutions and the policy makers.

Indeed, these new supranational regulations prepared by Brussels are harmonious with the existing international-global regulations (for example International Maritime Organization (IMO) conventions), but they take them further for the EU member states (and candidate countries) and bring new standards and additional regional and binding rules for maritime transportation sector representatives, particularly with regards to environmental protection. (For example; prevention of marine pollution by means of EU legislation supplementing the IMO-MARPOL Convention, or, European Maritime Safety Agency (EMSA) inspecting the maritime training-education standards in the member states, in addition to STCW of IMO.)

In this context, one recent development (in 2009) has been the European Commission's call for an ambitious long-term "zero-waste, zero-emission" objective for the maritime transportation sector in Europe. With this call, the European Commission has reaffirmed its intention to table draft legislation to cut greenhouse gas emissions from ships. To achieve this long-term goal, the commission also proposed to strengthen EU legislation on ship waste disposal at port facilities and improve its implementation. The Commission also underlined the importance of a European environmental management system to monitor improvements in the maritime sector's environmental performance. According to the EU Commission, the next ten years represent a "unique opportunity" to strengthen the shipping sector's contribution to EU goals on sustainable transport. In particular, the Commission stressed that promoting short sea shipping will help reduce congestion in the road transport sector.

3. EUROPEAN UNION'S "ZERO-WASTE AND ZERO-EMMISSION MARITIME TRANSPORT POLICY" UNTIL 2018

For Europe, shipping has been one of the key stepping stones to economic growth and prosperity throughout its history. Maritime transport services are essential in helping the European economy and European companies to compete globally. Moreover, shipping and all related maritime industries are an important source of revenues and jobs in Europe. Short-sea shipping carries 40% of intra-European freight. With more than 400 million sea passengers passing through European ports each year, maritime transport has also a direct impact on the quality of life of citizens, both as tourists and inhabitants of islands and peripheral regions.

In recent years, European maritime transport administrations and the European shipping industry have made significant efforts to improve the environmental record of maritime transport. The EU regulatory framework has been strengthened and cooperation with Member States has been increased to tackle issues including the prevention of accidents and incidents, atmospheric emissions, ballast water treatment and ship recycling. Lastly, in 2009, the European Commission has called for an ambitious long-term "zero-waste, zero-emission" objective for the maritime sector, which aims at increasing the competitiveness of the EU maritime sector and improve its environmental performance by 2018. The main priorities of the EU's proposed Zero-Waste and Zero-Emission Policy are:

- Ensuring steady progress towards a coherent and comprehensive approach to reduce greenhouse gas emissions (GHG) from international shipping, combining technical, operational and market-based measures.
- Actively working in the IMO to pursue the limitation or reduction of emissions of greenhouse gases from ships.
- Ensuring that Member States are able to achieve "good environmental status" in marine waters covered by their sovereignty or jurisdiction by 2020, as required by the new Marine Strategy Framework Directive.
- Strengthening EU legislation regarding port reception facilities for ship-generated waste and cargo residue, improving the implementation arrangements. In that regard, ensuring both the availability of adequate facilities and administrative procedures to meet the expected traffic growth.
- Ensuring the adoption of the IMO Convention on Ship Recycling and its future implementation.
- Overseeing the smooth implementation of the amendments adopted by the IMO in October 2008 to MARPOL Annex VI to reduce sulphur oxides and nitrogen oxides emissions from ships. This includes assessing which European sea areas qualify as Emission Control Areas, the availability of the adequate fuels and the impacts on short-sea shipping.
- Promoting alternative fuel solutions in ports, such as the use of shore-side electricity. (The Commission will propose a time-limited tax exemption for shore-side electricity in the forthcoming review of the Energy Taxation Directive as a first step and elaborate a comprehensive incentive and regulatory framework.)
- Re-launching the Commission's 'Quality Shipping Campaign', by means of partnership agreements with the EU maritime administrations, the maritime industries at large and the users of maritime transport services.

- Promoting a European Environmental Management System for Maritime Transport (EMS-MT), targeting the continuous improvement of the environmental performance of shipping; modulation of registration fees, port dues and other charges, with a view to rewarding efforts towards greener shipping. [5]

The EU's proposed Zero-Waste and Zero-Emission policy is surely a major step in developing environmental friendly maritime transportation services in the European continent. It can be considered as a European Constitution (a binding major supranational guideline) for environment friendly maritime activities for the member states and the candidate countries. In the following years, the relevant lacking legislative documents-laws/regulations (as well as the technical infrastructure) will be prepared by the EU in line with this objective and the sectors' activities in the European continent will be closely monitored. The EU's Zero-Waste and Zero-Emission policy can also function as a catalyst for the development of global legislative frameworks. Particularly, it can function as a basis for the further development of IMO's MARPOL's Annex VI or the further strengthening of the United Nations Framework Convention on Climate Change and its related protocols.

In this context, the following pages will focus on the current environmental record of the world shipping fleet particularly with regards to gas emissions to the atmosphere, and will thus comment on the possible influence of the EU's Zero-Waste and Zero-Emission policy on the change of this current picture.

4. THE ENVIRONMENTAL RECORD OF THE WORLD SHIPPING FLEET WITH REGARDS TO THE EMISSIONS TO THE ATMOSPHERE AND THE EXISTING LEGAL FRAMEWORK AT REGIONAL AND GLOBAL LEVELS

IMO-MARPOL CONVENTION ANNEX VI:

Currently, the Marpol Annex VI is the only globally applicable and the most developed binding document for monitoring-controlling the shipping fleet in the world with regards to emissions to the atmosphere. As is well known, the International Maritime Organization (IMO) is a specialized United Nations agency responsible for improving maritime safety and preventing pollution from ships. And within the IMO system, the air pollution from ships is regulated by Annex VI of 'MARPOL Convention'. The MARPOL Convention is the main binding international convention for prevention of pollution of the marine environment by ships. It is a combination of two treaties adopted in 1973 and 1978 respectively and also includes the Protocol of 1997 (namely, Annex VI). The Convention includes regulations and currently includes six technical Annexes. The SOx and NOx emissions (as well as PM Emission) from ships are limited according to the regulations in the Annex-VI. The convention also prohibits the deliberate release of ozone depleting substances. [6]

The NOx control requirements of Annex VI apply to marine diesel engines of over 130 kW output power, installed on a vessel constructed on or after 1/1/2000 and any engine that undergoes a major conversion on or after 1/1/2000, excluding engines used for emergency purposes.

The limit values are determined from the engine's rated speed as indicated in Table 1. The emission value for a diesel engine is to be determined in accordance with the NOx Technical Code 2008 in the case of Tier II and Tier III limits.

Table 1: The NOx Limit Values [7]

Tiers	Ship construction date on and after	Emission Factors (g / kWh) n = engine's rated speed (rpm)		
		n < 130	n < 130-1999	n > = 2000
I	1 January 2000	17.0	$45.\ n^{-0.2}$	9.8
II	1 January 2011	14.4	$44\ .\ n^{-0.23}$	7.7
III	1 January 2016	3.4	$9\ .\ n^{-0.2}$	2.0

MARPOL also defines certain sea areas as "*special areas*" according to their oceanographical and ecological condition as well as their sea traffic. These special areas require a higher level of protection when compared with other areas of the world seas. Annex VI Regulations for the Prevention of Air Pollution from Ships defines certain sulphur oxide (SOx) Emission Control Areas for tighter controls on sulphur emissions. [8]

SOx and PM emission controls apply to all fuel oil, combustion equipment and devices onboard and therefore include both main and all auxiliary engines together with items such boilers and inert gas generators. These controls are achieved by limiting the maximum sulphur content of the fuel oils as loaded, bunkered, and subsequently used onboard. The defined fuel sulphur limits over the years are shown in Figure 1. [9]

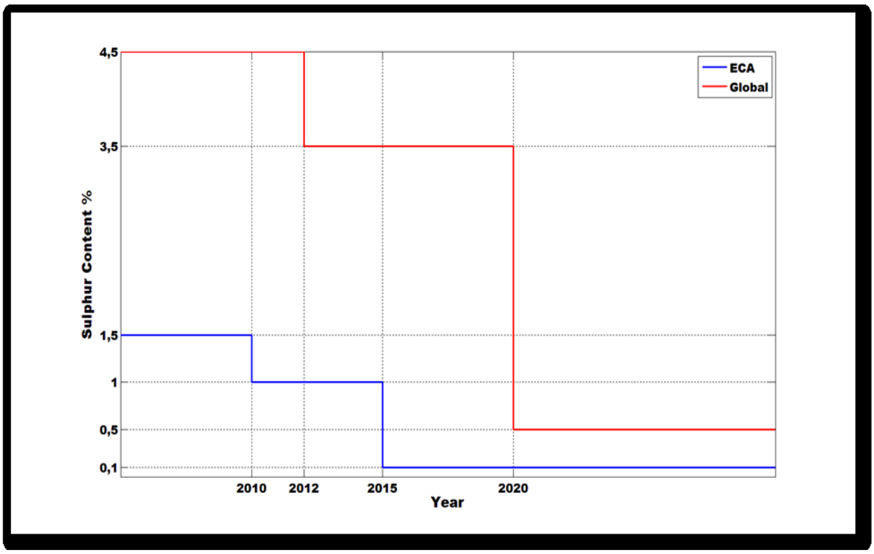

Figure 1: Fuel Sulphur Limits (Marpol Annex VI)

In terms of secondary control methods, guidelines (Marine Environment Protection Committee.184(59)) have been adopted for exhaust gas cleaning systems which operate by water washing the exhaust gas stream prior to discharge to the atmosphere, in using such arrangements there would be no constraint on the sulphur content of the fuel oils as bunkered other than that given the system's certification. [10]

IMO also provides the criteria and procedures for the submission of proposals for the designation of Emission Control Areas. An Emission Control Area should be evaluated by IMO for adoption according to prevention, reduction and emission control needs.

"The proposal shall include:

- a clear delineation of the proposed area of application, along with a reference chart on which the area is marked;
- the type or types of emission(s) that is or are being proposed for control (i.e. Sox and particulate matter or NOx or all three types of emissions);
- a description of the human populations and environmental areas at risk from the impacts of ship emissions;
- an assessment that emissions from ships operating in the proposed area of application are contributing to ambient concentrations of air pollution or to adverse environmental impacts. Such assessment shall include a description of the impacts of the relevant emissions on human health and the environment, such as adverse impacts to terrestrial and aquatic ecosystems, areas of natural productivity, critical habitats, water quality, human health, and areas of cultural and scientific significance, if applicable. The sources of relevant data (e.g., relevant meteorological data) including methodologies used shall be identified;
- the nature of the ship traffic in the proposed Emission Control Area, including the patterns and density of such traffic;
- a description of the control measures taken by the proposing Party or Parties addressing land-based sources of SOx, NOx and particulate matter emissions affecting the human populations and environmental areas at risk that are in place and operating concurrent with the consideration of measures to be adopted in relation to provisions of regulations 13 and 14 of Annex VI;
- the relative costs of reducing emissions from ships when compared with land-based controls, and the economic impacts on shipping engaged in international trade
- an assessment of the amount of fuel that will be affected by the ECA (Emission Control Area). Where volumes affected would be significant, a fuel supply analysis and prognosis should be provided."

"The geographical limits of an Emission Control Area will be based on the relevant criteria outlined above, including emissions and deposition from ships navigating in the proposed area, traffic patterns and density, and wind conditions." [11]

GLOBAL SHIPPING EMISSIONS:

Shipping was responsible for the 1,046 million tons of CO2 emissions in 2007 and this was equal to the 3.3% of the global emissions as of that year. Particularly, the international shipping (excluding transportation related emissions in inland waterways) produced 870 million tons of this emission, the same year, corresponding to the 2.7% of the global shipping related emissions of CO2. Again in 2007, the annual shipping emissions of NO_x, SO_2 and PM are estimated as 25, 15 and 1.8 million tons respectively. According to the future emission scenarios, if environment friendly policies (green shipping methods) are not implemented, the shipping emissions may increase by 150% to 250% as a consequence of the growth in shipping industry by 2050. [12]

Although, this scenario is already too alarming; the experts expect that other emissions such as NOx, SOx, HC, PM may decrease as the ships energy efficiency is continuously increasing. Furthermore, it is expected that with global implementation of the revised IMO-MARPOL Annex VI, we would see emission reductions in the long run. This reduction prospect is given in Table 2.

Table 2: Expected Reductions of Emissions (Due to Revised IMO-MARPOL Annex VI) [13]

	Global	**ECA**
NOx (g / kW-h)	15-20 %	80 %
SO_2 (g / kW-h)	80 %	96 %
Pm (g / kW-h)	73 %	83 %

-ECA: Emission Control Areas

For the year 2000, the total emissions of the five pollutants (NO_x, SO_2, CO_2, HC and PM-in ports) from shipping movements (EMEP domain) are estimated as 3617, 2578, 157298, 134 and 21 kt. [14] A detailed database of shipping emission inventory for the Mediterranean Sea (for the year 2005) shows that, annual shipping emissions of NO_x, SO_2, CO_2 and PM (from all ships more than 500 grt are) 1,447 kt, 863 kt, 64,836 kt and 98 kt based on 50x50 grid cells. Also, these ships consumed 20,426 kt of fuel in that year. [15]

THE CURRENT SITUATION IN (AND THE POLICIES OF) THE USA:

The U.S. Environmental Protection Agency (EPA) is a member of the U.S. delegation to the IMO and its Marine Environment Protection Committee (MEPC). The U.S. Environmental Protection Agency's (EPA) emission control program for marine engines consists of several sets of standards, which vary based on the type of engine (gasoline or diesel powered) and engine size. These standards apply to new manufacture of engines after the effective date of entry into force of the standards. Code of Federal Regulations (CFR) for the current regulations applies to marine diesel engines.

Also, the United States and Canada submitted a proposal to IMO to designate the coast of both countries as ECA. IMO approved the proposal and this ECA is the third such geographical area following the Baltic Sea and North Sea. (California has its own state restrictions that will be operational until the North American ECA comes into force.)

The USA and Canada governments expect that the sulphur fuel restriction starting from 2015 will reduce SOx and PM emissions by more than 85%, as well as the NOx emissions controls on engines leading to an expected 80% reduction. (A recent study by the IMO estimated that fuel consumption within the ECAs accounted for 8% of global fuel consumption.)

Ships will have the alternative to fit an 'exhaust gas cleaning device', such as a scrubber, if equivalent reductions can be achieved. Additionally, the EPA has also proposed a ban on high-sulphur bunker fuel to be sold in the US for use in the ECA. If there is no exemption, the EPA's proposed law change would appear to prevent ships buying high-sulphur fuel oil in the US for use in the ECA despite having a scrubber fitted.

From the proposal to the IMO, the outer boundary of the proposed North American ECA is 200 nautical miles from the territorial sea baseline, except that it will not extend into the marine areas subject to the sovereignty, sovereign rights, or jurisdiction of any State other than the United States or Canada consistent with international law and that is without prejudice to any un-delimited maritime boundaries. The US and Canada proposal says that the two countries account for more than 20 percent of goods shipped via ocean going vessels. The US typically sees over 64,000 vessel calls at its ports annually, and Canada's ports can see up to 29,000 vessel calls.

EPA revealed new fuel standards for marine fuels in the US from 2014. Beginning from June 1, 2014; to produce, import, sell, offer for sale, dispense, supply, offer for supply, store or transport any fuel with a sulphur content above 0.10% for use in an ECA or US internal waters is prohibited. Any distillate or fuel oil grade fuel not intended for use in the ECA must be clearly marked during its transportation and documentation available to identify that it is in non-conformity with the sulphur standard.

On July 1, 2009 the California Air Resources Board (ARB) revealed new rules that require ocean-going vessels operating within 24 nautical miles of California's coastline to use either MGO with a maximum of 1.5% sulphur, or marine diesel oil (MDO) with a maximum of 0.5% sulphur in their main engines, auxiliary engines and auxiliary boilers. The sulphur limit under the ARB regulation will reduce to 0.10% for both MDO and MGO beginning from January 1, 2012. [16]

The United States has also proposed the specific portions of the coastal waters around Puerto Rico and the U.S. Virgin Islands for the designation of an ECA. This action would control the emission of nitrogen oxides (NOx), sulfur oxides (SOx), and particulate matter (PM) from ships operating in the area. The ECA is expected to reduce emissions of NOx by 11,000 tons, PM2.5 by 3,300 tons, and SOx by 31,000 tons per year, which is 27 percent, 86 percent, and 96 percent, respectively, below levels in 2020 absent the ECA. The overall cost of the ECA is estimated at $70 million. [17]

5. GENERAL CONCLUSIONS: THE EUROPEAN UNION'S 'ZERO WASTE-ZERO EMISSION POLICY' AND ITS POTENTIAL IMPACT ON THE DEVELOPMENT OF SIMILAR BINDING LEGISLATION IN THE WORLD

For reducing the greenhouse gas (climate change) emissions from shipping and ship waste disposal, the IMO has gradually specified and put into practice several technical, operational and market-based measures. Therefore one can say that, at first sight, the EU's proposed zero waste and zero emission policy is not such a novel approach to an already existing problem.

However, the EU's supranational policy decisions are surely more binding for the member states and candidate countries when compared with the IMO regulations. A country that does not approve MARPOL Annex VI is not obliged to follow this agreement in its territorial waters (although its fleet will have to abide by it during their international trade activities); however, the EU member states and candidate countries are directly influenced by the binding nature of the EU law, and therefore, they will have to strictly implement the newly developing zero waste and zero emission policy in their maritime activities.

Without doubt, the most important outcome of this newly emerging policy will be the increasing environmental standards in the EU ports, and thus, the fleet of the non-EU countries which has lower environmental standards (as well as the new member states that are still struggling in aligning with -and implementing- the EU *acquis*; such as Bulgaria and Romania) will have difficulties in trading with these geographies and their ports.

Furthermore, in the coming years, the EU's zero-waste and zero emission policy (as well as newly developing, alternative, legislation and monitoring methods in the USA) may function as a catalyst for further development and strengthening of existing IMO regulations which are today controlling the environmental standards in international shipping (and maritime activities).

The EU's proposed zero waste and zero emission policy does not indeed bring new 'limit values', which exist in MARPOL Convention and the related legislative frameworks in the USA. Instead, it focuses on (and develops) more broad environmental rules (and guidelines), which are strongly binding for the actors in the shipping sectors. This also shows that the technical infrastructure for the implementation of this policy and the clear details of the implementation mechanisms (such as the NOx Technical Code in MARPOL Annex VI) are not yet finalized at the EU level. Yet, the EU may also have an intention to use (or lobby for the further revision of) some of the existing technical procedures, limits and methods of the IMO's relevant conventions in implementing this extensive policy. Indeed, today, as the EU and the USA are the most influential shipping actors in the world, the IMO's MARPOL Convention is also generally revised in line with the wishes of these two important actors. For example, the IMO has managed to pass the relevant legislation about the sulphur limits in marine fuels (both in and outside Emission Control Areas) only after the EU and USA declared that they will implement these in their territorial waters.

Today, the cost of shipping related emissions is much higher in the ports due to high population density in these areas. In this context, one important environment friendly method to decrease the emissions in the ports is 'cold ironing' (the process of providing shore-side electrical power to a ship at berth, while its main and auxiliary engines are turned off) and this method is for the first time included into a governmental policy (although it is suggested by several scientific studies in the past, and currently being tested in California) with the EU's 'zero-waste and zero emission' proposal.

Furthermore, the proposed coordinated improvement of the waste disposal facilities in the ports is also a novel approach when compared with other parts of the world; as the policy aims for this, for the first time in such a massive scale, in the ports of the 27 EU member and 5 EU candidate states.

In conclusion, one can clearly say that the EU's zero-waste and zero emission policy is a major step forward for green shipping in Europe. Furthermore, in the coming years, it will also function as a benchmark for the developed countries in the world and may force the international organizations such as the IMO to take similar measures at the global level. Hence, the EU's success in implementing this broad policy agenda until 2018 at the regional level is going to be crucial for repeating the similar steps at a larger scale, possibly under the UN (IMO, UNFCCC, etc.) framework.

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STCW 78: Manila Amendments and Some Risk Assessment Aspects

Vladimir Loginovsky
DSc, Professor, Admiral Makarov State Maritime Academy
vl.loginovsky@rambler.ru

Abstract: in accordance with Manila Amendments to STCW 78 all the officers are required to have knowledge, understanding and proficiency in "Situation and risk assessment". The term "risk" occurs in different parts of the STCW 78 Code and applies to safety, security and protection of environment issues. The paper analyses the Manila Amendments to STCW 78 and researches some aspects of the qualitative technique for risk assessment based on fuzzy logic approach.
Keywords: STCW 78, Manila amendments, , risk, safety, protection of environment.

1. INTRODUCTION

The International Convention on Standards of Training, Certification and Watchkeeping (STCW), 1978 as amended, sets qualification standards for masters, officers and watchkeeping personnel on seagoing merchant ships. The work on amending the STCW Convention and Code was launched by STW Sub-Committee of IMO in January 2006 and culminated in a Diplomatic Conference in Manila, Philippines in June 2010. These amendments are known as „The 2010 Manila Amendments".

2. CONCEPT OF RISK IN STCW 78 CODE

Manila amendments to STCW 78 includes standards on situation and risk assessment in different fields of ship operation. Seafarer should comply with these standards and have knowledge, understanding and proficiency in risk assessment. If to look through the text of STCW 78 Code we can find a lot of provisions containing the term „risk" (Table 1).

Meanwhile, reading Chapter VIII and Part B of the Code you also face with terms containing risk, for example: risk of collision, specific risks, risks of over-reliance on ARPA (ECDIS), potential risk of improper functioning of the system; potential risk of human errors; reducing the risk of human error; risk assessment systems, risk of flooding, risk assessment before approaching ice-infested waters...

Without doubt the concept of risk is central one in Safety Management System of every and each shipping company and taking into account the IMO Resolution A. 1022

(26), which is in force from 01 June 2010 and also new risk-based format of inspections of ships set by Paris MOU from 01 January 2011 and also the new standard ISO 31000 - “Risk management- principles and guidance on implementation”, it’s obvious to note that including the concept of rick into Manila amendments to STCW 78 Convention and Code is a very much timely measure. Risk assessment and situation awareness are logically linked with other MET concepts as they are linked in reality with safety at sea.

In accordance with publication [3], “the concept of risk stands central in any discussion of safety. With reference to a given system or activity, the term ‘safety’ is normally used to describe the degree of freedom from danger, and the risk concept is a way of evaluating this.”

Table 1. STCW 78 competences containing the provosions on risk assessment

Competence	Tables of minimum standard of competence
Application of leadership and teamworking skills	*A-II/1,A-III/1, A-III/6*
Application of leadership and managerial skills	*A-II/2, A-III/2*
Maintain the safety of navigation through the use of ECDIS and associated navigation systems to assist command decision making	*A-II/2*
Forecast weather and oceanographic conditions	*A-II/2*
Safe use of electrical equipment	*A-III/5 ,A-III/7*
Ability to safely perform and monitor all cargo operations	*A-V/1-1-2 ,A-V/1-1-3, A-V/1-2-2*
Apply occupational health and safety precautions	*A-V/1-1-2 ,A-V/1-1-3, A-V/1-2-2*
Minimize the risk of fire and maintain a state of readiness to respond to emergency situations involving fire	*A-VI/1-2*
Take immediate action upon encountering an accident or other medical emergency	*A-VI/1-3*
Apply immediate first aid in the event of accident or illness on board	*A-VI/4-1*
Assess security risk, threat, and vulnerability	*A-VI/5*
Recognition of security risks and threats	*A-VI/6-2*

Simple statistical research of STCW 78 Code made with the help of Leximancer software resulted in the conceptual map (see Fig.1). The map provides three main sources of information about the content of document :

- The main concepts contained within the text and their relative importance;
- The strengths of links between concepts (how often they co-occur);
- The similarities in the context in which they occur.

The conceptual map shows the more deep links of the concept „risk" with other main concepts of STCW 78 Code (see Fig.1), where the concept „risk" is in the center of conceptual map. It means that risk in STCW 78 Code possesses a high degree of centrality. It is located on crossing of two main STCW themes as "Training" and "Ship". It is something like mathematical expectation of random sequence of the most frequent (important) STCW concepts. We can conclude that directly or indirectly the concept "risk" exists in all other concepts of the Code and professional training needs to pay attention to this concept seriously.

The more closer the concepts appear on the map, the more contextual similarity they have. So, the concepts „grounding", „collision", „situation" and „communication" are the most contextually similar to the concept „risk".

The results concerning the concept „risk" shown in Fig. 1 differs from results published in [2], as the there is another set of surrounding concepts, which were selected intentionally automatically as the most frequent (important) in the text.

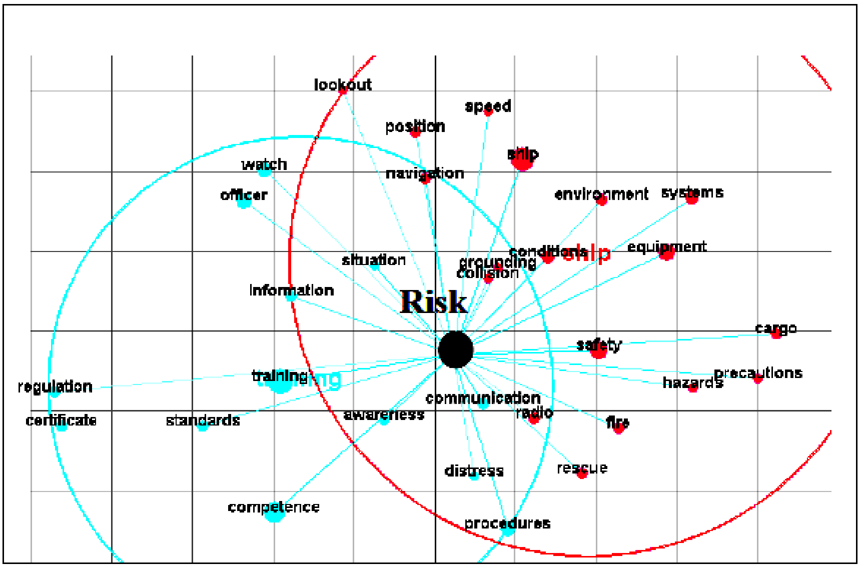

Figure 1. STCW 78 Code risk conceptual map.

So, taking it into account it is important to note that from automatically chosen the set of the most co-occurring concepts, the concept "risk" - is connected to all others and that is why these concepts can be used as risk management options and risk management measures.

What is risk ? In shipping the actors tend to view risk in an objective way in relation to safety, and as such use the concept of risk as an objective safety criteria. In shipping the following definition of risk is normally applied [3]:

$$R=PC \quad (1)$$

where *P*- the probability of occurrence of an undesired event (e.g. a ship collision) and *C*- the expected consequence in terms of human, economic and/or environmental loss. Equation (1) shows that objective risk has two equally important components, one of probability and one of consequence. Risk is often calculated for all relevant hazards,

hazards being the possible events and conditions that may result in severity. For example, a hazard with a high probability of occurrence and a high consequence has a high level of risk, and a high level of risk corresponds to a low level safety for the system under consideration. The opposite will be the case for a hazard with a low probability and a low consequence. Safety is evaluated by summing up all the relevant risks for a specific system.

The modified approach for risk assessment is given in publication [1], where formula (1) is transformed by the following way:

$$\text{Log}\,(R) = \log\,(P) + \log\,(C), \text{ or}$$
$$RI = FI + SI \qquad (2)$$

Where *RI, FI, SI* consequently risk , frequency and severity indexes.

Table 2 contains two approaches of risk assessment technique : quantitative and qualitative ones. Let's try to understand how are these approaches linked with each other.

3. FUZZY INFERENCE SYSTEM IN RISK MATRIX MODELING

We applied MATLAB fuzzy inference system (FIS) to make a model of formula (2). The structure of a model is shown in Figure 2. We used triangular membership functions (mf) and composed 28 fuzzy rules strictly in accordance with Table 2 data.

Table 2. Risk matrix

Risk Index (*RI*)					
		SEVERITY *(SI)*			
		1	2	3	4
FI	FREQUENCY	Minor	Significant	Severe	Catastrophic
7	Frequent	8	9	10	11
6		7	8	9	10
5	Reasonably probable	6	7	8	9
4		5	6	7	8
3	Remote	4	5	6	7
2		3	4	5	6
1	Extremely remote	2	3	4	5

The authors of publication [4] point the fact that the scale values for probability and severity are essentially arbitrary. There is no reason why the two scales should be the same or different. Similarly, there is no reason why they should be linear or nonlinear. Even linear scales do not divide the space linearly. If to follow this view the linguistic variables describing indexes FI and SI can have different and sometimes ambiguous values due to their fuzzy borders of frequency (probability) and severity.

Following [4] we can suppose that the configuration of risk matrix based on Table 2 suffers from a false symmetry, whereby equal values do not necessarily refer to equally risky situations.

So, to check the above the fuzzy model of nonlinear index *FI* was applied based on values of words describing their meaning in frequency terms from article [5] as follows: 300 (always), 261(very often), 237 (usually), 222 (often), 222 (rather often), 216 (frequently), 216 (generally), 150 (about as often as not), 102 (now and then), 87 sometimes), 84 (occasionally), 66 (once in a while), 48 (not often), 48 (usually not), 27 (seldom), 24(hardly ever), 21(very seldom), 15 (rarely), 6 (almost never), 0 (never). Here the numbers set the values of correspondent linguistic variables.

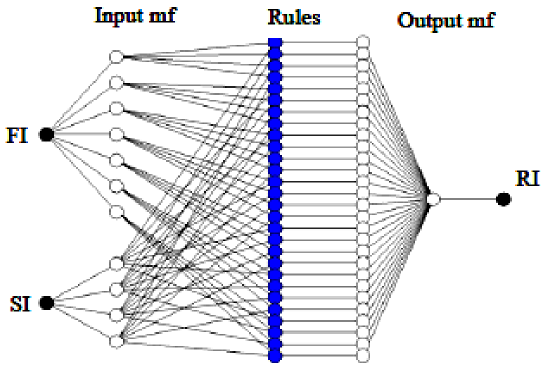

Figure 2. Strucure of FIS of concept „Risk”

The following fuzzy values were applied to Frequency Index in table 2: extremely remote = (15) rarely, remote = (27) seldom, reasonably probable = (84) occasionally, frequent= (216) frequently and the linear scale 1-7 was quantified in appropriate with the following nonlinear sequence: 15,27, 84, 216.

Linear and nonlinear results of FIS are shown in Figures 3-5, where from left to right you can see the transformation of linear model to nonlinear one. If to assume that interval RI=5-8 can be considered as a tolerable risk zone (T), then interval RI<5 is negligible risk zone (N) and RI> 8 is intolerable risk zone (I), then we can see the changing of configuration of these zones on Figures 4 and 5. This geometrical changing of N, T and I zones puts the task of need of more comprehensive research in this area ,as risk-based decision making procedure may lead to a very much ambiguous situation.

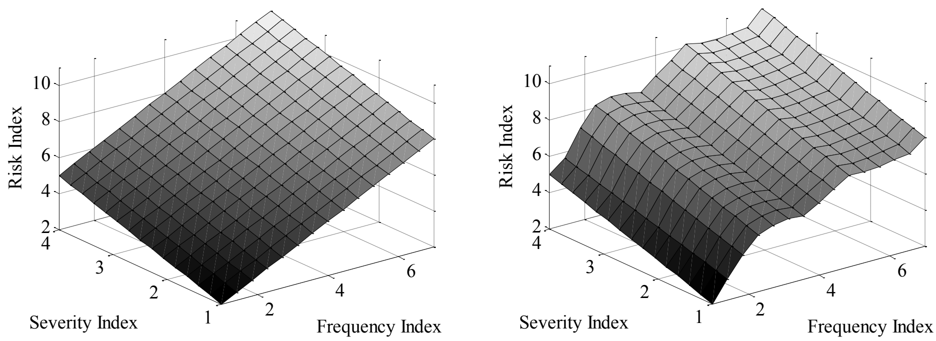

Figure 3. 3D Risk matrix (linear and nonlinear from left to right)

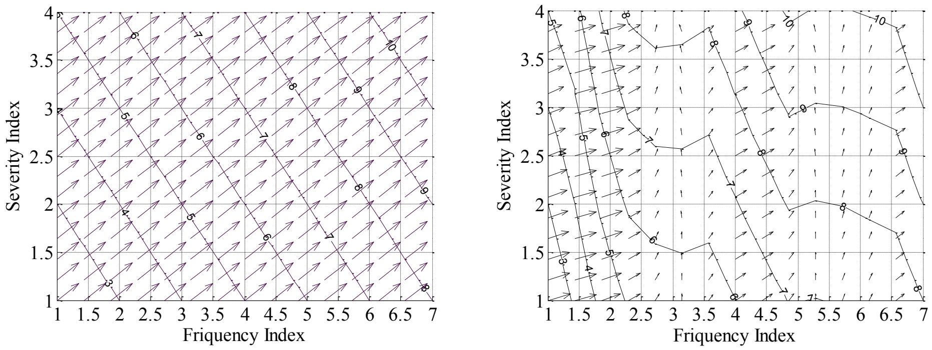

Figure 4. 2D Risk matrix with risk gradients and risk contours (linear and nonlinear from left to right)

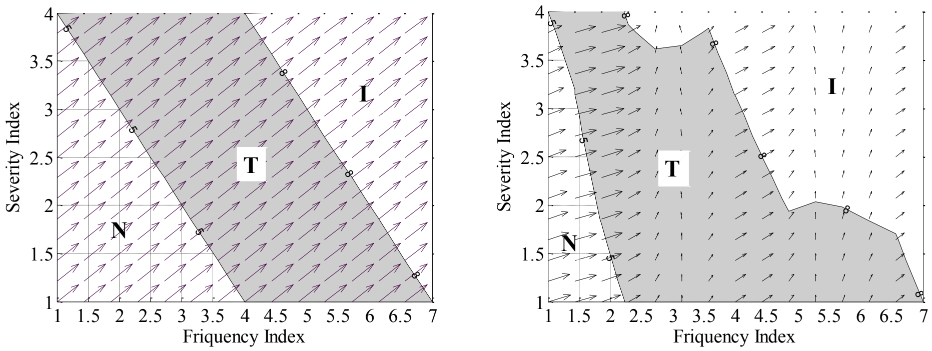

Figure 5. 2D Risk matrix with negligible (N), tolerable (T) and intolerable (I) risk zones (linear and nonlinear from left to right)

4. CONCLUSIONS

1. Concept “risk” in STCW 78 Code possesses a high degree of centrality. It is located on crossing of two main STCW themes as “Training” and “Ship”. It can be interpreted as something like the *mathematical expectation* of random sequence of the most frequent STCW concepts. It is possible to conclude that directly or indirectly the concept “risk” exists in all other concepts of the code and professional training needs to pay attention to this concept seriously.
2. So, taking into account the above conclusion it is also important to note that from automatically chosen set of the most co-occurring concepts, the concept “risk” - is connected to all others and that is why these concepts can be used as risk management options and risk management measures .
3. FIS is convenient and flexible tool for linear or nonlinear modeling of risk matrix. Both techniques ,as quantitative and qualitative ones can be used for practical and theoretical application.
4. Transformation from a quantitative to qualitative risk assessment demands preliminary more accurate standardization of meanings and values of appropriate linguistic variables both frequency and severity of consequences.

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Optimal Management of Fleet Relocation at Deepsea Fishing Grounds

Sergey Moiseenko
Dr., Prof, Capt., Baltic Fishing Fleet State Academy,
transport@bga.gazinter.net; moiseenkoss@rambler.ru

Leonid Meyler
Dr., Baltic Fishing Fleet State Academy,
transport@bga.gazinter.net; bgaintern@gazinter.net

Abstract: Methods of the fishing ground efficiency criteria definition, connected with the basic parameters of a vessel's production program, such as a catch volume, producing of food/commercial fish products, profit, etc. are presented in the paper. The structure of criteria reflects the basic conditions of producing and limits of fishery system subsystems: "catch", "catch processing", "material and technical supply of a vessel". These criteria reflect the purposes of the fishing system and means of their achievement. The practical example of calculation of efficiency (usefulness) criteria of a fishing ground for concrete type of a vessel is resulted in the paper.
Keywords: fishing fleet, fishing ground, relocation, efficiency criteria, theory of operations research

1. INTRODUCTION

The problem of fishing fleet or a single vessel relocation arises in connection with a change of fishing conditions at a certain fishing ground. Simultaneously there is a forecast of good fishing conditions at other grounds or subregions and it is required to make a decision, what of them to choose for fishing. As well vessels of various types with different production capacities can catch fish at the certain fishing ground. In this connection fishing operations of some vessels can be effective at one or another fishing ground but less effective for operations at others. Thus, there is a problem of fleet optimal regional allocation at fishing grounds.

This problem have been solved earlier [1, 2, 3] by methods of linear programming taking into account different limitations on using of fishing vessels at certain fishing grounds; on catching by certain vessels' types, on seasonality of fishing, etc. Mathematical models presented there can be realized if there are the planned catch at the fishing grounds and the production plan for each period. These approaches were based on parameters of fishing operation which had a proper to the planned state economics character.

At present, in conditions of the market economics, decision makers have to solve this problem taking into account some basic arbitrarily given parameters of a fishing vessel or a group of vessels production program. It should be noted [4], that the role of expert estimation is not reduced even if there is the mathematical models for catch forecasting and fishing fleet allocation. This is due to the large number of unstable factors, changing fishing conditions, a low reliability of the biological predictions, etc, and, finally, a whole group of such subjective factors as the organizational problems of fishing, personnel problems and some others. One of the latest papers [5] says that a large number of complex cybernetic systems with multi-level structure can be allocated in processes of catching, fishing and in the management of fish stocks. Methods of optimal management theory, systems analysis, theory of operations, mathematical modeling, information theory, etc. are used in the analysis or synthesis of such systems. For example, considering the process of catching fish, management systems of fishing objects, fishing gear, other technical means of fishing in general are allocated. Optimality criteria for solving general and specific optimization problems are usually a combination of several indicators. The problem of decision-making in the management of complex processes and systems is related to the choice of options to achieve management objectives. In general, several variants of many possible are chosen but in the special case a concrete variant of actions is chosen. Selection is made by the decision maker, who has certain rights and powers. This same person is responsible for the consequences of the decisions. Concerning to the problem described in this paper, the decision maker has to optimally allocate fishing vessels at certain fishing grounds.

It is necessary to define efficiency (usefulness) criteria of a fishing ground to resolve the above mentioned problem. Management decisions on the fleet allocation have to be made taking into account these criteria. Generally, a fishing system is represented consisting of several subsystems, such as “a fishing vessel”, “fishing gear”, “fishing objects”, “catch”, “catch processing”, “delivery of production to the port or to a fish factory”, “technical supply of a fishing vessel”, etc. All these sub-systems define fulfillment of the production program and a fishing production quota of the voyage by each fishing vessel. It is suggested [6] that the basic parameters of a vessel’s production program are:

– catch volume,
– producing of food,
– commercial fish products,
– profit.

Also an effectiveness of a chosen fishing ground is connected to these parameters.

2. EFFICIENCY (USEFULNESS) CRITERIA OF A FISHING GROUND

2.1 A fishing ground subregion usefulness on a catch volume criterion

This criterion is defined as a ratio of the expected catch value by a vessel or a group of vessels in time t to the value of the planned catch for this time taking into account time for the vessel (a group of vessels) passage to the fishing ground subregion:

$$F_{1k}^{l}=\frac{\sum_{i,j,k}W_{im}^{l}g_{km}^{l}N_{km}^{l}k_{km}t^{l}}{\sum_{k,m}g_{km}^{pl}N_{km}^{l}(t^{l}+t_{n}^{l})} \tag{1}$$

where W_{im}^{l} - a weighted estimate of *i* fish species in a catch in *m* way to catch fish at *l* fishing ground subregion; g_{km}^{l} - an expected catch value per a fishing day by *k* vessel type, t/day; N_{km}^{l} - a number of vessels directed to the fishing ground subregion, units; t^{l} – fishing operation time of a vessel (a group of vessels) at *l* fishing ground subregion, days; g_{km}^{pl} - daily (planned) rate of catch by *k* vessel type with *m* way to catch fish, t/day; k_{km} - coefficient of actual fishing time usage; t_{n}^{l} - time for a vessel (a group of vessels) passage to the fishing ground subregion, days.

Values of W_{im}^{l} and g_{km}^{l} - are defined from short-term forecasts of operative fish searching.

It should be noted that this criterion also depends on such factors as the adaptation of catch objects to the type of fishing gear. That is, if fishing vessels have been operated for a long time at the certain fishing ground, for example, with the specific trawl type, some kinds of fish are getting used to the hydrodynamic fields (velocities and pressures) inside the trawl. This case the catch will be probably not effective. This factor is under investigation till now [7, 8].

2.2 A fishing ground subregion usefulness on a food raw material output criterion

This criterion is defined by the formula:

$$F_{2k}^{l}=\frac{\sum_{k,m}W_{mn}^{l}g_{km}^{l}N_{km}^{l}k_{km}t^{l}}{\sum_{k,m}g_{km}^{n}N_{km}^{l}(t^{l}+t_{n}^{l})} \tag{2}$$

where W_{mm}^{l} - a weighted estimate of a food raw in the total mass of the catch; g_{km}^{n} - a planned value of a raw use for food, t.

2.3 A fishing ground subregion usefulness on a commercial fish products output criterion

This criterion is defined as a ratio of an expected commercial fish output in value terms to the planned value of this parameter. This criterion can be designed in the following way. A vessel or a group of vessels are directed conditionally to the fishing ground subregion.

$$N_{km}^{l} \leq N_{km_{acc}}^{l} \tag{3}$$

where $N_{km_{acc}}^{l}$ - acceptable number of vessels for simultaneous fishing at the fishing ground subregion.

Then an expected catch value for duration of vessels stay at fishing ground t^l is calculated. Also a value of a criteria function on the maximum cost of a commercial output for a vessel or a group of vessels is calculated using a linear optimization model. In general, the model has the form:

$$\sum_{i,j,k,m} c_{ij} x_{ijkm} \rightarrow \max \tag{4}$$

$$\sum_{i,j,k,m} a_{ij} x_{ijkm} \leq \sum_{i,k,m} W_{im}^{l} g_{km}^{l} N_{km}^{l} k_{km} t^{l} \tag{5}$$

$$\sum_{i,j} x_{ijk} \leq \sum_{i,j} C_{ijk} \tag{6}$$

$$\sum_{i,j} x_{ijk} \leq \sum_{i,j} P_{ijk} \tag{7}$$

where $x_{ijkm} \geq 0$ – a value of fish products of *j* assortment made of *i* kind of a fish raw, caught by *k* type of a vessel in *m* way to catch fish, t; c_{ij} – a cost of fish products; a_{ij} – a rate of raw consumption; C_{ijk} – capacity of the technological equipment of *k* vessel type, t/day; P_{ijk} - resources required for fish production, t.

The planned daily volume of commercial fish products is calculated according to the fishing production quota of the voyage:

$$T_{pl} = \sum_{i,j,m} c_{ijkm} x_{ijkm} \tag{8}$$

The criterion is defined by the formula:

$$F_{3k}^{l} = \frac{max \sum_{i,j,k,m} c_{ijkm} x_{ijkm} t^{l}}{T_{pl}(t^{l} + t_{n}^{l})} \tag{9}$$

2.4 A fishing ground subregion usefulness on a profit criterion

This criterion is designed similar to the criterion F_{3k}^{l} and calculated by the formula:

$$F_{4k}^{l} = \frac{\sum_{i,j,k,m} b_{ijkm} x_{ijkm}}{\sum_{i,j,k,m} b_{ijkm} x_{ijkm} (t^{l} + t_{n}^{l})} \qquad (10)$$

where b_{ijkm} – profit from realization of one ton of fish products by k type of a vessel in m way to catch fish.

The structure of criteria F_{3k}^{l} and F_{4k}^{l} reflects main conditions of production and limits of subsystems "catch", "catch processing", "material and technical supply of a vessel". Criteria themselves reflect purposes of the fishing system and means to achieve them. Effectiveness of k - type vessel or group of vessels operation at l fishing ground subregion can be presented as the composite vector criterion:

$$\overline{F}_{k}^{l} = \left[F_{1k}^{\,l}; F_{2k}^{\,l}; F_{3k}^{\,l}; F_{4k}^{\,l}\right] \qquad (11)$$

Criteria of the fishing ground subregion usefulness can be calculated by simplified formulae. For example, criteria for trawler or seiner types of fishing vessels are calculated as:

$$F_{1k}^{\,l} = \frac{P_k g_k^l k_k t^l}{g_k^{pl} (t + t_n)} \qquad (12)$$

where P_k - probability of effective fishing by k type of a vessel.

$$F_{2k}^{\,l} = \frac{W_{ik}}{W_k^{pl}} F_{1k}^{\,l} \qquad (13)$$

where W_{ik} - a weighted estimate of a food raw in the total mass of i fish species in a catch by k type of a vessel; W_k^{pl} – rate of a planned raw for food fish products.

$$F_{3k}^{\,l} = \frac{max \sum_{ij} c_{ij} x_{ij} t}{T_{pl} (t + t_n)} \qquad (14)$$

$$F_{4k}^{\,l} = \frac{max \sum_{ij} b_{ij} x_{ij}}{b_{pl} (t + t_n)} t \qquad (15)$$

where b_{pl} - a planned daily profit.

Probability of effective fishing for each vessel is different and depends on a set of factors. It is defined on a base of statistical trials as a particular of the event. Also P_k can be given a priori using a method of expert evaluations. A coefficient of a fishing time usage is defined with as a ratio of actual fishing time to common duration of a vessel stay at the fishing ground. By short-term forecasting this coefficient can be given also taking into account an analysis of internal and external factors, evaluating on the fishing system, like weather and sea conditions, a vessel and fishing gear status, conditions of fishing and commercial fish concentration, etc. The value of an expected daily catch for a vessel is given in the short-term forecast, but can be defined on results of other vessels fishing by the formula:

$$g_k^l = \frac{3g_{k\min}^l + 2g_{k\max}^l}{5} \tag{16}$$

where $g_{k\max}^l$ and $g_{k\min}^l$ - maximal and minimal catch values by k vessel type operated at l fishing ground subregion.

3. SELECTION OF AN OPTIMAL SOLUTION FOR VESSELS RELOCATION IN FISHERIES

A search for an optimal actions variant in multi-criteria problems is associated with big difficulties, because of contradictions arising between certain local criteria. An effort to improve any one local criterion is usually a deterioration of another. For example, the desire to increase a catch value and simultaneously to increase a profit is often contradictory. Because fishing fleet can have a big catch, but a small profit at one fishing subregion, while at the other – the smaller catch, but the great profit. A search of an optimal solution is connected to the choice of a compromise scheme, that is, with vectors comparison. Let the usefulness of two fishing ground subregions is presented by the vector effectiveness criteria:

$\overline{F}_k^{1l} = \left[F_{1k}^{1l}; F_{2k}^{1l}; F_{3k}^{1l}; F_{4k}^{1l}\right]$ - the 1-st subregion;

$\overline{F}_k^{2l} = \left[F_{1k}^{2l}; F_{2k}^{2l}; F_{3k}^{2l}; F_{4k}^{2l}\right]$ - the 2-nd subregion.

Methods of decision-making [9, 10] give following rules of vectors comparison that can be used to assess the preferences of the selection of a fishing ground subregion.

3.1 The principle of absolute equitable compromise

This principle is that a compromise is considered as “an equitable” when the total absolute level of reduction of one or more criteria does not exceed the total of the absolute level of other criteria increasing. This principle corresponds to the principle of optimality, which consists in maximizing the sum of local criteria:

$$\underset{\overline{F} \in \Omega_{\overline{F}}^c}{opt}\ \overline{F} = \underset{\overline{F} \in \Omega_{\overline{F}}^c}{max} \sum_{i=1}^{n} F_i \tag{17}$$

where F – an optimal solution of the integrated criterion; *opt* – an operator of optimization, that defines the chosen principle of optimization; Ω - a region of acceptable solutions that can be divided on two non-intersecting parts: Ω_F^a - an accord region, where the quality of the solution can be improved simultaneously in all the local criteria and without decreasing any of the criteria level; Ω_F^c - a region of compromises, where improving the quality of a solution under one local criteria leads to deterioration of the quality of solutions under others.

It is obviously, that the optimal solution can belong only to the region of compromises, as the decision in the accord region can be improved by appropriate criteria. For example, the value of total absolute compromise Δ_{abs} is calculated by comparing two vector criteria as follows:

$$\Delta_{abs.} = \left[F_{1k}^{2l} + F_{2k}^{2l} + F_{3k}^{2l} + F_{4k}^{2l}\right] - \left[F_{1k}^{1l} + F_{2k}^{1l} + +F_{3k}^{1l} + F_{4k}^{1l}\right] \quad (18)$$

Preference will be given for the operation, the sum of the criteria according to which is more. Consequently, the 1-st subregion gets priority.

3.2 The principle of relative equitable compromise

This principle is that a compromise is considered as "an equitable" Δ_{rel} when the total relative level of reduction of one or more criteria does not exceed the total relative level of increasing the efficiency under other criteria. In this case the principle of optimality is written as a multiplication of local criteria, on which a maximum is found as:

$$\underset{\overline{F} \in \Omega_{\overline{F}}^{c}}{opt}\, \overline{F} = \underset{\overline{F} \in \Omega_{\overline{F}}^{c}}{max} \prod_{i=1}^{n} F_i \quad (19)$$

$$\Delta_{rel.}^{1} = \sum_{i=1}^{n} \frac{F_i^{2l} - F_i^{1l}}{F_i^{1l}}; \quad \Delta_{rel}^{2} = \sum_{i=1}^{n} \frac{F_i^{3l} - F_i^{2l}}{F_i^{2l}}; \quad \Delta_{rel.}^{3} = \sum_{i=1}^{n} \frac{F_i^{3l} - F_i^{1l}}{F_i^{1l}}$$

where n – a number of criteria.

3.3 The principle of priority

Local criteria of usefulness may be ranked by priority. Then the problem of finding the optimal solution (the choice of a fishing ground subregion) reduces to the following models: the order of priorities is given in the sequence: $F_{4k}^l, F_{3k}^l, F_{2k}^l, F_{1k}^l$, that is:

$$F_{4k}^l = \max;\; F_{3k}^l \geq F_{3acc}; F_{2k}^l \geq F_{2acc;} F_{1k}^l \geq F_{1acc} \quad (20)$$

where F_{iacc} – acceptable values of local criteria.

An order of priorities is given by the decision maker, responsible for the decision, and based on the analysis of the vessels status and environmental factors.

3.4 The problem of criteria convolution

The problem of criteria convolution, considered in the theory of operations research, consists in the transition from a vector criterion to some generalized scalar criterion. Thus, if local criteria are measured in the same scale, the generalized criterion is calculated as a weighted average of local criteria:

$$F_{gen}^{l} = \sum_{i} \alpha_i F_{ik}^{l} \tag{21}$$

where $\sum_{i} \alpha_i = 1$ – a sum of weighted estimates of each criteria.

Using the principle of criteria convolution is related to the difficulty of α_i values choosing. It is possible to use an empirical method of calculation to determine the weighted estimates of local criteria F_{ik}^{l} . The method is based in the following. Implementation of the planned indicators of a fishing vessel is calculated as the ratio of actual output to the planned one for the same period of time. Obtained nondimensional values characterize the quantitative assessment of implementation of the voyage plan in fixed time and can be written as a vector:

$$\overline{\Phi} = [\Phi_{1k}; \Phi_{2k}; \Phi_{3k}; \Phi_{4k}] \tag{22}$$

where $\Phi_{1k}, \Phi_{2k}, \Phi_{3k}, \Phi_{4k}$ - nondimensional estimations characterizing implementation by k type of a vessel of planned indicators on catch, food, commercial fishing product and profit.

If the decision maker aims to provide an increase first and second indicator, the corresponding weighted estimates are assigned large compared with the estimates of the remaining criteria. In that case estimations can be guided by a common sense. If the aim is a steady smoothing estimation, the weights α_i can be determined from the system of equations:

$$\frac{\Phi_1}{\Phi_2} = \frac{\alpha_2}{\alpha_1}; \ \frac{\Phi_2}{\Phi_3} = \frac{\alpha_3}{\alpha_2}; \ \frac{\Phi_2}{\Phi_4} = \frac{\alpha_4}{\alpha_2} \tag{23}$$

4. FISHING VESSELS REGIONAL ALLOCATION AT FISHING GROUND SUBREGIONS

4.1 Procedure for the problem resolving

Let suppose that twenty fishing vessels of type A and five vessels of the type B have fishing procedures at the certain fishing ground. There is a forecast of fishing conditions for the three subregions. Production characteristics and resources of vessels are known. Procedure for the problem resolving reduces to implementation the following main operations:

- to calculate criteria F_{1k}^{l} and F_{2k}^{l} for each of subregions and a type of vessels;

- having made a mathematical model of the form (4-7) for each type of vessels, simulating their fishing in each of subregions, to solve the linear programming task by simplex method;
- to calculate values of the F_{3k}^{l} criterion for each of subregions and a type of vessels (or the concrete vessel);
- to solve the linear programming task of the form (4-7) for maximum of profit and to calculate the criterion F_{4k}^{l} ;
- to choose a scheme of compromise and to compare the vector functions of usefulness, to determine the priority of subregions, taking into account the type of a vessel;
- to distribute vessels at fishing ground subregions taking into account restrictions on the number of vessels N_{kmacc}^{l} at a subregion, if such restrictions exist.

Let us assume that values of the effectiveness criteria are calculated and the results shown in Table 1.

Table 1

Type of a vessel	Fishing ground subregion	Criteria values				N_{kmacc}^{l}
		F_{1k}	F_{2k}	F_{3k}	F_{4k}	
A	1	1.2	0.4	0.5	0.6	20
	2	0.6	0.9	1.0	1.2	15
	3	1.0	0.7	0.8	0.9	10
B	1	1.4	0.4	0.9	0.8	25
	2	0.6	0.9	0.8	0.9	20
	3	1.1	0.7	0.9	1.0	15

Then, using the absolute equitable compromise principle, vector effectiveness criteria are compared sequentially in accordance with formulae (17, 18). For the 1-st and 2-nd fishing ground subregions and for the B-type of vessels:

$$\Delta_{abs.} = \left[F_{1k}^{2l} + F_{2k}^{2l} + F_{3k}^{2l} + F_{4k}^{2l}\right] - \left[F_{1k}^{1l} + F_{2k}^{1l} + F_{3k}^{1l} + F_{4k}^{1l}\right] = 3.7 - 2.7 = 1.0$$

Thus, the 2-nd subregion has a preference for the A-type of vessels. It is possible to see that comparing the 1-st and 3-rd subregions $\Delta_{abs\,.}$ = - 0.7, therefore the 3-rd subregion is preferable than the 1-st one. When the 2-nd subregion is compared to the 3-rd subregion $\Delta_{abs\,.}$ = 0.3, therefore the 2-nd subregion is preferable than the 3-rd one. Thus, the usefulness priority of subregions for the A-type of vessels is: the 2-nd, the 3-rd, the 1-st. The priority of subregions for the B-type of vessels is defined similarly. In this case it is: the 3-rd, the 1-st, the 2-nd. Vessels' allocation is made taking into account restrictions on the number of vessels N_{kmacc}^{l} given in the Table 1. Definition of the vessels number directed to one or another subregion is found by the method of variants search limitation. Thus, in this example, 15 vessels of the A-type expediently to direct to the 2-nd subregion, 5 vessels of the A-type to the 3-rd subregion and 5 vessels of the B-type to the 1-st subregion.

4.2 Alternative solutions (the principle of strict priority)

Alternative solutions of multicriteria problems can be considered on different schemes of compromise. Let us consider such solutions.

A mathematical model of the form (20) realizes the principle of strict priority. A model of vessels' allocation problem is presented in Table 2.

The criterion F_{3k}^{l} for vessels of the A-type reaches the maximum value at the 2-nd subregion and the second largest value of this criterion is at 3-rd subregion. The maximum value of the criterion for vessels of the B-type is achieved at the 3-rd subregion also.

A rational distribution of vessels at subregions is: 15 vessels of the A-type direct to the 2-nd subregion; 5 vessels of the B-type and 5 vessels of the A-type direct to the 3-rd subregion.

Table 2

Type of a vessel	Criteria	Subregions			F_{acc}
		1	2	3	
A	$max\, F_{3k}^{l}$	0.5	1.0	0.8	–
	F_{4k}^{l}	0.6	1.2	0.9	0.9
	F_{1k}^{l}	1.2	0.6	1.0	0.5
	F_{2k}^{l}	0.4	0.9	0.7	0.7
	N_{kmacc}^{l}	20	15	10	–
B	$max\, F_{3k}^{l}$	1.4	0.6	1.1	–
	F_{4k}^{l}	0.8	0.9	1.0	0.9
	F_{3k}^{l}	0.9	0.8	0.9	0.8
	F_{2k}^{l}	0.4	0.9	0.7	0.7
	N_{kmacc}^{l}	25	20	15	–

4.3 Alternative solutions (the principle of criteria convolution)

The principle of criteria convolution gives another alternative solution for vessels allocation. Let operating indicators for vessels of the type A are characterized by the vector $\overline{\Phi}_1 = [0.8; 0.3; 1.0; 1.0]$, for vessels of the type B by the vector $\overline{\Phi}_2 = [1.2; 0.8; 0.9; 0.6]$. Values of generalized effectiveness criteria of fishing subregions calculated by the formula (21) are shown in Table 3. Data analysis in Table 3 shows that for vessels of the type A is most effective the 2-nd and the 3-rd subregions, and for vessels of the type B is preferable to work at the 3-rd subregions. A rational variant of vessels allocation is: to direct 15 vessels of the type A to the 2-nd subregion, 5 vessels of the type A and 5 vessels of the type B to the 3-rd subregion. This example shows that the solution result of fleet allocation coincided for various schemes of the compromise. But it should be considered as a special case only, that is, in general, solutions can be different. Therefore, the decision maker chooses any variant from alternative ones.

Table 3

Type of a vessel	Weights				Subregion	Generalized criterion F^l_{gen}
	α_1	α_2	α_3	α_4		
A	0.34	0.25	0.2	0.2	1 2 3	0,73 0,86 0,86
B	0.17	0.26	0.23	0.35	1 2 3	0,83 0,87 0,93

5. CONCLUSION

The paper presents definition of efficiency (usefulness) criteria of fishing grounds for optimal fishing vessels allocation. According to suggested four basic parameters of a vessel's production program the paper describes mathematical models and the order of the procedure for the problem resolving. The given example shows practical results of calculation and the base for decision making which can be used in practice.

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Removal of Particulate Matter and NOx from Boiler Exhaust Gas in Electrostatic Water Spraying Scrubber

Nguyen Dai An
Faculty of Marine Engineering, Vietnam Maritime University
nguyendaiandhhh@gmail.com

Tran Hong Ha
Faculty of Marine Engineering, Vietnam Maritime University
tranhongha@vimaru.edu.vn

Abstract : Boiler exhaust gas consists of many components that cause air pollution. These pollutants normally are mixed. To eliminate them, a scrubber is currently used, depending on a coal fuel used for combustion source in the boiler. In this study, experiments were performed with combination using emulsion oil and an electrostatic water spraying scrubber to evaluate effectiveness for simultaneous removal of NO_x and particulate matter (PM) emissions in marine exhaust gas. The combustion of coal oil and its emulsions was investigated in experiments. Two comparisons between coal oil and oil-water emulsion flames are presented that, due to the different initial conditions of the spray, provide complementary information. The combustion efficiency is improved when water is emulsified with coal oil. The electrostatic water spraying scrubber, studied in this paper, combines advantages of electrostatic precipitators and inertial wet scrubbers, and removes many shortcomings inherent to both of these systems operating independent. Total PM removal efficiency was higher than 99% by electrostatic water spraying scrubber. As the results the electrostatic water spraying scrubber appears to be a promising alternative method for control of mass-based as well as number-based PM emissions.

Keyword*:* Boiler exhausts gas, scrubber, electrostatic spraying water

1. INTRODUCTIONS

Removal of PM smaller than a few micrometers from marine gases presents a serious problem. PM of this size, such as smoke, fine powders, or oil mist, which are usually hazardous to human health, are not easy to remove by conventional methods. Therefore, an effective control of PM in the size range from 0.1 to 2μm is still a great challenge for engineers. To solve these problems, electrostatic water spraying scrubber which combines advantages of dry and irrigated electrostatic precipitators, and conventional inertial scrubbers [1]. In electrostatic water spraying scrubber, PM and scrubbing droplets are electrically charged to opposite polarities. The charged droplets capture the oppositely charged PM due to Coulomb attraction forces. Hereinafter in this paper, the scrubber using electrostatic forces will be referred to as "electrostatic water spraying scrubber" and the precipitation process as "electro scrubbing". The major objective of this study was to evaluate the potential of electrostatic water spray in controlling pollutant in marine exhaust gas and to improve PM removal efficiency.

Coal oil emulsions have evolved from earlier attempts to reduce combustion temperature for NO_x reduction purposes. Of all the methods proposed to introduce water into the combustion chamber, emulsions appear to be the most appropriate because they require no equipment retrofitting. This type of delivery may also provide advantages due to enhanced droplet evaporation caused by droplet micro-explosion from rapid gasification of the suspended water in the atomised droplets. A reduction in soot formation may be the result of different mechanisms. Some authors [2] explain the decrease in soot concentration as arising from more uniform oxygen distribution as a consequence of the improved mixing caused by the secondary atomization.

2. EXPERIMENTAL WORKS

2.1 Experimental setup

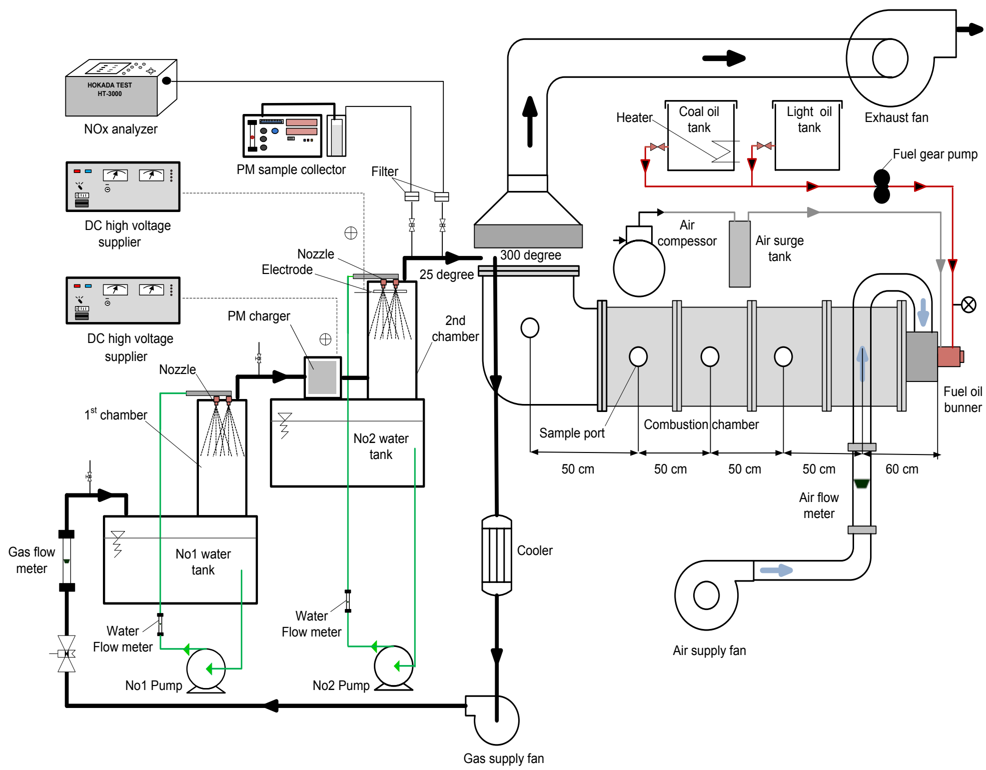

Figure 1. Schematic diagram of experimental setup

Table 1. Oil property

Property	Composition
Density [g/cm^3] 15^{0}C	1.1937
Flash Point [^{0}C]	116
Kinetic viscosity [cSt]	100 (50^{0}C)
Pour Point [^{0}C]	-7.5
Ash [mass%]	0.05
Sulfur [mass%]	0.5
Water [vol%]	0.1
Residual Carbon [mass%]	0.55
Low heating value	38.26 MJ/kJ

Table 2. Aditive

Sodium (Na)	4.86 wt %
Calcium (Ca)	0.001 wt %
Chlorine (Cl)	4.34 wt %
Density (at 20^{0}C)	1.101 g/cm^3
pH (at 20^{0}C)	13.5

Table 3. Working parameters of the equipments

Coal oil consumption for burning	3.2 l/min
Air supply into combustion chamber	4700 l/min
Coal oil supply pressure	0.05 MPa
Atomized air pressure	1 MPa
Coal oil temperature inlet	120 ^{0}C
Gas flow rate enter scrubber	1800 l/hr
Gas temperature inlet scrubber	300 ^{0}C
Gas temperature outlet scrubber	25 ^{0}C

The combustion chamber used in experiment is a horizontal cylinder 2.75 m long and of 0.4 m i.d., with the flow moving upwards. The furnace is formed by four annular segments, a roof and a convergent exit section. All these elements are cooled by separate water jackets, with independent measurements of the flow rate and the exit water temperature. This furnace was used as PM and other pollutant emission source. Coal fuel oil in table 1 was mixed 10% water and additive (table 2) using throughout these experiments. An electrostatic water spraying scrubber used to collect mainly PM in exhaust gas, it shown schematically in Figure 1. The scrubber consists of two chambers. In the first chamber, the water from tank No1 was pumped through two nozzles (orifice diameter 1mm) with flow rate 3.4 l/min. A mount of larger course PM are removed in this chamber. Ultra fine and condensable PM which could not be collected by water are grown to a few tenths of a micron in preparation for removal, and then remain PM were charged by a PM charger. The charger was made of stainless steel saws (4 pcs) as positive electrodes that connect to high voltage supplier adjusted to various voltages range from 1.0kV to 10kV to charge PM positive. These saws were mounted between 5 steel plates which connected to earth. In the second chamber, the water was pumped from tank No2 by centrifugal pump and discharged through two nozzles (orifice diameter 0.5 mm) with flow rate 0.8 l/min. They created droplets with 190-198 µm in diameter measured by Phase Droppler Particle Analyzer Aerometric. A stainless electrode (induction electrode) of inner diameter 15 mm is placed around upper edge of spraying head of nozzle. The induction electrode was connected electrically to a high DC voltage power supply adjusted to various voltages range from 1kV to 5kV to charged water droplets. This arrangement can provide a strong charging field with a relatively low voltage. Thus under stable operating conditions, a nagative charged water droplet cloud is formed to collect charged PM and fall down to the tank, then relatively clean water from the top of the tank is re-circulated by pump to the charging electro, where it is recharged, completing the cycle.

2.2 Measurement of PM mass concentration

The raw and after-treated PM were directly sampled by the filters, and the PM mass on each filter was determined gravimetrically by the difference in mass before and after each test PM mass concentrations in treated or untreated exhaust gas were determined by isokinetic sampling using EPA Method 5 ‘‘Sampling Method for Stationary Sources’’. At least six tests were conducted at each engine load condition and water scrubbing performance such as no spray water (NS); after first chamber (1^{st}); neutral droplet-neutral PM (ND-NP); charged droplet-neutral PM (CD-NP); charged PM-neutral droplet (CP-ND); charged PM-charged droplet (CP-CD). In this method, the PM was collected on a 60-mm glass microfiber. The total PM mass was determined by the gravimetric method.

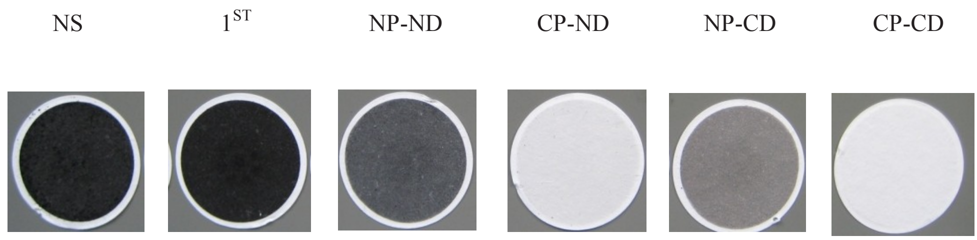

Figure 2. PM mass collected on the filters at various scrubbing performance of water droplet

3. RESULTS AND DISCUSSION

3.1 Reductions of NOx using emulsion oil

Figure 3 shows the measured NO and NOx concentrations for coal oil and emulsion along axial length of the combustion chamber. The NO and NOx emissions display a remarkable difference between the coal oil and emulsion combustion tests. The addition 10 % of water has a dramatic effect on the flame. The presence of water in coal oil brings about a considerable reduction in NOx emission. The results indicated that 10% water in the coal can give a reduction in NO and NOx emission of up to 28-48% and 18-42%, respectively. As a result from the coal oil combustion process about 90% of the NOx is NO. The NO is primarily formed by the oxidation of atmospheric nitrogen (N2). Water added to the fuel lowers the combustion temperature due to water evaporation. When the water in the coal-water emulsion evaporates, the surrounding fuel is vaporized, too. This increases the surface area of the coal oil. The lower temperature and the better coal oil distribution are leading to a lower formation of NO and NOx. The flame temperatures are reduced by

65 K. The heat absorbed by the water injected in the emulsion and enhanced radiative heat transfer due to the higher particle number density. The distribution of NOx indicates that a significant reduction is obtained in the final part of the flame; this may be attributed to a decrease in the rate of thermal-NO formation as a consequence of lower gas temperatures.

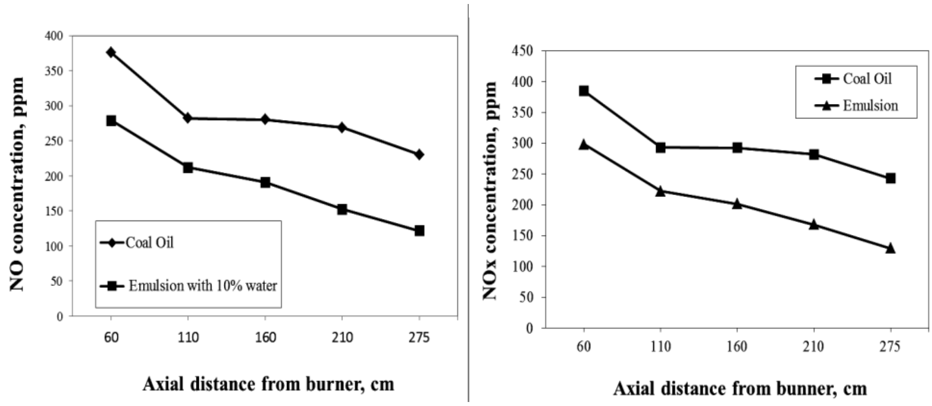

Figure 3. NO and NOx concentration at different positions of furnace

3.2 Reduction of PM by using electrostatic water spraying scrubber

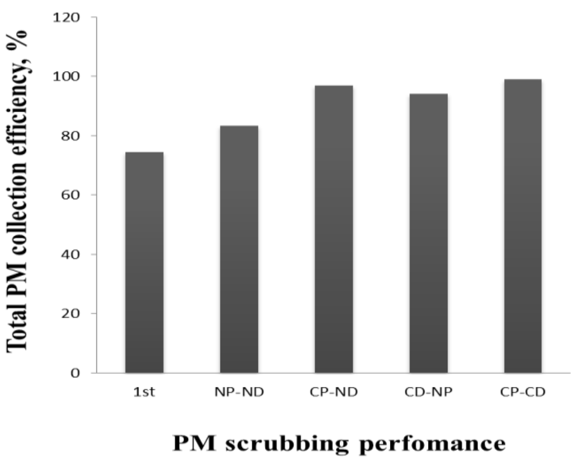

Figure 4. PM mass concentration at various scrubbing performances of the scrubber

In Figure 4 shows PM collection efficiency of the scrubber. Comparison of the results of water performances such as no spray water, neutral water and neutral PM, charged water and neutral PM, spray neutral water and charged PM, both charge PM and water droplets. When the scrubber using neutral water to remove neutral PM, it only collects coarse PM by simple impaction mechanism as conventionally. But these is not affect on fine particulate matter, because of their very lightweight, fine PM are pushed out of the part of the water droplets and are forced to follow the streamlines; therefore, PM was removed with low efficiency at various engine loads. The highest PM collection efficiency only reaches to 72% for first chamber and 80 % for both chambers. It can be note that the same amount of spraying water, in cases using charged droplet-neutral PM or neutral droplet-charged PM result in more effective collection of PM than using neutral droplet-neutral PM. Because an image charge of opposite sign is induce on neutral objects, generating a force of attraction. These forces lead to the PM-water droplet attracted each other that stronger than impaction and interception mechanism causing an increase in the efficiency of PM collection up to 97%.

The better results were obtained when both PM and water droplets were oppositely charged. The collection efficiency was gained in this case as high as 99%, corresponding to positive PM and negative droplets more many time upper than using neutral droplets-neutral PM 20% . The collection efficiency was highly increased due to there are Coulomb force between charged droplet and charged PM [3], these forces form a strong mechanism to drive charged PM to charged droplet. It was demonstrated experimentally that the electrical charging of droplets and PM allows an increase of the collection efficiency of PM that compare with conventional scrubber at the same amount of using water

4. CONCLUSIONS

1. The spatial distribution of NOx inside the combustion chamber indicates that the generation of NOx over the final part of the flame is reduced by the addition of water. The main source of NOx in that region is considered to be the thermal mechanism, and the observed reduction in NOx formation is in accord with the decrease in flame temperatures. Reduction in NO and NO_x emission of up to 28-48% and 18-42%, respectively.
2. The addition of water to heavy oil in emulsion form can significantly accelerate the evaporation and combustion processes in the flame. These effects are very important if the fuel spray is of relatively poor quality (coal oil and emulsion), while the changes are much weaker when fine atomization of the heavy oil is achieved (coal oil and emulsion). Among the possible effects of water addition, the micro-explosion phenomenon is considered responsible for the significant changes in the flame. The consequence is higher burnout of the cenospheres initially generated in the flame, so that the unburnt carbon when firing emulsions is reduced by from 5-36 %.
3. The electrostatic water spraying scrubber was found to remove the fine PM effectively. It was demonstrated experimentally that the electrical charging of droplets and particulate matter allows an increase of the collection efficiency of PM from diesel exhaust gas. The total collection efficiency of PM as high as 99%. Pressure drop of exhaust gas is very low when it is crossing the system. All soluble acid and caustic gases are removed at the same levels as conventional scrubbers. Further improvement of the removal efficiency is obtained by charging sprays utilizing electrical forces can effectively operate for small sizes of PM.

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Marine Traffic Safety Diagnostic Scheme in Korea

Jin-Soo Park
Professor, Navigation Department, Korea Maritime University,
jspark@hhu.ac.kr

Young-Soo Park
Assistant Professor, Sea Training Center, Korea Maritime University,
youngsoo@hhu.ac.kr

Ik-Soon Cho
Head of Maritime Safety Research Center,
The Korea Ship Safety Technology Authority (KST)
ischo@kst.or.kr

Dae-Won Kim
Graduate School, Korea Maritime University,
kim_daewon@hhu.ac.kr

Abstract: According to the Marine Traffic Safety Law, revised in 2009, Marine Traffic Safety Diagnostic Scheme is introduced to secure the safe navigation, prevent the marine accident and to maximize the efficiency of the port operation. The diagnostic system aims to investigate, measure and evaluate the effect of the various development project such as the construction of bridge over navigable waterway, and of piers in port and etc. Then the diagnostic results should be reflected on the project designed for the safe navigation. This paper introduces the Marine Traffic Safety Diagnostic Scheme includes the diagnostic process, evaluation items, diagnostic criteria, registration criteria of the diagnostic agent and the standards of written diagnostic report. This paper also discusses various marine traffic safety evaluation model including ES model & IWRAP model which is the most important part of the system.

Keywords: marine traffic safety diagnostic, safe navigation, diagnostic process, diagnostic criteria, diagnostic agent, diagnostic report, marine traffic safety evaluation model.

1. INTRODUCTION

The probability of navigational accident is increasing significantly with growth of ship's size, variety of marine facilities, bridges crossing waterways and port development in Korean coastal waters. Especially, the construction of bridges crossing navigable waterway is being promoted aiming at expanding social infrastructure and optimizing the overland routes through private investment. The construction, however, tends to focus more on the commercial requirements rather than on the marine traffic safety, which causes big risks not only threatening the safety of ship traffic, but also causing some severe conflicts among the stakeholders.[1]

For this reason, the Ministry of Land, Transport and Maritime Affairs(MLTM) amended the Korean Marine Traffic Laws to enact the Marine Traffic Safety Diagnostic Scheme (MTSDS) which is to evaluate the traffic safety for all kinds of port and water facilities concerning with ship's passage. The act took effect from Nov. 2009.[2]

The purpose of this paper is to introduce the diagnostic scheme which includes the process, evaluation items, diagnostic criteria, registration criteria of the diagnostic agent and the standards of written diagnostic report and a discussion of various marine traffic safety evaluation models.

2. MARINE TRAFFIC SAFETY DIAGNOSTIC SCHEME

The Marine Traffic Safety Diagnostic Scheme (MTSDS) is briefly introduced in this part.[3]

2.1 Concept of MTSDS

MTSDS is a formal safety diagnosis examination in the field of existing or future maritime transportation by an independent audit team. It systematically estimates and identifies the potential risk elements associated with the development plan and provide an opportunity to improve the traffic safety for developers. Therefore, MTSDS is to identify potential safety hazards which may affect all mariners from the initial design phase, and to suggest all possible measures to eliminate or mitigate those problems.[4]

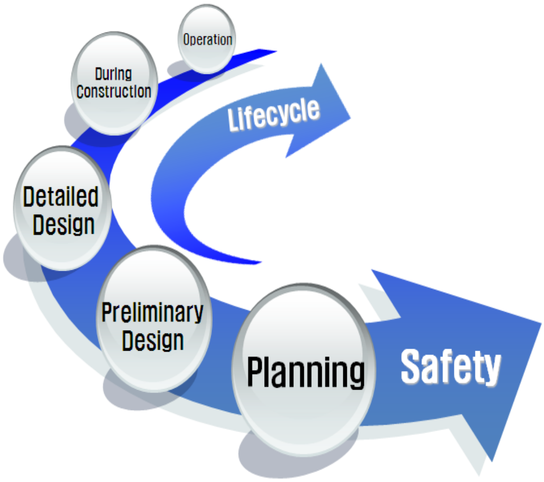
The Article 2 (Definition) in the Korean Marine Traffic Safety Law defines the audit scheme as the professional investigation, measurement and evaluation of the safety hazards that may occur from the projects listed below;

1) The establishment and change of water zones
2) The construction, laying and repairing of bridges, tunnels and/or undersea cables in the water zones
3) The development and redevelopment of harbors and ports
4) Projects regulated by the ordinances of the Ministry(MLTM) as a project that remarkably affects other maritime traffic safety.

MTSDS is now a mandatory requirement in all marine projects except in special circumstance like emergency construction which makes little influence on navigational safety. In this case, it is possible to submit in a simplified audit report which can exclude full-mission ship handling simulation.

2.2 Efficiency of audit scheme

In general, it is known that faster the audit is performed, safer the results are obtained and the less costs are incurred. That is, it is more advantageous to make a compensation through a feasibility study or an audit in the initial design phase than during construction stage.[6]



Construction processing analysis of domestic bridges crossing navigable waterways and improvements, 2010

Figure 1. Relation between project lifecycle and safety improvement

In addition, the potential benefits obtained through the implementation of an audit system are listed below;

1) The possibility of occurrence of marine casualties can be reduced and the consequent savings in marine accident-related costs can be made;
2) The efficiency in a harbor operation is maximized through the safer traffic and smoother operation;
3) The Waterway becomes safer
4) Designers come to pay attention to the safety of vessels
5) The possibility of additionally implemented safety measures can be reduced, and the overall risk is reduced
6) The design technology considering the structures in maritime field is improved
7) Economic benefits are expected by blocking the factors that may cause marine incidents

It is expected to have an advantage in improving safety policies and project designs in an economic aspect of reducing marine incidents when the audit system is executed.

Badly designed and maintained sea routes can contribute to human error and lead to marine incidents. Conversely, well designed and maintained sea routes, where the needs of mariners have been anticipated, can reduce potential risks.

2.3 Process of MTSDS

The audit typically proceeds according to the process as shown in Figure 2. Even though some steps can be omitted or simplified according to the characteristics and scale of the project, but basically, the steps for performing an audit should be observed. Also another important thing is to listen the opinions of marine user groups during the kick-off & final meeting in a process of auditing.

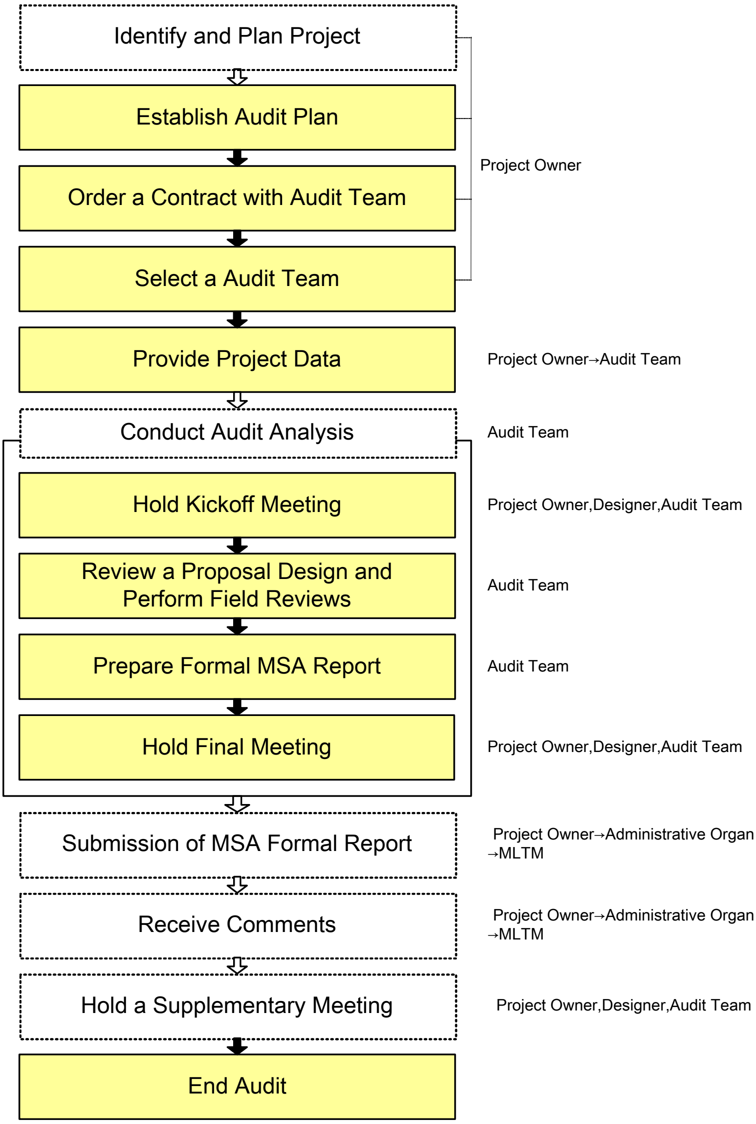


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Figure 2. Process of MTSDS

2.4 Investigation items

The essential items during the audit are needed for the procedures of performing the evaluation, using all kinds of evaluation technologies like a simulation technology, and establishing the safety measures required on a basis of the evaluation results after the basic investigation on maritime traffic and the traffic states are measured.

Table 1 show an investigation and evaluation methods that have to be performed in detail. The vertical axis shows the projects of audit objects and the horizontal axis lists the method of the investigation and a standard method of the audit, which all should be performed for each object project, and whether or not to hold an evaluation committee. The mark "●" in the table means the item must be evaluated, but the mark "△" means the item may be reviewed as necessary.

Table 1. Performance audit items by projects

Schemes		Survey of traffic state	Measurement of traffic state	Adequacy Assessment				Safety Measures
				Navigational Safety	Berth/ Un-berth	Mooring	Traffic Flow	
Water zone	Establishment	●	●	●	△	-	△	●
	Change	●	●	●	△	-	-	●
Facility	Construction	●	●	●	△	△	●	●
	Repair	●	●	●	-	-	-	●
Harbor/ piers	Development	●	●	●	●	●	△	●
	Redevelopment	●	●	●	●	●	-	●
Other Project		●	●	●	△	△	△	●

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2.5 Assessment committee

An audit assessment committee, composed of over 20 persons, shall be established to evaluate the audit report professionally, and the results of the committee shall be reported to the Ministry (MLTM). The assessment results made by the Committee shall be notified to the project owner with any review opinion, and in case it is judged to be a poor audit, suspension shall be imposed.

Since it is difficult to form an assessment committee for every audit object due to a time and budget limit, thus the evaluation on audit results shall be performed under one of the following conditions.

1) In case a safety audit is not properly performed and it may result in a serious risk to maritime traffic safety
2) In case a project for audit objects seriously affects maritime traffic safety
3) The Ministry (MLTM) and the administrative organization acknowledge the fact that, judge from the results, a poor audit has been performed and require an audit team to evaluate those results.

Table 2. Audit items

Survey of Existing Marine traffic state	**Measurement of Existing marine traffic state**
- Project outline - Design criteria - Natural environment - Navigation condition survey - Marine traffic survey	- Audit on the characteristics of marine traffic - Analysis of Mariners' opinion - Audit on marine traffic congestion - Audit on current marine traffic flow
Establishment of Safety Countermeasures	**Adequate Assessment of Marine Traffic System**
- Experts' Opinion - Assessment items if need be alternative - - Countermeasures for safety	- Navigational safety assessment - Berthing/Un-berthing safety assessment - Mooring safety assessment - Marine traffic flow assessment - Comprehensive assessment

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2.6 Audit institute

The objective of selecting an audit institute is to choose an independent, qualified and multidisciplinary team of experts who can successfully conduct the safety audit. It may be fair to say that success of failure of the MTSDS depends on the quality and ability of the selected audit institute. The role of audit institute is very important in MTSDS.

An audit institute is recommended to consist of a minimum of 8 experts and required to be independent from the design team. Also they should be registered to the MLTM and equipped with the facility of three dimensional full mission ship handling simulator.

There are three registered audit institutes such as Mokpo Maritime University(MMU), Maritime & Ocean Engineering Research Institute(MOERI) and Korea Maritime University(KMU), and one more will be registered shortly (Korea Institute of Maritime & Fisheries Technology, KIMFT) at the moment.

2.7 Prepare the audit report

The audit report prepared by the audit institute is expected to describe potential safety problems and identify the recommendations to overcome or mitigate them.

The main body of the audit report will contain all of the identified safety issues, evaluation of safety risks and suggestions concluding statement signed by the audit team members indicating that they have participated in the audit and agreed consensus on its findings. Especially, all safety problems highlighted should be stated as clearly as possible.

The suggestions and recommendations on audit reports should be constructive and realistic considering the costs, and should recognize that project owners may have different options to achieve the desired result.

3. MARINE TRAFFIC SAFETY ASSESSMENT MODEL

The most important part of the MTSDS will be the process of risk assessment in the areas concerned. This chapter introduces various risk assessment models including ES model and IWRAP model used widely.

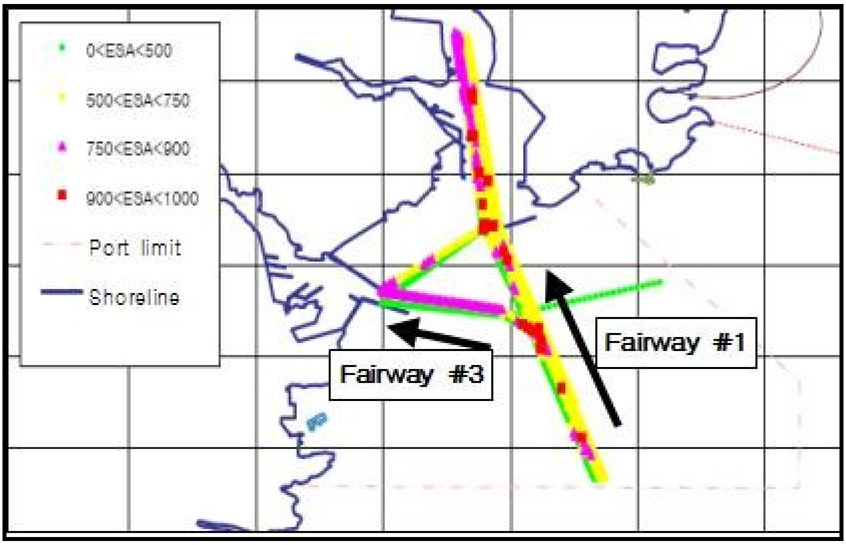
3.1 Environmental Stress (ES) Model

ES model is the most frequently used risk assessment model in the MTSDS. This model clarifies the acceptance criteria of the stress value based on mariners' perception of safety. Also this model evaluate the difficulty of ship handling arising from restrictions in maneuvering water area and arising from traffic congestion.[8]

ES model is composed of the following three parts.[9]

1) Evaluation of ship handling difficulty arising from restrictions on the water area available for maneuvering. A quantitative index expressing the degree of stress forced on the mariner by topographical restrictions (ES_L value – environmental value for land) is calculated on the basis of the time to collision (TTC) with any obstacles.
2) Evaluation of ship handling difficulty arising from restrictions on the freedom to make collision avoidance maneuvers. A quantitative index expressing the degree of stress forced on the mariner by traffic congestion (ES_S value – environmental stress value for ship) is calculated on the basis of the time to collision (TTC) with ships.
3) Aggregate evaluation of ship handling difficulty forced by both topographical and traffic environments, in which the stress value (ES_A value – environmental stress value for aggregation) is derived by superimposing the value ES_L and the value ES_S.

In the respective calculations of the values ES_L and ES_S a common index was used and the same algorithm was introduced to perform simultaneous aggregate evaluations of ship handling difficulty as experienced in encounters with other ships in ports and narrow waterways.



A primary study on the development of evaluation model for marine traffic safety assessment, 2010

Figure 3. Result of ES model assessment, Ulsan, Korea

When ES_A value is over 750, it is classified as unacceptable criteria of stress for mariners. Figure 3 is the assessment result of Ulsan, Korea. It is found that environmental stress of No.1 and NO.3 fairway is partially unacceptable. [10]

However, there are some problems that ES model would not correct because it reflected the Japanese mariners' sense of risk and applying risk of inside and outside of fairway is same.

3.2 IALA Waterway Risk Assessment Program (IWRAP)

IWRAP is one of the representative quantitative assessment model. The objective of this model is quantifying the risks involved with vessel traffic in specific geographical areas. On the basis of a specified traffic condition and other elements, IWRAP calculates the annual number of collision and grounding in the specified navigational area.[11]

IWRAP is composed with Model view which inputs a basic vessel traffic data and Job view which show a result of probability data and risk analysis chart. In Model view, basic data is input to calculate probabilities such as route setting, traffic volume, causation factor, depth, weather condition, etc. Job view can check the result values and show risk visualized charts.

Table 3. Result of IWRAP assessment, Ulsan, Korea

Case	Result	Unit
Powered Grounding	1.37536	Incidents / Year
Drifting Grounding	0.839026	Incidents / Year
Total Groundings	**2.21438**	**Incidents / Year**
Overtaking	0.198466	Incidents / Year
Head On	0.263021	Incidents / Year
Crossing	0.0440573	Incidents / Year
Merging	0.0287787	Incidents / Year
Bend	0.147784	Incidents / Year
Area	$2.70438*e^{-07}$	Incidents / Year
Total Collisions	**0.682107**	**Incidents / Year**

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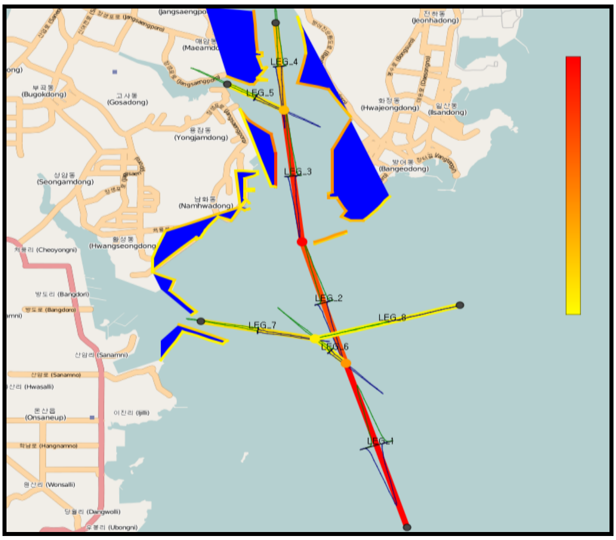

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Figure 4. Visualized result of IWRAP assessment, Ulsan, Korea

Table 3 and Figure 4 shows the result of IWRAP assessment by same data with ES model assessment. As seen above, high risk points are similar to ES model results.

3.3 Other Models

Another assessment tool recommended by the IALA is PAWSA, Ports And Waterway Safety Assessment, which is developed by United States Coast Guard. 5 steps of PAWSA is illustrated in Figure 5.

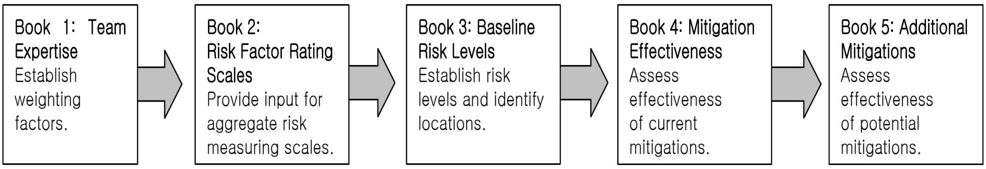

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Figure 5. Process of PAWSA

Formal Safety Assessment (FSA) tool is widely used in maritime sector, since it is adopted by the Maritime Safety Committee of IMO in 2001. FSA has also 5 steps of process which is shown in Figure 6.

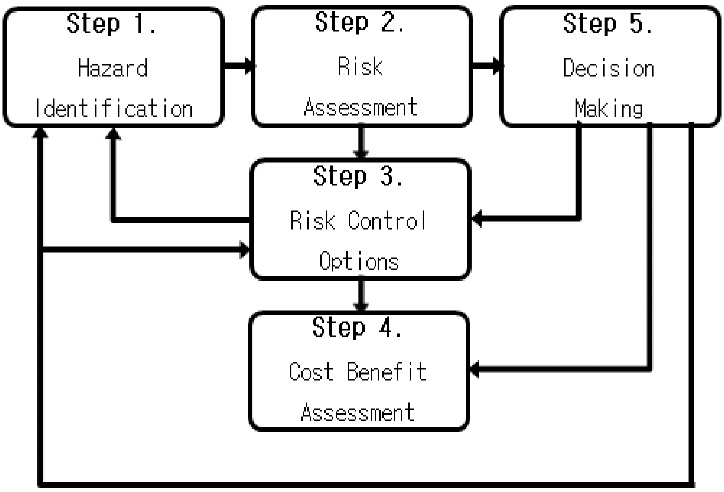

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Figure 6. Process of FSA

Other tools are MARA (Marine Traffic Risk Assessment) which is developed by the Hong Kong, and PMSC (Port Marine Safety Code) which is developed by U.K. based on the FSA methodology.

4. CONCLUSIONS

The possibility of navigational accident is increasing significantly with growth of ship's size & volume, variety of marine facilities, bridges crossing waterways and port development in Korean coastal waters. Especially, the construction of bridges crossing navigable waterway brought severe conflicts among the stakeholders.
In this regards, the Ministry (MLTM) introduced MTSDS to enhance the marine traffic safety , and to reduce the marine accidents ultimately.

This paper introduced the MTSDS including the concept of MTSDS, necessity/ efficiency/ process of the audit, investigation items, experts committee to evaluate the audit report and audit institute.

Although the MTSD Scheme, that has just begun, has some imperfection and some parts should be revised, we are sure the scheme significantly contribute to enhance the marine traffic safety in the Waterway, and to give clear guidelines to the designers (port construction & civil engineering) who involve in the project planned.

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Meeting Stakeholders' Interests in Developing a Bachelor Programme in Nautical Studies

James Parsons
Capt. Dr. ,School of Maritime Studies, Fisheries and Marine Institute, Memorial University
Jim.Parsons@mi.mun.ca

Stefan Wendelin Douvier
Capt. Dr., Hochschule Bremen, University of Applied Sciences, Centre of Maritime Studies
Stefan-Wendelin.Douvier@LBA.HS-Bremen.de

Thomas Pawlik
Prof. Dr., Hochschule Bremen, University of Applied Sciences, Centre of Maritime Studies
Thomas.Pawlik@HS-Bremen.de

Willi Wittig
Capt. Assoc.-Prof. MSc., Hochschule Bremen, University of Applied Sciences, Centre of Maritime Studies
Willi.Wittig@HS-Bremen.de

Abstract: This paper deals with the question how to meet various stakeholders' interests in developing a new Bachelor programme in Nautical Studies. The relevant international, European and national administrative requirements are reviewed. Furthermore the interests of potential employers and graduates from a Bachelor programme in Nautical Studies are discussed. The paper is based on a real-world case at the Centre of Maritime Studies at Hochschule Bremen (University of Applied Sciences), Germany and refers to its competing specific environment. Finally, as a result of the discussion, the chosen structure and content of the Bachelor programme in Nautical Studies is presented.

Keywords: Bachelor programme in Nautical Studies, Bologna Process, STCW-Convention, Stakeholder Approach, Shore Based Employment, Accreditation

1. INTRODUCTION

Decisions on how to design a new study programme generally have to take into account a wide range of different interests and market requirements. This is quite evident in the academic field of Nautical Studies. This paper deals with the question how to meet various stakeholders' interests in developing a new Bachelor programme in Nautical Studies. It is based on a real-world case at the University of Applied Sciences Bremen, Germany where the existing course in Nautical Studies (German "Diplom-Wirtschaftsingenieur für Seeverkehr") had to be totally redesigned as a result of the introduction of Bachelor and Master programmes in German higher education institutions.

The first section reviews various administrative requirements for developing a new programme in Nautical Studies. First, it discusses the supranational framework (STCW – International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, Quality Certification etc.) as well as the European framework (i.e. Bologna Requirements, EMSA – European Maritime Safety Agency). Next, national requirements are elaborated for both the STCW related parts of the study programme and its general academic accreditation. Additional requirements are also identified at both federal state and university levels. Section two discusses, with the help of expert interviews, the interests of potential employers of graduates from a Bachelor programme in Nautical Studies. These employers include, among others, ship operators, ship owners, ship managers, institutions from the field of maritime administration, academies, classification societies, marine insurance companies and other members of the maritime sector. This labour-market related discussion is enhanced by looking also at the interests of potential students. Here, the different possible entry levels into an academic Nautical Study programme have to be analysed. Section three focuses on competing national and international Nautical Study programmes. In section four the German system of accreditation is discussed. The final section summarises the findings of the paper and presents, as a result of the discussion, the chosen structure and content of the Bachelor programme in Nautical Studies at the University of Applied Sciences Bremen.

2. COMPETING PROGRAMMES

Before developing a new programme of nautical studies it will be prudent to conduct a market study to ascertain what the competition is offering. From the perspective of the Centre of Maritime Studies at Hochschule Bremen, the competition is seen as German universities and colleges, and other international universities in close vicinity, that offer nautical study programmes

2.1 Non-Universities

In Germany there are four colleges offering STCW A II/2 related study programmes: Fachschule für Seefahrt Flensburg, Fachschule Seefahrt Leer, Fachschule Seefahrt Rostock-Warnemünde and Staatliche Seefahrtschule Cuxhaven.

Before entering college a student has to complete a three year training period as ship mechanic (AB deck and engine) or alternatively a three year programme as "Schiffs-betriebstechnischer Assistent" (assistant on ship's operation technology). The two year study programme at all four colleges embraces both general subjects (i.e. mathematics, physics, chemistry, German and English language) and subjects covering the STCW A II/2 requirements. Students are taught by college instructors who usually also are qualified master mariners. The nautical programmes offered are harmonized between the relevant state departments of education. Consequently, programme differentiation is challenging.

2.2 German Universities

In Germany there are five campuses offering programmes in Nautical Studies. From West to East there are: Leer (Hochschule Emden/Leer), Elsfleth (Jade Hochschule), Bremen (Centre of Maritime Studies at Hochschule Bremen), Flensburg (Fachhochschule Flensburg) and Warnemünde (Hochschule Wismar). All have a long tradition in maritime training. For example, Bremen School of Navigation, being one of the predecessors of Hochschule Bremen, was founded in the year 1799. Today, all German nautical campuses belong to Universities of Applied Sciences. While education is scientifically based, it retains a strong practical focus and is highly applications oriented. Professors at such institutions are required to have both an academic background and several years of non-university work experience in a subject related position [1]. As of January 2011 there were 1,371 students enrolled in German Nautical Study programmes.

All competing German Nautical Study programmes embrace eight semesters, including 52 weeks seafaring practice in line with the Training Record Book for Deck Cadets. Taking into account that most of the content of Nautical Study programmes is more or less determined by the STCW regulations, there is very little room for differentiation. For example, Leer offers, in addition to the core-curriculum, modules covering the field of technical and natural sciences (especially ship technology) whereas Flensburg puts a special emphasis on supply chain management and logistics.

2.3 International Universities

Other universities emphasize the following subjects in addition to general navigational studies:

- Faculty of Science and Technology, University of Plymouth: Opportunity to acquire the skills required to operate in the offshore surveying industry and the offshore seismic industry.
- Antwerp Maritime Academy: Offers, in response to the growing demand from maritime companies (e.g. merchant marine, towing and dredging companies) and official authorities (e.g. pilotage services) for external nautical training, modules including: “All the Principles Concerning ‘Salvage’”, “Introduction to Hydrography” and “Flags Etiquette”.
- Netherlands Maritime University, Rotterdam: Offers “Inland Waterways and Water Transport” and “The Business of Shipbuilding Sale and Purchase”. This expansion of the educational frame is a reaction to the fact that mariners often change their profession and search for employment ashore.

3. MARKET REQUIREMENTS

3.1 Maritime Cluster Interests

3.1.1 Ship Owners

In 2010 German ship-owners owned some 1.742 containerships of more than 1.000 gross tons (GT) representing 37% of the world's containership fleet. With an average age of approximately 10 years, containerships represent the youngest segment of the shipping industry. During spring 2010 a German ship owner, the Hamburg based Reederei Offen, assumed ownership of CPO Savona with a capacity of more than 14.000 TEU [2]. These examples demonstrate that German ship owners operate a fleet of state of the art vessels.

In addition to having competent masters able to manage complex operations on board sophisticated ships, highly qualified professionals are also required in shore management positions. Consequently, from a ship owner's point of view nautical study programmes have to exceed minimum STCW standards. Competences in leadership of intercultural teams, commercial thinking, complex thinking, decision making in critical situations, legal understanding and others are expected from successful applicants.

3.1.2 Maritime Administration

Some maritime administrations and authorities operate vessels in order to fulfill their duties. Consequently, competent personnel are recruited from the pool of available seafarers. While special skills are often a part of on the job training, the educational foundation is supplied by Nautical Studies. Maritime authorities are not able to maintain their own training programmes on the scale of that being provided by Universities. The legal background regarding shipping is also part of Nautical Studies and the base for further specialization in administration matters. Authorities save large amounts of educational time and costs when they employ seafarers possessing an academic maritime background. Seafarers possessing advanced knowledge that students of other fields of studies cannot compete with. The understanding of the party on the opposite side is implemented in advance and has not to be trained and learnt.

3.1.3 Maritime Insurance

Like maritime authorities, insurance companies are also motivated to have staff with maritime experience. Even if during the sea-going period one might not have experienced all the different areas of the shipping industry, the graduates of maritime universities are prepared for professional ship operations. Thus, the insurance sector expects nautical graduates to have broad maritime competence. This broad competence needs to be based on the practical experience of ship operations at sea and in port and is difficult to substitute with only theoretical studies. In order to save costs for external experts like surveyors in the area of maritime casualty investigation, maritime insurance companies expect employees to have sufficient understanding of maritime operations.

3.2 Potential students

Numerous attempts have been made in Germany to systematically research the average time graduates from nautical study programmes serve onboard ships before they shift from ship to shore based occupations. While no valid results have been presented, it appears that the majority of students who join nautical degree programmes will stop sailing approximately four years after graduation.

Thus, students aim to qualify themselves not only as master mariners according to the provisions of the STCW Convention but also in those subject areas they deem appropriate for their future shore based field of occupation. Generally these are subjects providing knowledge and competences in maritime economics, maritime law, maritime insurance, maritime technology, maritime management and maritime technology.

Since within the nautical study programmes offered by the various universities and colleges there is hardly any variation possible on the contents of the STCW A II/2 related modules the future students will base their decision for their future place of study among others on criteria such as quality of the programmes, potential for specialization and of course available master programmes.

4. ADMINISTRATIVE REQUIREMENTS

In addition to the market requirements also a number of administrative requirements have to be taken into account. This section depicts the present situation from an international, a European and the German perspective.

4.1 Supranational Framework

4.1.1 STCW

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (the STCW Convention) consists of general requirements and detailed regulations which are contained in its Annex 1, the so-called “STCW-Code”. “Part A of the Code is mandatory. The minimum standards of competence required for seagoing personnel are given in detail in a series of tables” [3]. The aim of the STCW Convention is the standardization of training and education of seafarers worldwide. All flag-states being party to the convention have to comply with its provisions. To reach this, they have to establish and maintain an administration for the supervision of training and educational facilities and certification systems and offices. “Parties are required to provide detailed information to IMO concerning administrative measures taken to ensure compliance with the Convention, education and training courses, certification procedures and other factors relevant to implementation” [4]. The latest update of the convention will enter into force on 1st January 2012. Major changes resulting from the so called “Manila amendments to the STCW Convention and Code” include, among others, a stronger focus on leadership and training, an enlargement of technical navigation, and clear obligations of the shipping company and senior personnel onboard for the proper conduct of practical training [5]. Germany is party to the STCW Convention and therefore the training and education of seafarers at “Hochschule Bremen” is determined by the regulations of STCW.

4.1.2 Quality Certification

The 1995 revision of the STCW Convention introduced, for the first time, the necessity for IMO member states to introduce a quality assurance scheme within their MET (Maritime Education and Training) and certification system. Within the European Union, *Article 9* of the “DIRECTIVE 2001/25/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4th April 2001 on the minimum level of training of seafarers” obliges member states to ensure that standards of education and training required under the STCW Convention are achieved. For that reason, a continuous monitoring of training facilities and personnel has to take place by means of a quality standards system. The application of those standards underlies internal quality assurance reviews. Member states have to carry out independent evaluations at least every five years. Independent means that persons without involvement in the delivery of education at that institution are assessing knowledge, understanding, skills and competence acquisition. The thereto related documentation has to be passed to the responsible institution inside the member state with the aim to correct deficiencies within a short period of time. No later than six months after evaluation the report has to be passed to the European Commission [6]. By means of regular EMSA inspections the European Commission supervises the enforcement of the respective EU directive. Also, the STCW requirements ask member states to deliver the same information to IMO.

4.2 European Framework: Bologna Requirements

As a result of the so-called “Bologna Process”, the European Higher Education Area (EHEA) was officially launched in March 2010. The key elements of the EHEA are summarized in table 1.

Table 1. Areas of action of the Bologna Process on the path to the European Higher Education Area [7]

1.	Adoption of a system of easily readable and comparable degrees, including the implementation of the European Diploma Supplement.
2.	Adoption of a system essentially based on three cycles, undergraduate, graduate and doctoral.
3.	Establishment of a system of credits.
4.	Promotion of mobility.
5.	Focus on Lifelong Learning.
6.	Promotion of European co-operation in quality assurance.
7.	Promotion of the European dimensions in Higher Education.
8.	Inclusion of Higher Education Institutions and Students.
9.	Promotion of the attractiveness of the European Higher Education Area.
10.	Doctoral Studies and the synergy between the EHEA and the European Research Area (ERA).

For developing the new Bachelor programme in Nautical Studies at Hochschule Bremen, the first five areas of action mentioned in table 1 had to be especially considered: 1) The German Degree “Diplom-Wirtschaftsingenieur für Seeverkehr” was well established on the German labour market but not very well known outside the country. Nevertheless, this was never a big issue as all graduates received their STCW-management level certificate issued by the Federal department of transport in addition to the German university degree. It has to be mentioned that from the point of view of some applicants, for a certain period of time Bremen even attained a unique selling proposition for delivering the degree “Diplom-Wirtschaftsingenieur für Seeverkehr” after Leer, Elsfleth, Flensburg and Warnemünde had implemented their BSc-programmes. 2) In developing the new Bachelor programme it was important to enable the compatibility to consecutive Master programmes such as Maritime Management or Logistics. 3) Credit points in accordance with the European Credit Transfer System had to be allocated to all modules of the new Bachelor programme. 4) With more than 300 cooperation agreements with partner universities all over the world and more than 60 international study courses, Hochschule Bremen as a whole is recognized for its international profile. However, in the past only a minority of nautical students opted for one or more semesters abroad. Thus, the task to enhance students' mobility was also high on the agenda of the curriculum developers. 5) Lifelong learning was also an issue in designing the curriculum as quite regularly graduates from nautical colleges ("Seefahrtsschulen") have to be integrated in the course of studies as they wish to achieve higher academic qualifications.

4.3 National Framework

4.3.1 "StAK"

In Germany all aspects of STCW related maritime education and training is coordina-ted and harmonized by the "Ständige Arbeitsgemeinschaft der Küstenländer für das Seefahrtsbildungswesen" (StAK). Members of StAK are the Federal Government (party to the STCW Convention), the German Coastal States (Bremen, Hamburg, Lower-Saxony, Mecklenburg-Pomerania and Schleswig-Holstein) and the social partners (ship-owners asso-ciation (VDR) and trade union (ver.di)). Since the end of 2010 the universities and colleges offering nautical and/or technical STCW related education can participate by means of one delegate from the "Bundesarbeitsgemeinschaft der Leiter der Ausbildungsstätten Seefahrt" (BALAS) with an observer status at the various StAK-meetings.

Due to the German Federal Constitution, where the Federal Government bears responsibility for foreign affairs and the State Governments have the principal responsibility for education (primary, secondary and higher education) [8], the introduction of the StAK became necessary in order to ensure a) that in Germany the different STCW related educational programmes meet the STCW requirements (Federal Governments interests) and b) that the STCW related programmes offered in the different German National States (Länder) do not vary much in quality and content in order to have an equal contribution of students and hence an equal share of public spending (State Governments interests).

4.3.2 Ministry of Transport and Federal Maritime Agency

On maritime transport matters at an international level and inside the European Union, the Federal Ministry of Transport, Building and Urban Development formulates and represents the position of the German government. Towards the International Maritime Organization (IMO), Germany seeks to play a major role in developing and updating international standards for the maritime shipping industry. Additionally, with respect to multilateral agreements, Germany has signed a number of bilateral shipping agreements facilitating maritime transport with selected countries of partnership [9]. The Ministry is the designated authority in Germany for the supervision of the entire maritime administration including MET. Many tasks are delegated to subordinated federal authorities such as the Federal Maritime Agency ("Bundesamt für Seeschifffahrt und Hydrographie"/BSH). Under the provisions of STCW it has several responsibilities. In addition to issuing certificates of competency the BSH assesses and certifies non-public training institutes offering training courses leading to certificates of proficiency (such as ship security officer or training according to STCW chapter 5).

4.3.3 Academic Accreditation

As a rule, all study programmes have to be accredited. The German accreditation system follows a decentralized approach (see figure 1) legally based on the Law for the establishment of the Foundation for the Accreditation of study programmes in Germany. Universities apply for the accreditation of their programmes directly to approved accreditation agencies. The programme to be accredited has to be in line with the criteria for the accreditation of study programmes, issued by the Accreditation Council and it has to follow the common structural guidelines of the Länder (federal states) in the Federal Republic of Germany. The peer-review principle is quite important in the process of accreditation and at least one site visit is conducted by a group of evaluators.

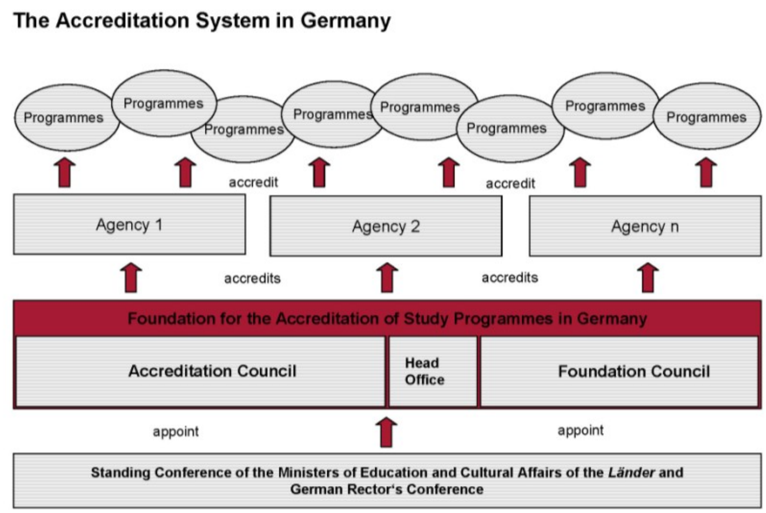

Figure 1. The Accreditation System in Germany [10].

4.4 Federal State Level Framework

Within the federal structure of Germany, educational tasks are primarily the responsibility of the federal states [11]. Since 1982 Hochschule Bremen has been one of four universities owned by the Federal State of Bremen. All sixteen German Federal States are keen to transform the study programmes of their universities into Bachelor-/Master structures in accordance with the Bologna requirements. The German Rectors' Conference regularly reports on the progress in implementing the two-tier study system in Germany. As per 1 September 2010, on average 81.9 percent of all study courses had been transformed, ranging from 98 percent in the Federal State of Niedersachsen to 64 percent in the Federal State of Saarland. The Federal State of Bremen, with a transformation rate of 89.5 percent, ranked seventh in that comparison [12].

The Bremen State Ministry of Education and Science allocates a certain fraction of the universities' budgets depending on the extent to which set objectives have been reached by the universities. The set of objectives embraces indicators such as number of graduates, number of international students, number of students graduating after the allotted number of semesters, third-party funds, and the number of study programmes in line with the Bologna system [13]. Thus, it becomes clear that the question to transform a study programme is not mainly market driven, but also particularly influenced by controlling measures in the relation between the university and the State Ministry of Education and Science.

4.5 University Requirements

When the two-tier study system was introduced at Hochschule Bremen, the relevant bodies decided to use this externally driven change as an internal opportunity to harmonize all study programmes at the university in terms of length of study, number of modules per semester, allocated credit points and related workload etc.. The main objectives of this harmonization were to enable more internal and external mobility of the students and to generate synergies between the different faculties, e.g. in order to encourage more interdisciplinary programmes. Figure 2 illustrates the result of the harmonization process. As a rule, the length of all Bachelor study courses has to be seven semesters with five modules per semester. Each module has a work load of 180 hours per semester divided into one third of contact hours and two thirds of students' self-learning time. Only in special cases will the presidential committee of the university accept Bachelor courses with a length of eight semesters, all other elements of the harmonized system are more or less unchangeable.

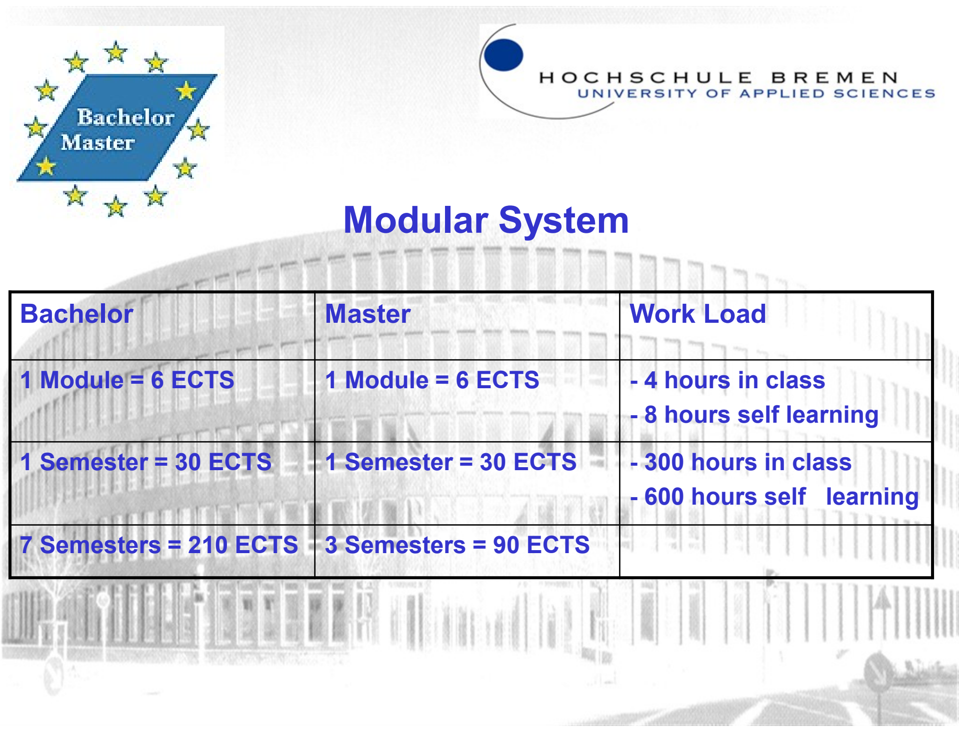

Figure 2. Two-tier study system at Hochschule Bremen [14].

Other challenges in developing the new study programme were the consideration of gender justice as well as the integration of diversity topics into the curriculum. Furthermore, the new programme in Nautical Studies was not allowed to need more resources in terms of staff, simulator capacity, lecture rooms etc. than the existing programme.

5. ACCREDITATION

Programme accreditations aim to assess three interlinked levels: 1) educational objectives and learning outcomes, 2) input criteria such as resources, support processes or quality assurance and 3) outcome orientation, incl. feedback loops from employers and alumni. According to ASIIN (Akkreditierungsagentur für Studiengänge der Ingenieurwissenschaften, der Informatik, der Naturwissenschaften und der Mathematik e.V.), one of the German accreditation agencies "the accreditation procedure evaluates the logic and effectiveness of the educational process in a degree programme. The combination of the elements in the individual phases of the process and the relationship between the three phases – and especially between the objectives and their implementation – play a key role in the overall assessment of the accreditation procedure." [15]. In the process of accreditation numerous criteria are checked. For example the appropriate name of the degree programme, entry requirements, accessibility for disabled students, qualifications of the teaching staff, research and publication record of the relevant university unit, the framework for examinations etc. The modular structure of the programme to be assessed is crucial. Thus, the description of modules require special attention and should among other criteria clearly specify the contents and target qualifications, the teaching formats, admission requirements, usability outside the study programme, students' workload, credits and conditions for their award [16].

6. CONCLUSION

It has become evident that a wide range of different interests and market requirements as described in this paper lead to the necessity of making appropriate concessions in designing a study programme in Nautical Studies. Due to external constraints the freedom to develop a well differentiated curriculum is comparatively limited. Consequently, it was not possible to integrate some innovative approaches into the new programme in Nautical Studies at Hochschule Bremen. For example, it was discussed to facilitate the second practical semester for distance learning by means of computer based training. Furthermore, it was proposed to entirely restructure the existing German MET system where a Nautical Bachelor programme would lead to STCW operational level and a Nautical Master programme to the respective STCW management level certificate of competency.

Finally, it was decided to put special emphasis on: 1) A slot for students' international mobility. 2) The ability for students to receive the certificate of competency for ratings forming part of the navigational watch prior to the second practical study period. 3) The introduction of a specialized module covering the assessment of the competences achieved over the course of the programme. 4) An STCW enrichment in maritime management. The stakeholders' interests were among others reflected in permanent discussion with members of the advisory board of the Centre of Maritime Studies at Hochschule Bremen. The advisory board includes executives from shipping companies, port operators, ship owners' associations, classification societies and MET.

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Using Inert Gas to Treat Aquatic Organisms in Ballast Water of the Ships

Pham Huu Tan
Faculty of Marine Engineering, Vietnam Maritime University
phamhuutan@vimaru.edu.vn

Tran Hong Ha
Falculty of Marine Engineering, Vietnam Maritime University
tranhongha@vimaru.edu.vn

Abstract: The ballast water and sediments carried by ships have been identified as a major pathway for the transport of harmful invasive aquatic organisms and pathogens. Ships often take on ballast water in one port and carry such ballast to other ports where it is discharged. The ballast water and sediments contain living organisms which, despite the harsh conditions in the ballast tanks and piping systems, survive to compete with native species in the port of discharge. If the non-native organisms have few natural predators or other natural controls they may become invasive and change the local ecosystems, sometimes dramatically. Ballast Water Management Convention was adopted 2/13/2004 stated: beforeThe ship ballast pumped out the ship ballast water must be treatment. This paper presents a method of ballast water treatment with inert gas. When aeration tanks inert inert gas into the air will push out the inert form of air and water environment of the bunker, so the organisms in water and ballast will be destroyed. Safe environment with an inert atmosphere of goods will also reduce the possibility of causing corrosion of oxygen tanks leaked items.
Keyword: inert gas, ballast water, organisms

1. INSTRUCTIONS

Ballast water is the source of the spread of certain harmful organisms from place to place around the world [1] like: Zebra mussel spread from Europe to the Great Lakes between the USA and Canada, causing great damage to the water projects, spending billions of U.S dollar. Cholera income derived from ballast water spread to many parts of South America, Gulf of Mexico and elsewhere. Disease in sea water fleas black water (water Cladoceran flee) spread to the Baltic Sea and development of very powerful, destroying creatures, indigenous phytoplankton, trapped fishing nets, gill nets, influence to the region's indigenous economy. Because of the impact of infectious diseases brought by ballast water is huge, Ballast Water Management Convention was adopted 2/13/2004 stated: The ship ballast pumped out before the ship ballast water must be treatment. Currently the ballast water treatment is done by changing the ballast water. Regulation B-4 of the BWM Convention to make the request on the exchange of ballast water. Ballast water exchange can be done through one of three methods [2]:

Sequential method: Domestic ballast water tanks or pits are pumped out at least 95% by volume, and then, new ballast water is getting into alternative ballast water was pumped out.

Flow through method: new ballast water is pumped into underground tanks or ballast water is to push the boat out through the hole opened on the open deck. When applying this method, the volume of water is pumped through the ballast water tanks or pits must be at least equal to three times the volume of the bunker or tunnel.

Dilution method: new ballast water pumping from the top of the ballast water tanks or silos, and ballast water is pumped from the bottom of the bunker or tunnel discharge with a flow equivalent to ballast water discharge are received in order to maintain the water level in the bunker or tunnel has not changed. Similar to flow through method, the method of dilution, the volume of water is pumped through the ballast water tanks or pits must be at least three times the volume of the bunker or tunnel there.

When conventions WBM effect for different-sized ships, the ballast water exchange methods mentioned above will be phased out and eventually removed altogether and replaced by ballast water treatment measures. Ballast water treatment measures are applied to meet the meet the criteria specified in Regulation D-2 of the BWM Convention. Systems and ballast water treatment equipment must be approved in accordance with Guide G-8 and / or process BWN G9 of the Convention (see Resolution MEPC.174 (58) and MEPC.126 (53)). Table 1 below presents a number of treatment systems.

Table 1. The ballast water treatment system has been type approved [3]

System Name	Maritime authorities approved	Guidelines and procedures apply
PureBallast-Alfa Laval	DNV on behalf of the Norwegian government	G8 & G9
OceanSaver®-OceanSaver	DNV on behalf of the Norwegian government	G8 & G9
Sedna®-Hamann AG	Germany	G8 & G9
Electro-CleanTM- Techcross	Korea	G8 & G9
NEI Treatment Systems	Liberia and Marshall Islands	G8
Hyde Marine BWTS	LR behalf of UK Government	G8

However, these methods are very high cost. Method inert atmosphere of the aeration tank by inert ballast water into the tank to bring high-performance processors. This method has two main uses is to kill the organisms carrying the pathogen by means of inert chemicals in the water tank, to prevent oxidation corrosion of ballast tank leak caused Safe section.

2. TREATMENT METHOD

Ballast water treatment method on board inert gas is shown in Figure 1 below.

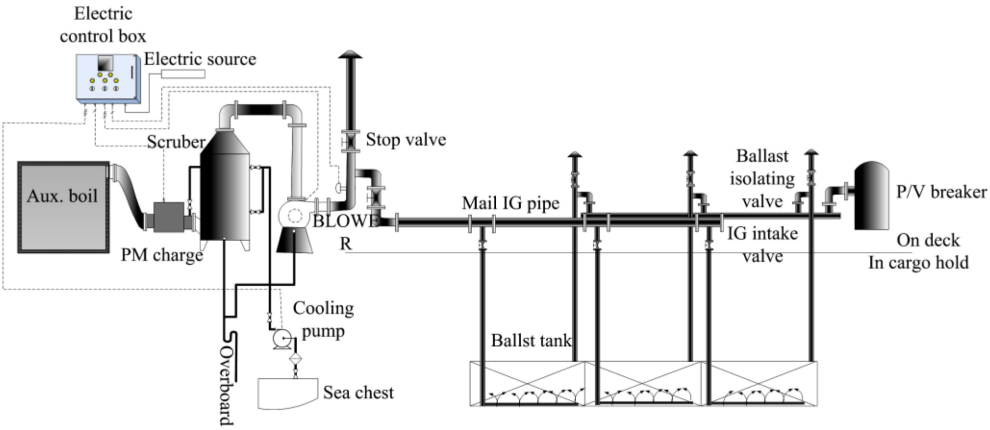

Figure 1. Ballast water treatment system using inert gas

Boiler exhaust gas is drawn through an electrostatic filter tower use sea water to filter exhaust gas and other impurities in Figure 2. Seawater cool down temperature of the exhaust gas from above 135^0C to 10^0C-20^0C. Electrostatic towers are steel cylinders containing a trap which has many doors. Each trap has been slotted cap taken on the door of "The Trap.". The sea water enter the tower from the top and flows through each trap. A series of walls are arranged to ensure that a trap was about 20mm deep in water. The "trap" at the bottom are arranged so that water is directed from the class "trap" to trap the other next. The exhaust gas before enter the tower it is charged by electrostatic charger. Where exhuast gas were positively charged, leading to the tower is then filtered through the water at the bottom cushion, going up over her husband "trap" it will in turn pass through the water layer in the "trap", through the slot of the slot cap which will distribute gas through the surface of the water system on the "trap.". Water will attract positively charged soot particles, virtually soot particles trapped in the trap. At the top of the cage "trap" people arranged a water separator and the waste gas. To remove the SO_2 in the exhaust gas the exhaust gas is discharged to the $Ca(OH)_{2.}$

The exhast gas after the filtration tower just left of $CO_{2,}$ N_2 inert gas, then a fan will be pushed into the inert gas system. Inert gas will be supplied in the space of ballast tanks. Inert in the process of aeration into the water, inert gas will gradually dilute O_2 concentration in the water and air space of the bunker. Normal levels of O_2 in seawater containing 5-6% range. From experimental results shown that when we went into the aeration tank of water to dilute it in water 2.5-3.5% depending on the O_2 in inert gas. However, when O_2 concentrations in water decreased to 2.5 to 3.5%, most organisms can not survive. Inert gas into the bunker should Jacuzzi filled with water to O_2 concentrations in water decreased to 2.5 to 3.5%, the amount of exhaust gas from the jacuzzi on the right by 0.5 to 1 times the tank volume and even can even larger. Aeration time should range from 4-6 hours. After scouring inert gas into the ballast tanks, the tanks must be isolated from outer space. To solve this problem is on the front of the tank vent pipe to locate the valve. However, when the vent pipe is closed phenomenon will happen to change the pressure in the ballast tank when the tank temperature changes or when the waves. To overcome this, the vents will be connected to normal pressure regulation. This structure shown in Figure 3.

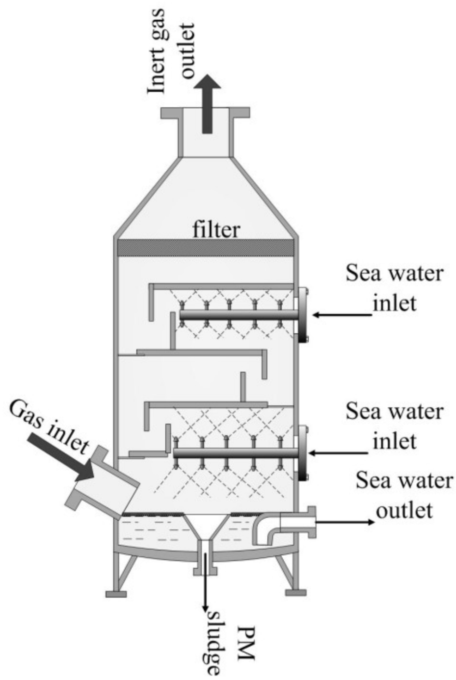

Figure 2. Electrostatic filter water tower

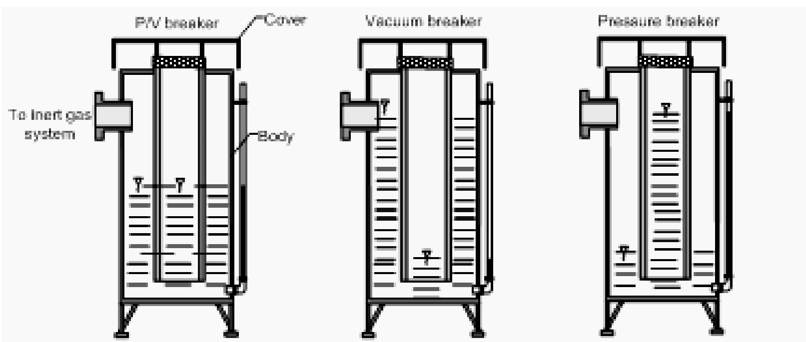

Figure 3. Average Pressure Regulator

3. DESIGN INERT GAS SYSTEM

Through experiments, the inert gas load Q_{IG} (m^3/ hour) with a total capacity of ½ water tanks. To ensure a inert gas enter the ballast tank to reduce O_2 content about 2.5 to 3.5%, then it takes about 6 hours. Inert gas is loaded per second:

$$Q_{IGs} = \frac{Q_{IG}}{6x3600} \quad \text{or} \quad Q_{IGs} = \frac{V_T}{12x3600} \quad (m^3/s) \tag{1}$$

In which V_T = total ballasst water tank capacity (m^3)

Diameter of main pipe D [4]:

$$D = \sqrt{\frac{4.Q_{IGs}}{\pi.v}} \quad (m) \tag{2}$$

Inlet pipe diameter d_i[4]:

$$d_i = \sqrt{\frac{4Q_{IGs}}{i.\pi.v}} \quad (m) \tag{3}$$

Where: *i* = number of ballast tanks, *v* = velocity of inert gas in the tank m/s. Q inert gas calculated by l / sec.

Tower diameter D_{scrub}:[4]

$$D_{scrub} = \sqrt{\frac{4.Q_{IGs}}{\pi.v_{scrub}}} \quad (m) \tag{4}$$

v_{scrub}- Speed filter working in the tower m/s.

Tower high H_{scrub}:

$$H_{scrub}=3D_{scrub} \quad (m) \tag{5}$$

Resistance calculated on the pipeline[4]:

$$\sum H_{tt} = \sum H_\lambda + \sum H_\xi \quad (mH_2O) \tag{6}$$

In which $\sum H_\lambda$ = Loss due to friction of flow on the pipeline, $\sum H_\xi$ = Partial loss[4].

$$\sum H_\lambda = \sum_{i=1}^{n} \lambda_1 \frac{L_i}{D_i} \cdot \frac{v_i^2}{2g} \quad (mH_2O) \tag{7}$$

$$\sum H_\xi = \sum_{i=1}^{n} \xi_1 \cdot \frac{v_i^2}{2g} \quad (mH_2O) \tag{8}$$

Where λ = *coefficient* losses along the *way,* ζ = local loss coefficient

Properties chosen head of the fan[4]:

$$H_{pan} = \sum H_{tt} = \sum H_{\lambda} + \sum H_{\xi} \quad (mH_2O) \tag{9}$$

Select the fan capacity[4]:

$$Q_{pan} = \gamma_{H_2O}.H_{pan}.Q_{IG}.\eta_{pan}. \quad KW \tag{10}$$

Where: $_{Pan}\,\eta$ = mechanical efficiency of *fans,* = Specific gravity of *water.*
From these calculations, on the basis of Visual Basic 6.0 software, we will build software for the design of computing systems ballast water treatment with inert gas.

4. EXPERIMENTS

A production of inert gas chamber shown in Figure 4, this chamber with the use of DO to low-carbon fuel. Filtered water tower is a pyramid scheme using filtered water to neutralize many types of trap doors. Spraying water into the tower is taken from water tanks. Most of the larger soot particles are disposed in the trap. Soot particles are retained because they are positively charged in charging devices with potential for soot-loaded from a 10 kV. Most of the soot particles are separated in the filter tower. To remove SO_2 in the exhaust gas in a tank with air from 5-10kg $Ca(OH)_2$. Exhaust soot after being purified and the impurities are left mainly CO_2 and N_2 will be pushed out a fan. Partly through the election and lead the extract to reduce the temperature cooling down to temperatures greater than ambient temperature from 10^0C-20^0C, then passed through a flowmeter into the bunker and jacuzzi. Safe testing volume is 1 m^3 inside the container nearly full of water. Drop in the bunker with some organisms such as fish, shrimp, crabs and oysters to check the results of treatment.

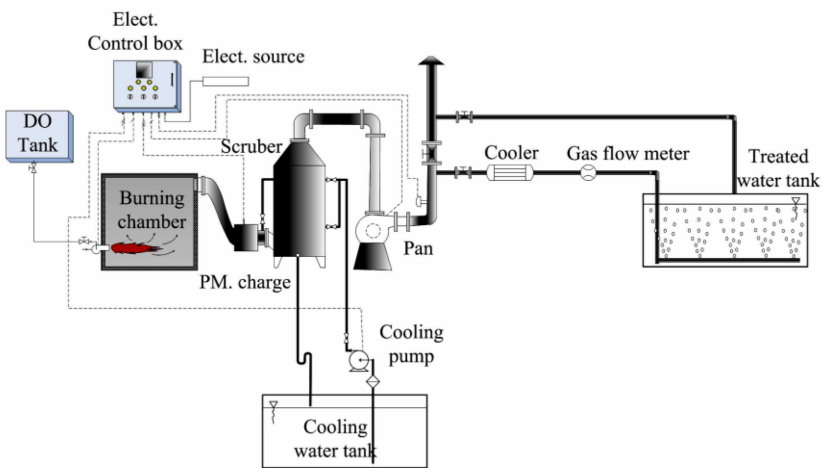

Figure 4. Experimental ballast water treatment system using inert gas

5. RESULTS AND DICUSSIONS

Results of sampling and analysis components of the exhaust gases before and after electrostatic filter tower is shown in Table 2 below.

Table 2. The composition analysis of emission characteristics before and after filtering

	Before	***After***
CO_2	30%	30%
CO	1,3%	0,0%
PM	1,0%	0,0%
O_2	1,5%	1,5%
SO_2	0,2%	0,0%
N_2	66%	66%

In Figure 5, reflecting the results of treatment by living organisms in water by inert gas. In case we have an inert aeration is 50^0C temperature in tanks filled with water until the measured concentration of O_2 in the country reached 3.5%, the amount of microorganisms that are destroyed very quickly. Within 5 hours to about 60% of organisms had been killed, and within 20 hours, virtually all of the creatures are destroyed. If the temperature inert gas into the tank scouring around 30^0C with water contained in tanks, the tanks about ¾ effectively destroying inferior creatures. If the tank full of water and temperature inert gas in the tank is loaded into 30^0C is more effective than biocides as well as the amount of water contained in the tank is not full, but less effective when inert aeration with high temperature , because when the water temperature is greater than 40^0C, the organism is very difficult to survive. However, cases of water tanks filled with the same low-temperature scouring more realistic controller.

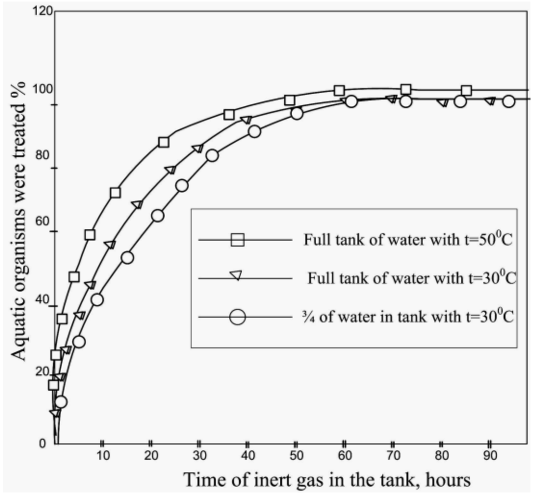

Figure 5. Results in the treatment of organisms with aeration tanks inert

On the other hand if the concentration of O_2 reduction in the bunker will reduce the oxidation tank shell steel tanks leak cause category. Steel oxidation process takes place as follows:

$$Fe+O_2 \rightarrow Fe_2O_3 \quad (11)$$

Therefore, reducing the surface leakage tank section. However, to do this is in the tank must always be loaded inert gas, even when the water is not safe ballasst.

6. CONLUSIONS

Use of ballast water treatment with inert gas can be an effective treatment in the future, because it meets the IMO requirements for water treatment systems are eliminated ballasst to 90% and domestic animals have ballasst. This method costs relatively low cost, non-toxic and environmental pollution. If equipped with water treatment systems on board inert gas balasst will reduce the likelihood of leaks Safe section. This is the main reason for the ballast water of red rust.

Besides inert gas system can also be used as a fire system for the cargo hold, the bunker oil on board very effective.

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Application of Regulations Concerning the Transport of Dangerous Goods Transported in Bulk

Marzenna Popek
Gdynia Maritime University,
Department of Chemistry and Industrial Commodity Science
marzenap@am.gdynia.pl

Abstract: The main task of International Maritime Organization and Governments is develop a comprehensive body of international conventions, codes and recommendations. Certain IMO activities are dictated by the need to take action on specific areas of maritime safety, and protection of marine environment: evaluation of safety and environmental hazards of chemicals, analysis of maritime casualties and maritime incidents reporting. When the wet granular materials, such as mineral concentrates and coals lose their shear strength, resulted from increase pore pressure, they flow like fluids. This phenomenon is called liquefaction and causes dangerous cargo shift. The main factor which influences on the liquefaction of solid bulk cargoes is moisture content. According to the chapter VI of the SOLAS Convention, it is required that cargoes which may liquefy shall only be accepted for loading when the actual moisture content of the cargo is less than its Transportable Moisture Content. In this work the results of investigation on possibility of using biodegradable materials as absorbers of water from mineral concentrates, before the transportation by sea, are presented. To prevent sliding and shifting of ore concentrates in storage starch materials are added to the ore concentrates.
Keywords: mineral concentrates, liquefaction, shifting, starch polymer

1. INTRODUCTION

International Maritime Organization and Governments should have the possibility to establish permanent arrangements in order to ensure the safe transportation of dangerous goods. The successful application of regulations concerning the transport of dangerous goods is greatly depend on the appreciation by all persons concerned of the risks involved and on a detailed understanding of the regulations. The International Maritime Organization plays an important role in the promotion of maritime safety and the prevention of marine pollution from ships. To have the greatest effect on safety of life, prevention of serious injury, protection of the marine environment the following items are taken into account as higher priority: measures to promote the widest possible implementation and enforcement of IMO instruments by the shipping community, measures aimed at substantially preventing maritime casualties or marine pollution incidents, measures following a series of incidents causing or indicating risk of loss of life, significant injuries to persons, measures aimed at improving the safety and health of ship's crews and personnel, measures to correct significant inadequacies identified in existing instruments.

1.1 IMO instruments for ensure safety transportation

The main task of IMO is to develop a comprehensive body of international conventions, codes and recommendations. The most important conventions are accepted and implemented by countries whose combined merchant fleets represent 98% of the world. The International Maritime Organization has adopted over the years a number of internationally recognized codes and guides, which are of direct relevance to the safe and secure transport and handling of dangerous cargoes in port areas, and which may serve as valuable source of information in the development of national legal requirements

Some goods transported by sea can present a hazard during transport because of their chemical nature. The term "dangerous goods" includes any empty uncleanness packaging (such as tank-containers, receptacles, intermediate bulk containers (IBC's), bulk packaging, portable tanks or tank vehicles) which previously contained dangerous goods, unless the packaging have been sufficiently cleaned of residue of the dangerous cargoes and purged of vapors so as to nullify any hazard or has been filled with a substances not classified as being dangerous. The classification of dangerous goods and general provisions concerning listing, labeling were adopted in 1948.

The International Convention for the Safety of Life at Sea (SOLAS Convention) is the most important international convention dealing with maritime safety [1]. SOLAS in a present version was adopted in 1974 and entered in force in 1980. The provisions of Chapter VII of the Convention "*Carriage of dangerous goods in packed form or in solid form in bulk*" contain the main regulations concerning the transport the dangerous goods by sea. To minimizing the risk of negligent or incidental release of marine pollutants transported by sea The International Convention for the Prevention of Pollution from ships (MARPOL 73/78) was adopted and entered into force on 2 October 1983 [2].

As a further step to regulate the carriage of dangerous goods by sea was approval by Maritime Safety Committee the International Maritime Dangerous Goods (IMDG Code) in 1965 [3]. The IMDG Code amplifies the requirements of both conventions and has become the authoritative text on all aspects of handling packed dangerous goods and marine pollutants by sea. Since 1 January 2004, the IMDG Code has attained mandatory status. To ensure safety sea transport of solid bulk cargoes the Sub-committee on Containers and Solid Bulk Cargoes (DSC) of International Maritime Organization (IMO) issued International Maritime Solid Bulk Cargoes Code (IMSBC Code) [4].

1.2 Mineral concentrates – MHB cargoes

Bulk shipping has been used for many years to reduce the cost of sea transport and the transport of bulk cargoes is a vitual component of international trade. Such trade require a sufficient volume of cargo suitable for bulk handling and hence justify a tailored shipping operation. The five major dry bulk cargoes are coal, mineral concentrates, grain, bauxite and phosphate rock, and each year the trade in bulk increases [5].

The safe transportation of solid bulk cargoes is a responsible task. Some of these cargoes are classified as dangerous goods - Materials Hazardous in Bulk (MHB). Shipment of solid bulk cargoes may be associated with several hazards. One of these hazards is deterioration or loss of ships stability, which may be a result of lateral shift of an excessively wet loose cargo, which can pass into liquid state.

The ore concentrates and similar materials are considered as a three-phase structure, which consist of: solids (mineral grains), water and air. Mineral grains are very small; they are from 0,001 mm to several millimetres large. Disintegration level and percentage of particular size fraction may differ depending on concentrate type.

In three – phase structure air and water fill the pores between mineral grains. When the cyclic load is applied to such material in sea transport conditions, due to ship rolling and vibration, particles of a material may move microscopically and the volume of void may decrease. The air, permeability coefficient of that is about 500 times greater than that of water, first escapes. In such case, if the void is filled with the water and the water flow through the small void is resisted, the pressure of the water in void increases. Shear strength of granular materials is maintained by friction force between particles and cohesion. Friction force is a product of effective compressive force between particles and a friction coefficient. When pressure of water in void become high, effective compressive force between particles become small. In such cases, if the cohesion is negligible, shear strength of the granular material becomes very low and the material flows [6,7]. Such phenomenon is called *"liquefaction*".

The main factor which influences on the liquefaction of solid bulk cargoes is moisture content The basic idea of the requirement for the material which may liquefy is limitation the moisture content of the cargo. To minimize the risk of liquefaction the IMSBC Code introduces the upper bound of moisture content of cargo, which is defined by the Flow Moisture Point (FMP). Flow Moisture Point is moisture content, which allows for passing the bulk cargoes from solid into liquid state. For materials prone to liquefaction, the IMSBC Code provisions is that cargo must be shipped at moisture content significantly less than the FMP. According to the chapter VI of the SOLAS Convention, it is required that cargoes which may liquefy shall only be accepted for loading when the actual moisture content of the cargo is less than its Transportable Moisture Content. The TML is defined as 90 % of the FMP. These cargoes prone to liquefaction, should never be carried without checking the moisture content. The IMSBC Code lays down that a certificate stating the relevant characteristics of the material to be loaded should be provided at the loading port, incorporating also the TML. The Code provides information how the moisture content of mineral concentrates can be tested and assessed. experimental procedures.

The behavior of a mineral concentrate that liable to liquefy and its threat to the ship's stability is closely related to the effect of a liquid free surface. Although this view may suitable in many cases, it does no fully reflect the known mechanisms of liquefaction. At a moisture content above that of TML, shift of cargo may occur as a result of liquefaction. Certain cargoes are susceptible to rapid moisture migration and may develop a dangerous base during the voyage, even if the average moisture content is less than the TML. Moist mineral concentrate, being compacted in the bottom layers and thus filling the gaps between particles completely with water, may slide on this saturated layer. The top layer may still appear in a dry and safe condition.

Both sliding and liquefaction are very dangerous: either may cause severe structural damage to a ship and both are known to have caused the loss of vessels carrying solid bulk cargoes. The events may take place gradually, giving a ship's master time to compensate for a shift in cargo or they may occur so rapidly that there is insufficient time to send off a distress signal before the vessel and crew are lost.

A large group of organic polymers fined use in the mineral industry with the specific function [8]. Particularly attractive are the new materials based on natural renewable resources, preventing further impact on the environment.

Starch is non – expensive biopolymer available from annually renewable resource. It is totally biodegradable in a wide variety of environments and allows the development of totally degradable products. The purpose of this work was investigation on possibility of using biodegradable thermoplastic materials as absorbers moisture. To prevent sliding and shifting of ore concentrates in storage materials composed of starch, cellulose and polycaprolactone are added to the concentrates.

2. EXPERIMENTAL PROCEDURES

2.1 Materials

Following concentrate was used for the test:

Flotation lead concentrate, composed mainly of PbS. The concentrate is produced in Ore Mining and Smelting Works in Trzebinia. Flotation lead concentrate is produced in a flotation process with the use of flotation and foam generating chemicals.

The water content in flotation lead concentrate is about 3,5 – 5 %. Flotation lead concentrate is a typical material, "which may liquefy".

Following starch materials were tested (potato starch obtained from Potato Industry Company at Luboń):

- Polymer Y Class – made of thermoplastic starch and cellulose derivatives from natural origin (made by Novamont S.P.A.),
- Polymer Z Class – made of starch and polycaprolactone (made by Novamont S.P.A.),
- Crosslinked starch – acetylic diamylaceus adipate -"Lubostat", (obtained from Potato Industry Company at Luboń),
- Crosslinked starch - diamylaceus adipate -"AD", (obtained from Potato Industry Company at Luboń,)
- Natural starch – granulated product, (obtained from Potato Industry Company at Luboń).

The samples of starch materials were in granular form. The experiments were conducted for samples of concentrate: without starch materials and for mixtures contain concentrate and 0,5%, 1 % and 2% of starch materials .

The used polymer materials are classified as a low environmental impact product.

The liquefaction may take place when the content of grains with the size 0,3 mm and less is grater then 10%. In the flotation lead concentrate the contents of particles with a diameter smaller than 0,3 mm are essentially greater than 10% and amount 62%.The content of particles greater than 1 mm is about 10%. This is the reason why flotation lead concentrates may liquefy.

The starch material does not significantly change grain size distribution of concentrates [9].

2.2 Methods

Estimation of FMP

The evaluation of FMP was performed with the use of the Flow Table Method and Proctor C/Fagerberg, according to the recommendations given in Appendix D in the IMSBC Code. Flow Table Method is not applicable for the coarse–grained concentrate, such as sedimentary galena. Application of this method is not possible if content of particles with size within 0,02 and 0,3 mm is greater than 10 %.

Permeability of concentrates:

The permeability is the rate at which water under pressure can diffuse through the voids in the mineral concentrates. Mineral concentrates are permeable to water because the voids between the particles are interconnected. The degree of permeability is characterized by the permeability coefficient k, also referred to as hydraulic conductivity.

According to the classification of soils, based on their coefficient of permeability, mineral concentrates are the materials with the low degree of permeability.The permeability of mineral concentrates depends primarily on the size and shape of grains, shape and arrangement of voids, void ratio, degree of saturation, and temperature.

Measurement of the cohesion:

The estimation of cohesion angle was performed in the direct shear apparatus by carrying the shearing with the help of lower and upper part of displacing box containing the tested concentrate. In the experiment the samples were compacted in a dry state. The moisture content corresponds to the TML value estimated in Flow Table Test.

In the experiments the samples were compacted. The consolidation conditions (in the holds) were simulated by using vertical loads: 0 N, 98 N, 196 N, 294 N and 490 N, what corresponds to the normal stresses: 0, 1,532 $*10^4$ N/m^2, 3,0645 $*10^4$ N/m^2, 4,589 $*10^4$ N/m^2, 7,659 $*10^4$ N/m^2 respectively. The test without any stress corresponds to the stress in the hold during the loading. Increasing values of normal stresses represents the changes in the bulk cargoes during the sea transportation.

3. RESULTS AND DISSCUSION

The value of TML for flotation lead concentrate is 7,4 %. The starch materials were added to the concentrates in wet state (water content corresponding to the TML of tested materials).

The results of estimation TML for mixtures of flotation lead concentrate with polymer Y and Z are presented in Table 1.

Table 1. TML values determined by means of Flow Table and Proctor C/Fagerberg

Samples	TML [%]	
	Flow Table	**Proctor C/Fagerberg**
Flotation lead concentrate	7,41	7,94
Flotation lead concentrate + 0,5 % polymer Y	7,42	7,98
Flotation lead concentrate+ 2,0 % polymer Y	7,5	7,85
Flotation lead concentrate+ 0,5 % polymer Z	7,35	7,82
Flotation lead concentrate+ 0,5 % polymer Z	7,4	7,91

Despite the presence of polymer in tested concentrates, the values of estimated TML are similar, because liquefaction is tightly related to the grain size contents. The results of the grain size analysis indicate that polymer does not significantly change grain size distribution. Results obtained by using ProctorC/Fagerberg Method are higher in all cases than those given by Flow Table Method.

The samples with Lubostat, AD and granulated starch were tested for estimation TML at several time intervals. The results are presented in Table 2 -3.

Table 2. Transportable Moisture Limit determined by Flow Table Method–flotation lead concentrate + 0,5 % starch

Sample type	TML [%]			
	Time			
	24 h	48 h	72 h	96 h
Flotation lead concentrate + Lubostat	8,11	8,6	8,8	8,8
Flotation lead concentrate + AD	8,8	8,9	8,9	9,0
Flotation lead concentrate + granulated starch	7,9	7,9	7,9	7,9

Table 3. Transportable Moisture Limit determined by Flow Table Method–flotation lead concentrate + 2 % starch

Sample type	TML [%]			
	Time			
	24 h	48 h	72 h	96 h
Flotation lead concentrate + Lubostast	9,40	9,45	9,5	9,45
Flotation lead concentrate + AD	9,35	9,33	9,36	9,39
Flotation lead concentrate + granulated starch	8,2	8,8	8,55	8,55

0,5 % and 2 % of starch material in mixture with flotation lead concentrate does not significantly change grain size distribution.

Starch material absorbed water from the mixtures at the amount approximately proportional to the starch material content in the mineral concentrates. It can be noticed that modified starch presents higher solubility than granulated starch. In general, the higher values of TML were observed in case of testing flotation lead concentrate + 2 % of starch material. For the mixtures containing 2 % Lubostat and AD the greater increasing of TML was observed than for concentrate containing 2 % granulated starch. The time of saturation of the starch material with water did not influence on the TML value.

The results of permeability tests are presented in Table 4.

Table 4. Results of permeability test

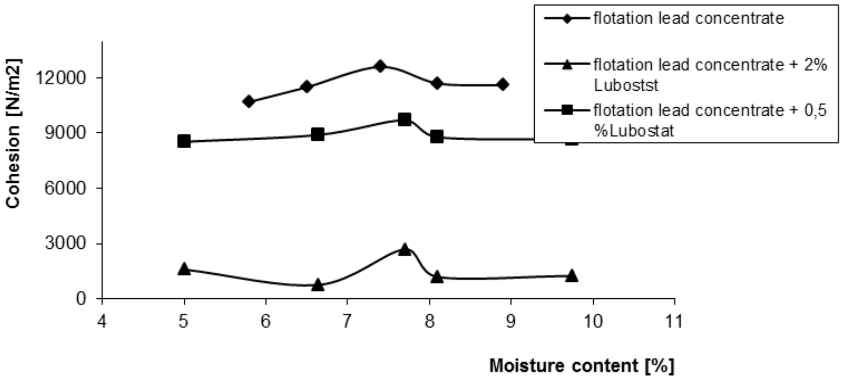
Sample type	Permeability coefficient [m/s]	
	Flotation lead concentrate + 1% of starch material	**Flotation lead concentrate + 2% of starch material**
Flotation lead concentrate + polymer Y	$2,2 *10^{-3}$	$1,35*10^{-4}$
Flotation lead concentrate + polymer Z	$3,5*10^{-3}$	$2,62*10^{-3}$
Flotation lead concentrate + Lubostat	$1,8 *10^{-3}$	$5,58*10^{-4}$
Flotation lead concentrate + AD	$2,34*10^{-3}$	$3,84*10^{-3}$
Flotation lead concentrate + granulated starch	$1,12*10^{-3}$	$2,33*10^{-3}$

Based on the results of the tests the effect of different content of the samples on the permeability was observed.

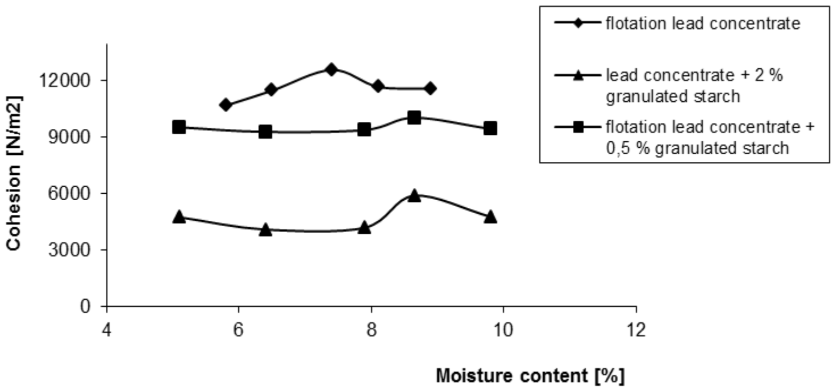
The maximum value of permeability coefficient k was achieved for mineral concentrate without any starch materials and reached the value $8*10^{-3}$ m/s.

The ability to permeability of mixtures is related to the type of starch material. In all cases, for samples with starch material, the decrease of permeability was obtained. If the content of starch material in the mineral concentrate increases, the value of permeability coefficient decreases. The greatest decreasing of permeability coefficient was observed for mixtures containing 2 % of Lubostat.

The changes of cohesion as a function of moisture content are presented in Figures 1 [a,b,c].



a]



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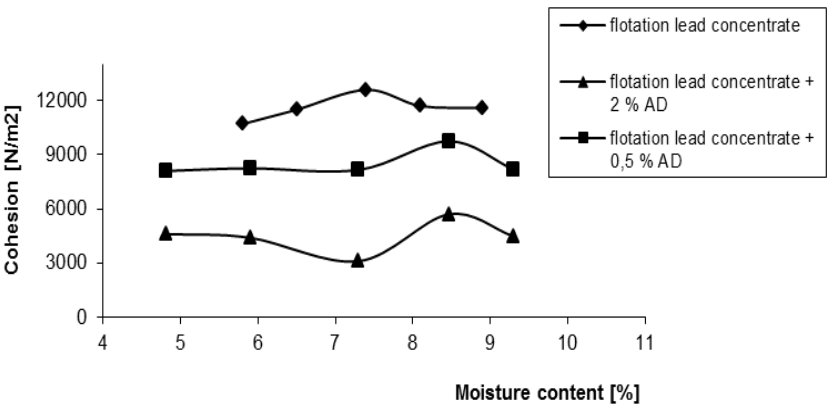

c]

Figure. 1. The changes of cohesion as a function of moisture content: a) flotation lead concentrate + Lubostat; b) flotation lead concentrate+ granulated starch; c) flotation lead concentrate+ AD.

The above presented results indicate that the starch materials significantly change the cohesion. Presence the starch materials in mineral concentrate tends to reduction of cohesion. In all tested samples cohesion increase with the increasing of moisture content and reaches a maximum with the moisture approaching the TML and then it goes down. The extreme values are not reached at the same moisture content for all mixtures. The maximum values of cohesion is effected by the type of mixture. It confirms correlations between the TML values and maximum values of cohesion.

4. SUMMARY

The conclusion is based on the measurement of the TML, cohesion and permeability of the materials.

The presence of starch materials in tested mineral concentrate influences on the value of the cohesion, and on achieving the maximum values. The comparison of the cohesion confirms that the correlation occurs between those values and the TML values.

In all cases, for samples with starch material, the decrease of permeability was obtained. The ability to absorption water is related primarily to the composition of starch material and the percentage of starch in mixtures. Due to presence starch materials the risk of its passing into the liquid state is lower.

Polymer materials prevent drainage of the water from the particle pore, sliding and shifting of ore concentrates in storage. These polymer materials can be used as absorbers of water from mineral concentrates.

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Analysis on Ship Oil Pollution Damage Compensation System in China

Luzhen Ren
Jimei University, China,
renluzhen@hotmail.com

Luling Zeng
Jimei University, China,
potala@163.com

Abstract: Marine environmental protection is a worldwide crucial issue of common concerns. China has also actively involved in related Conventions of prevention and protection system. However, with respect to civil compensation for ship oil pollution damage, China lacks a perfect legal system. Through analyzing ship oil pollution compensation status in China and referring to international legislation, this paper analyses the differences between the Chinese system and international conventions, and the main problems, proposes the ideas in establishing a civil compensation liability system for oil pollution damage in China.
Keywords: oil pollution, compensation system, ship, China

1. INTRODUCTION

There happened a severe accident of explosion of oil tube in Dalian, China on 16th of July, 2010, which caused a tremendous damage of oil pollution to the sea in North China. It was said that approximately 60 to 90 thousands tones of crude oil were spilled into the area of Dalian harbour [Greenpeace, 2010]. There is no official statistics how much direct or indirect damage would be caused to the local economy. However, with respect to the civil compensation, according to the information declared lately, it is the local government who compensates the loss or damage suffered by the residents involved in fishing cultivation by the standard of their yearly average production in that area. It is not yet eventually solved so far as the oil pollution compensation, but it is clear that the civil compensation system to the oil damage is different from that in international conventions.

2. THE APPLICABLE LAW

China joined the International Convention on Civil Liability for Oil Pollution Damage 1969 (hereafter referred to as "CLC1969") on 30th of January, 1980, and became a member of the International Convention on Civil Liability for Oil Pollution Damage 1992 (hereafter referred to as "CLC1992") on 5th of January, 1999, which took into force to China on the 5th of January, 2000. Meanwhile, CLC1969 became void to China.

In addition, after notice the deficiency of CLC convention on the compensation to the oil damage, the International Maritime Organization (IMO) established the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (hereafter referred to as "FUND Convention") which constitutes dual-layer liability system together with CLC1969 and was amended by its 1992 Protocol.

In general, the oil pollution compensation mechanism which consists of above said international conventions can basically compensate the sufferers promptly, effectively as well as sufficiently. However, this system does not perfectly apply to oil pollution takes place in China. Presently, only the CLC1992 apply to China while the FUND Convention 1992 and its 2000 protocol bind part of China, which is Hongkong Special Administrative Zone, China.[SHEN Lanlei, 2008]

In the regime of Chinese domestic law, there is no civil legislation specifically governing oil pollution compensation. In legal practice, judges normally seek legal basis from the provisions incorporated in different codes, such as Environment Protection Code, Marine Environment Protection Code, General Principles of Civil Law, Maritime Code and other ordinances. The former two Codes are administrative codes; the provisions concerning civil compensation to oil pollution are general while stipulations in the ordinances are more practical.

3. DIFFERENCES ON SPECIFIC ISSUES

3.1 Applied Ship

In CLC 1992, the "Ship" means any sea-going vessel and seaborne craft of any type whatsoever constructed or adapted for the carriage of oil in bulk as cargo, provided that a ship capable of carrying oil and other cargoes shall be regarded as a ship only when it is actually carrying oil in bulk as cargo and during any voyage following such carriage unless it is proved that it has no residues of such carriage of oil in bulk aboard.

In Chinese domestic legislation, especially Article 3 of Chinese Maritime Code, the "Ship" is defined as "sea-going ships and other mobile units, but does not include ships or craft to be used for military or public service purposes, nor small ships of less than 20 tons gross tonnage". In certain administrative ordinances, although the types of applied ships have been mentioned, from overall view, there is lack of a clear definition of ships applied to oil pollution compensation system. As a member state of CLC, it is necessary for China to be accordance with CLC on this issue. [HU Zhengliang, 2009]

3.2 Applied Oil

With respect to the scope of applied oil, the same stipulations can be seen in Article 52.3 of the Ordinance of the Prevention of Pollution from Ships of PRC and article 95 of the Ocean Environment Protection Code of PRC, which is any type of oil and its refinery production including any persistent hydrocarbon mineral oil, non-persistent hydrocarbon mineral oil, as well as cargo oil and bunkers. Comparing to Article 1 of CLC 1992, which is "any persistent hydrocarbon mineral oil such as crude oil, fuel oil, heavy diesel oil and lubricating oil, whether carried on board a ship as cargo or in the bunkers of such a ship", the scope of applied oil in Chinese domestic law is broader than that in CLC 1992, which means the prohibition of pollution to the ocean environment caused by any types of oil and its refinery production.

3.3 Subject to Compensate

According to Article 3.4 of CLC 1992, the person or persons registered as the owner of the ship or, in the absence of registration, the person or persons owning the ship are identified as the Subject bearing the burden to compensate the loss or damage caused by oil pollution. This way of stipulation is helpful not only to protect the interest of sufferers but also to control the cost and to avoid the multi-action to the claimant.

However, there is no any provision in Chinese domestic law concerning the subject of the compensation of oil pollution. Only in the Ocean Environment Protection Code of PRC, there is a provision, which is Article 90.1, requesting that the responsible person should take action to diminish the threats and compensate the damage in case of causing pollution; in the case of that the pollution is totally caused by third party's intention or faults, this third party should be liable for the diminish of the threats and compensation to the damage. Even though the wording is different, the application in legal practice is quite same with CLC 1992.

3.4 Civil Liability to oil pollution

As to the liability system of oil pollution from ship, international conventions and domestic laws adopt the strict liability system. China is absolutely the case on this respect. "Who spills the oil; who is responsible" is a globally accepted principle. However, according to the Ocean Environment Protection Code of PRC, in the case of both-to-blame ship collision causing oil pollution while the accident is totally caused by third party's intention or faults, the shipowner should be exempt from the compensation.

Because of the relatively high risk of shipping industry, majority of the shipping countries impose the special protection to certain extent on shipping by legislation, which is the principle of limitation of compensation. But in Chinese domestic law, it is a vacuum. In legal practice, the loss or damage can claim includes physical loss or damage suffered by persons or legal bodies, loss or damage of interest or profit, expenditure of preventive measures as well as the further loss or damage etc.. [HU Zhengliang, 2009]

As far as the limitation of compensation is concerned, in 2000 protocol to CLC 1992, the limitation of compensation has been increased to 897,700,000 Special Drawing Right (SDR). The existing provisions in china mainly exist in Chapter 11 of CMC of PRC. This is the situation should be corrected as soon as possible.

4. OVERALL DISCUSSION AND RECOMMENDATIONS

In the last decade, the oil transportation increased rapidly. According to the Development Report of Oil-gas industry for 2010 republished by CNPC Research Institute of Economics and Technology recently, the amount of imported oil is moving upward continuously and has exceeded 200 million tons in China. The probability of the oil spill accident also gradually increases. That is a new challenge for state's response to environmental pollution emergencies and the ability for compensation.

Marine Environment Protection Code of PRC amended in 1999 is the Legal basis of establishing the oil pollution compensation mechanism. According to Article 66 of this Code, the State shall put into practice responsibility system of civil liability compensation for vessel-based oil pollution, and shall establish vessel-based oil pollution mandatory insurance, oil pollution compensation fund system in accordance with the principles of owners of the vessel and the cargoes jointly undertaking liabilities for vessel-based oil pollution compensations. Specific measures for the implementation of vessel-based oil pollution insurance and oil pollution compensation fund system shall be formulated by the State Council. [The Ministry of Communication, 2009]

Regulations on Prevention and Control of Pollution to the Marine Environment by Vessels came into force on 1st of March, 2010, which has been voted by the Committee of State Council on 2nd of September, 2009.

Based on the Marine Environment Protection Code of PRC and Regulations on Prevention and Control of Pollution to the Marine Environment by Vessels, the damage compensation system of oil pollution would be further clarified. Ship oil pollution insurance and oil pollution damage compensation fund are the double protection for domestic oil pollution damage. Mandatory civil liability insurance is emphasized and regulated. It is important for China to enter a substantive stage of ship oil pollution damage compensation system.

According to Regulations on Administration of Prevention and Control of Pollution to the Marine Environment by Vessels, ships traveling in China's territorial sea must covered oil pollution insurance, besides the ship with a gross tonnage under 1000 tons and not carrying oil in bulk.

Further provisions are listed in the Enforcement Measures of the Mandatory Civil Liability Insurance for Oil Pollution Compensation， which is the supporting regulations of the Regulations on Administration of Prevention and Control of Pollution to the Marine Environment by Vessels.

It should be noted that applied ships in Chinese regulation are much stricter than in relevant international conventions, such as the applied gross tonnage. A stricter regulation would be bad for small oil vessels, but good for the industry and environment protection.

In addition, ministry of finance and ministry of communication of PRC jointly drafted a administrative regulations about the utilization methods for oil pollution compensation funds, including the source of fund, applied ships, applied oil, limit of compensation, Subrogation, time of validity and so on. But it has not been officially published yet. [SUN Yanli, 2009]

According to the regulation mentioned in last paragraph, the compensation fund is collecting from oil companies as per the contributions oil. The contribution rate is 0.3RMB per ton. Of course, the rate will be adjusted due to the oil pollution compensation situation.

Furthermore, Chinese relevant authorities endeavors to establish a relatively perfect system regarding compensation fund and mandatory insurance system, however it has long time to go from legislation to practical enforcement. Therefore, it is strongly recommended that the maritime administration in large city might suggest the local government to establish a port oil pollution prevention budget fund, which is specifically for the response to the contingency, from governmental finance by local legislation.

In addition, according to the statistics of International Oil Pollution Compensation Fund, it is Japan, Italy, Netherland, Korea, France, United Kingdom etc. 13 countries pay more contribution which take approximately 93.4% of the total contribution. But these countries obtain less compensation than the contribution they pay. For china, from the total number of contribution, in is temporarily not the good time to join the international fund. But the unification of international oil pollution compensation system is inevitable. China should take active action, step into the shoes of international society on this issue.

5. CONCLUSION

Ship oil pollution damage compensation System in China is composed of the provisions in different codes, and referring to the relevant international conventions. Mandatory civil liability insurance is emphasized in new regulations, which is stricter than CLC in some respects. Anyway, Establish the oil pollution compensation system which is conforming to the national conditions and international practices is the aim of China.

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Model of Human Elements for Maintenance Engineering in Maritime Field

Haryanti Rivai
Kobe University, Graduate School of Maritime Sciences, Japan
anthie_rivai@yahoo.com

Masao Furusho
Kobe University, Graduate School of Maritime Sciences, Japan

Shoji Fujimoto
Kobe University, Graduate School of Maritime Sciences, Japan

Masaki Fuchi
Kobe University, Graduate School of Maritime Sciences, Japan

Abstract: Various accidents surveys have the conclusion that human error is a primary cause of most major accidents on board. One of them can be contributed by maintenance errors in the critical elements on board. Regarding with this issue, the focus of this work is to prediction of human error probabilities during the process of maintenance to make improvement on maritime field. For decreasing of human error in maritime field, an expert method, from safety risk assessment, was adopted as a vehicle to predict the human error probabilities. In this research many good scenarios from maintenance event on board were studied in detail to make synergy effect with design of human factors assessment.

This process is done by forming a model of human reliability assessment with combined maintenance culture. This model consists of several steps, which the first step by analyzing the input as symptoms of functional failure, qualitative analysis of human errors, interpretations, quantifications, maintenance and safety culture effects, which aims to evaluate human error on board, especially in the areas of maintenance equipment

This modeling process is to establish a task error types of equipment, and interpret the types of failures on the equipment between single failures, multiple failures, Common Cause Failures (CCFs), Common Cause of Non Critical Failures (CCNFs) are then classification with error mode from human error.

The result from modeling on accident is indicated by the relations between the mode analyses with a critical error events are dominated by the critical condition of the engine overheats with the total of 36.6.%, the equipment have critical events caused by human error are generally influenced by mistake total percentage of 23 %, lapses, slips with the total of 19 %, and violations with the percentages of 16 %. Single failure could be

considered a starting point for maintenance culture. In the maintenance culture describes the maintenance of a balance between three critical demands to anticipate, react and monitoring and reflecting as well as between the demands of equipment.
Keywords: equipment failures, Common Cause Failures (CCFs), Common Cause of Non Critical Failures (CCNFs), human error, cognitive interpretation

1. INTRODUCTION

1.1 Background

Various accidents surveys have the conclusion that human error is a primary cause of most major accidents in maritime field. One of them were contributed by maintenance errors in the critical elements in maritime field. Regarding with this issue, the focus of this work is to prediction of human error probabilities during the process of maintenance to make improvement on maritime field. For decreasing of human error in maritime field, an expert method, from safety risk assessment, adopted as a vehicle to predict the human error probabilities.

Maintenance is particularly vulnerable to error because the work is often complex. Many activities involved in there such as frequently removal and replacement of a variety of components in the systems, incorrect action error, not restored to operational state, procedural error, involving cognition and action, these activities may also have the potential to induce unwanted and un-anticipated events and may render critical systems unavailable.

1.2 Review

The maintainer often does not directly see the consequences of their error but the effects of maintenance errors or unsafe acts are significant, affecting on not only economic performance but also more importantly on public safety. As illustrated by these high profile safety critical events, such as The Sultana, on 2000 years, The Erika ship accident and especially common cause. Several studies were conducted in the field. Explained in [1] that The accident causation model describes the causality behind an accident. It is from this model possible to describe performance-shaping factors and it is possible to describe performance both in a sense where it is adequate in the given situation and in a sense where it fails. In the last case the performance can be described using human error taxonomies. Some well-known examples of human error taxonomies are: The Human and Organizational Error Taxonomy (Reason 1997), Slips, lapses, mistakes, and violations (Reason 1990), Errors of omission, errors of commission, extraneous acts (Swain 1982, Swain & Guttman 1983) and Skill, rule, and knowledge based behavior (Rasmussen 1981). These taxonomies are actually in use in the maritime domain as tools in the retrospective analysis of accidents or in proactive human reliability assessments, (one example is Merrick et al. 2000). As illustrated by these examples, it is not just the design of the maintenance and inspection tasks themselves which influence the likelihood of maintenance errors occurring; wider organizational issues can also have an impact on maintenance performance.

1.3 Objectivities

Regarding with any issued, Thus, we aimed at evaluating the significant human risk factors in accident of KM.Gemilang and accumulation data from 2005-2008. years The objective is help better to manage operational maintenance supported by human reliability assessment and maintenance culture based on the condition limited resources. The purpose of the model of the human elements is to introduce method of doing maintenance on equipment through cognitive interpretation so that maintenance culture can be developed on maritime field

2. THE MODEL OF THE HUMAN ELEMENTS FOR ENGINEERING MAINTENANCE

2.1 Total failures from the system or equipment in applied human error

Many of the accidents in the maritime environment was influenced by the systems or equipment's has through accumulation from total failures so that maintenance engineering still needs to be improved. Explained [2] that in technical risk assessments and safety analyses, typical failures of safety critical systems are modeled in the form of representations such as event trees and fault trees. The failure probabilities of various hardware components in the system is combined together using the logic represented by these models to give the probability of the failure. There are a number of systems that could contribute to the mitigation of an accident sequence, the probabilities of failure of each of the individual systems (which have been evaluated using fault tree analysis) are then combined using an event tree. Correlation with maintenance engineering [3] that the approach used to identify applicable and effective preventive maintenance task is one that provides a logical path to address each functional failure of system. The purpose is determined the direction of flow analysis and helps to determine the functional consequences of the failure of system, which may be different for each cause of failure. Further development of the analysis will determine if there is duty applicable and effective maintenance that will preventive or corrective it.

2.2 The modified model for human reliability assessment combined with maintenance culture.

Safety management system can only accomplish so much; however, due to the inherent design of equipment is a significant contributor. Indeed, accepted good practice in the field of safety is that wherever practical, health and safety risks are controlled in the first instance through the design. Dependence on training, procedures and controls another organization should be regarded as a fall back where the control design is not feasible [4].

Selection of safety performance indicators should be soundly based on the model underlying the safety and strength of precursors that lead to failures of attention [12]. For effective development requires a model, because the maintenance activities is needed to identify where to direct limited one single aspect can often be inefficient or even misleading Shown in the figure 1.

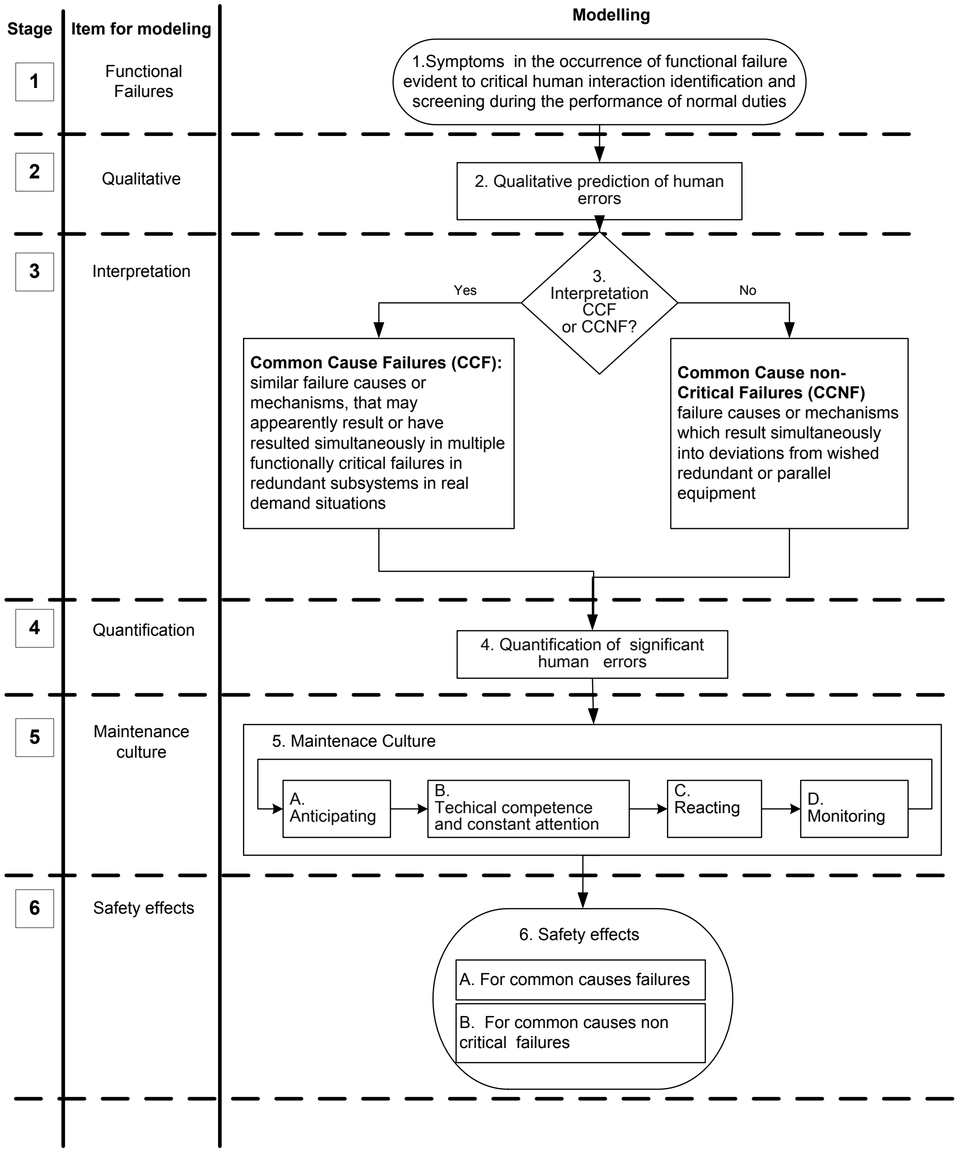

Figure1. Systematic human interaction reliability assessment combined with maintenance culture.

This model comprises six stages:

Table 1. Stage of modeling

Stage	Item for modeling	Description
1	Input as a symptoms of functional failure	This stage involves the symptoms analysis is provided an indication of the main areas at risk from human error so that resources expended on human reliability assessment can be appropriately prioritized.
2	Qualitative analysis of human errors	This stage involves the prediction error that can arise, using models of human error and factors performance analysis, and the nature of human interaction is involved (e.g. consequences of operation, personality, environment, interaction with equipment).
3	Interpretation	This stage involves interpretation about the cognitive function relevant to the identification of system states, or the diagnosis of plant situations [dec2008]. As a Common Cause Failure (CCFs) or Common Cause Non Failure (CCNFs).
4	Quantification	This stage involves a numerical quantification of the probability or frequency with errors (or change of error recovery) that identified in the previous stage (stage 3) in order to obtain the root causes of errors. After this stage , the probability of errors is combined with analysis of hardware to provide the overall measure of risk.
5	Maintenance culture	This stage involves the assessment of maintenance culture, the idea is that if the demands of instrumental (flexibility, methodologies, and learning) are adequately implemented in the organization, to suppose that the maintenance organization able to meet critical demands. Critical maintenance activities in order to anticipate demand based on equipment condition and state of crops and the impact of maintenance actions, and to plan maintenance tasks and resources required in advance.
6	Safety Effects	Common Cause Failures(CCFs) Task is necessary to ensure safe operation for leading multiple errors. Common Cause Non Failures (CCNFs) Task is required to ensure the availability necessary to avoid the safety effects of multiple failures so early warning of causes or mechanisms must be considered or leading to CCFs failures.

3. TASK TYPES ERROR OF EQUIPMENT

Failure is the termination of the ability of an item to perform the required functions and relations of human actions is involved of course can be interpreted as a human un-intended or intended action that produces an unintended result as we known human error [5]. The original cause coding used by the crew on board in the failure and repair work orders in is shown as an example in table 2.

Table 2. 4 M* Relation matrix between the failure and repair work

	A (Man)	B (Machine)	C (Media)	D (Management)
A (Man)	settings of parameter	design of equipment. equipment of standardizations	stress, fatigue,	wrong installation
B (Machine)	operation of machine irrelevant to the task	wrong installation of machine over reliance on the technology by operators	motions, fatigue, temperature	wrong order
C (Media)	loose connections	corrosion	noise vibration	Limit time and value
D (Management)	delayed actions	compatibility operating conditions equipment of standardization	crew responses	not coordination of maintenance management

Remarks; 4 M means Man, Machine, Media and Management

From table 2, in adaptation from source [6] that the failure and maintenance helps to identify candidates of human errors related to maintenance activities from the failure and maintenance history.

To reduce the effects of human error, then one of the functions of cognitive as known representation used to assist in the screening of candidates human error from equipment failure or system in order to establish maintenance culture of interconnected with other in figure 1. There are two steps used to identify the type of maintenance that to apply the taxonomy of error modes from cognitive human function and to distinguish the types of errors on the equipment or system.

3.1 Distinguishing the types of failures on the equipment

A system is often composed of many machines, which interact with one another. Sometimes a system have failed because one of the components which have failed to function. A component can fail due to many factors. Failures of components or system are due to impact and classified into single and multiple failures according to the effect from impact. Usually Any shock which leads to single failure or multiple failure and will be in to perform maintenance culture if the failure of human failure can be distinguished from the component of mechanism as well [8] Shown in table 3.

Table 3. Types of failure on the equipment

Types of failure	Description
Single failure	Failures of components are due to impact [8]
Multiple failure	The simultaneous failure of more than one component [8]
CCFs (Common Cause Failures)	Defined multiple failures that act on parallel or redundant circuit Some error is wrong or omitted is a trigger for human originated common cause failures, if they cannot meet their required function properly [7].
CCNFs (Common Cause Non Critical Failures)	Defined the equipment are not essential to the good function. In general, if the deviation gets worse, these precursors can develop into a common cause of failure [7].

3.2 Applying from the taxonomy of error modes

The classification system used for the analysis of error mode based on Hollnagel's error taxonomy CREAM [9,6]. Ten of the twenty-two modes of Cognitive Reliability and Error Analysis Method (CREAM) is identified in this analysis. Four additional fault modes, such as control failures, miss-calibration, and wrong input also generated a total of thirteen addressed mode error in this study. The taxonomy and definitions of the error mode from human error is used in this study have been modified given in figure 2.

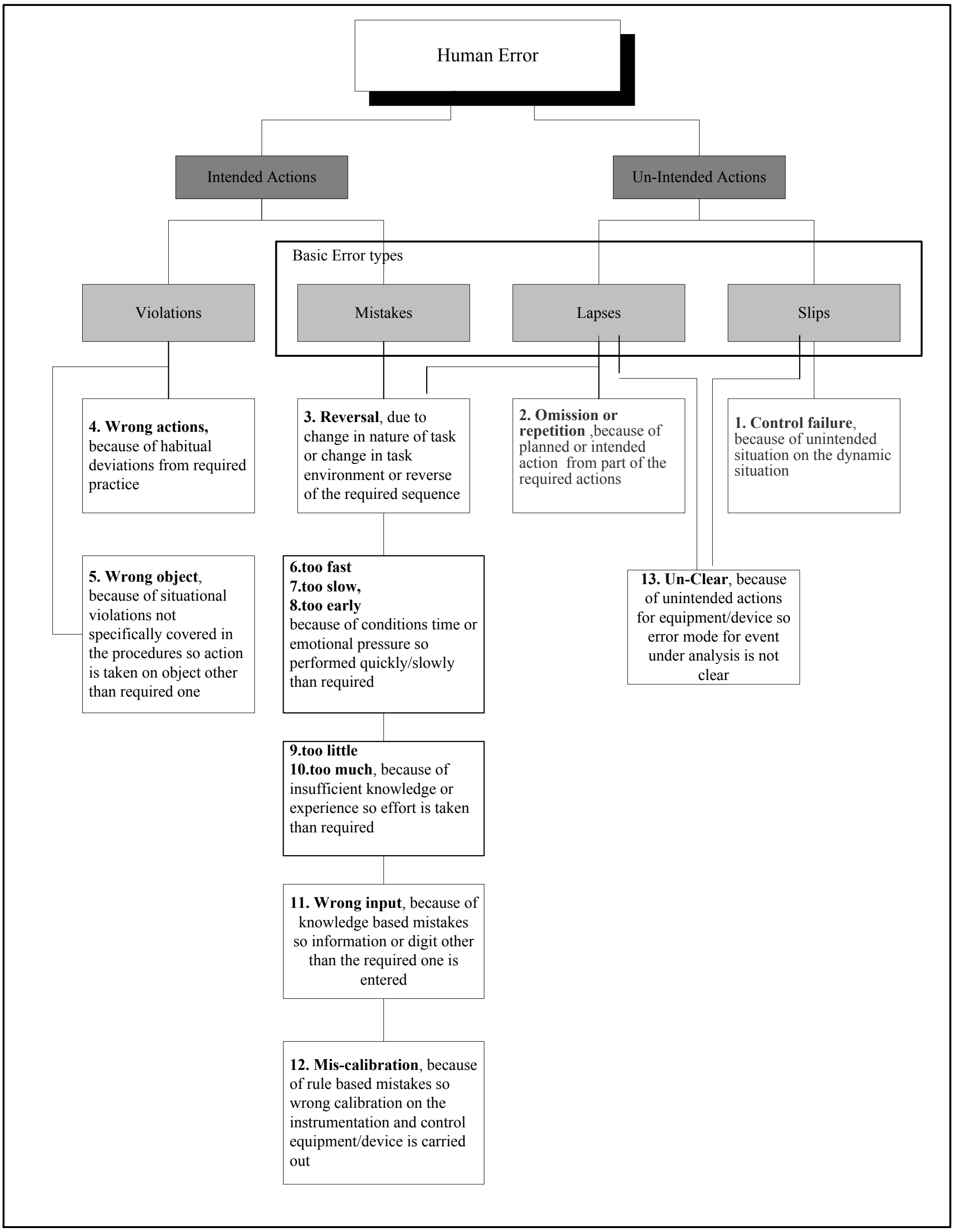

Figure2. The taxonomy of error modes from cognitive function

4. ANALYSIS AND CLASSIFICATION OF HUMAN ERRORS

Task and error type analysis was performed on the incidents reports for the unplanned on board KM. Gemilang trip events during 2006-2008. With the data, calculated reliability system with using are quantitative methods for any components there are in the system. In order to enable a better understanding of the analysis results and the report, important failure and error related terms used in this study are the first defined in figure 1.

In Table 4, an example of an analysis of human error in relation to maintenance [10] is presented. Identify tasks to be wrong as a "trigger failure" and the instant of time is a demanding task for analysis. The wrong task was searched by scrolling through the history of the earlier work of the failed equipment or system. Erroneous identification task required experience and technical knowledge of equipment maintenance and in some cases expert assessments are clearly needed to take the task possibilities, and simply by using from the table 3, to know the correlation between the types of failures on the equipment or system, shown in table 4.

Table4. Correlations between the types of failures on the equipment

Critical events	Root cause	Type of failure				Maintenance
		Single	Multiple	CCF	CCNF	
Engine will not crank with starter motor, or cranks slow	Remote control not in Neutral Position	O			O	Position the remote control exactly neutral
	Blown the ignition fuse or open circuit breaker		O	O	O	Replace the fuse-reset circuit breaker
	Loose and/or dirty wiring connection	O	O	O		Check the battery cables and starter circuit wiring. Clean and tighten all connections. Repair or replace the damaged wiring.
Engine Overheats	Loose or worn drive belt	O			O	Adjust or replace the belts as necessary.
	Collapsed, kinked, or leaking hoses.	O			O	Replace the hoses
	Transmission/engine oil cooler	O			O	Remove the water hoses and flush in opposite direction of the normal flow
	Faulty thermostat	O			O	Replace the thermostat
	Sea-water intake valve partially/ fully closed	O			O	Replace the impeller
	Faulty temperature, sending unit or gauge.	O	O		O	Test and replace as necessary
	Coolant level low in the fresh-water section of the cooling system.	O			O	Check the cooling system for leaks. Refill the system. See warning before removing the fill cap

Transmission slipping erratic operation	Low oil level	O	O		O	Add specified oil. Check the transmission for leaks
	Transmission overfilled causing oil aeration.	O	O		O	Drain required amount of oil
	Transmission shift lever not fully engaged	O	O		O	Adjust the shift linkage and remote control. Check the shift cables for freedom of movement and binding
	Contaminated fluid or foreign object	O	O		O	Determine and correct the contamination source and change the fluid
Fireworks safety	let one of the hydrant fire in a state does not operate	O	O		O	Ready condition through flushing, inspection, lubrication and cleaning

Remarks “O” means “yes” correlation between types of failures on equipment.

Variations of maintenance from Table 4, and applied [5,10] indicate a few things that can be used to establish shaping maintenance culture, among others

Anticipating. All actions appropriate for retaining an item/part/equipment, or restoring it to, a given condition. Incorrect, incomplete or unclear planning of maintenance or operability verification actions such as maintenance, servicing, installation, alignment, corrective, inspection or functional testing phases of work. Deficiencies in definition of decision of work scope, work order, operation order or procedure

Maintenance technical support and operation.. Flexibility is the ability two coordinates for controlling operations of equipment or systems. Methodological is the ability to explain the actions taken and methods used. Learning is the ability to analyze about incidents, accidents and operational experience. Mindfulness in everyday activities because lack of training, specialist or cross-functional knowledge to the tasks or planning.

Responding about sudden and unexpected incidents. Because of the lack of knowledge or poor information on the violation, so specific training on human behavior in emergencies are given deviation violations can be minimized.

Monitoring. Monitoring is to control from condition of equipment and reflecting on the effects of maintenance actions because errors or deficiencies in the design or modification of documentation, equipment, systems, installations or computer programs.

5. APPLICATION

In this section, incidents were presented to illustrate human failure in maintenance accidents an incidents based approach. Investigated by the National Transportation Safety Committee, Indonesia

Within the KM.Gemilang on board case study detailed classification models for human errors in relation to maintenance was enhanced to individualize better the quality errors related to maintenance. The use error classification in table 2, describes how the direct effects of human error in relation to maintenance appear on the equipment level.

Table 6. The relations between the mode analyses with a critical error events and error mode

Critical events	Root cause ***	Error mode*													Sum	Ratio %
		1	2	3	4	5	6	7	8	9	10	11	12	13		
A Engine will not crank with starter motor, or cranks slow	A1	0	1	0	1	0	1	1	1	1	1	1	0	0	8	13.4
	A2	1	1	1	1	1	0	0	0	0	0	0	0	0	5	8.3
	A3	0	1	1	1	1	1	0	1	0	1	0	0	0	7	11.7
B Engine over heats	B1	0	1	0	1	0	0	0	0	0	0	0	0	0	2	3.3
	B2	0	1	0	1	0	0	0	0	0	0	0	0	0	2	3.3
	B3	1	1	0	1	0	0	0	0	0	1	0	0	0	4	6.7
	B4	0	1	0	0	0	1	0	0	0	0	0	1	0	3	5
	B5	1	1	0	0	0	1	0	1	0	1	0	0	0	5	8.3
	B6	0	1	0	0	0	0	0	0	0	0	0	1	0	2	3.3
	B7	0	1	0	1	0	1	0	1	0	0	0	0	0	4	6.7
C Transmissi on slipping erratic operation	C1	1	1	0	1	0	0	0	1	0	0	0	0	0	4	6.7
	C2	1	1	0	0	0	0	1	0	1	0	0	0	0	4	6.7
	C3	1	1	0	1	0	1	0	0	1	1	0	0	0	6	10
	C4	0	0	1	1	0	0	0	0	0	0	0	0	0	2	3.3
D Fireworks safety	D1	0	0	0	1	0	0	0	1	0	0	0	0	0	2	3.3
Remarks	Total	6	13	3	11	2	6	2	6	3	5	1	2	0	60	100

A1=Remote control not in neutral position
A2= Blowing the ignition fuse or open circuit breaker
A3=Loose and /or dirty wiring connection
B1=Loose or worn drive belt;
B2=collapsed kinked or leaking hoses
B3=Transmission/engine oil cooler
B4=Faulty thermostat
B5=Sea water intake valve partially/fully closed;
B6= Faulty temperature sending unit or gauge
B7= Coolant level low in the fresh water section of the cooling system
C1=Low oil level
C2=Transmission overfilled causing oil aeration
C3=Transmission shift level not fully engaged
C4=contaminated fluid or foreign object
D1= let one the hydrant fire in a state does not operate

Error mode*
1 =control failure 2= wrong action 3=wrong object 4=omission; 5=reversal
6=too early 7=too much 8=too little 9=too fast;
10=too slow 11=wrong input 12=miss-calibration 13=unclear.

The results from Table 6, indicated by the relations between the mode analyses with a critical error events are dominated by the critical condition of the engine overheats with the total of 36.6.%. While the error value analysis mode is dominated by the root cause of the condition of the remote control not in a neutral position, with the total of 13.4%, and the condition of loose or dirty wiring connection with the total of 11.7%.

The reason why the wrong action mode takes up a large portion of the total error modes every root cause is that the wrong action the condition from engine during operation on board and response to a transient contributes to burst on board

The results from figure 2 and table 6, indicated by the correlation between human error mode from cognitive function with critical failure, are mistakes dominated with the total 23 %, lapses, slips with the total 19 %, and violations with the percentages are 16%.

6. CONSIDERATION

(1) The system is influenced by mistake. According to the review of most of the analysis of a single error in accumulation data from 2005-2008 years given result that engine over heat as a critical events more involved in human error led to failure than any other critical events.

(2) Review the results of the root causes of human events common cause failure analysis shows also that the planning phase of maintenance work and operability verification measures is a very demanding task because of complex environmental planning different goals, safety requirements and instructions, and technical needs of multifunctional plants, maintenance and operation knowledge.

(3) Involvement dominate in single failure have to depend on error area engine will not crank. The dominance comes from the high number of maintenance objects. However, these results emphasize the responsibilities and requirements of both flexibility and specialization of the maintenance, design and planning of the operation, and the need for instrument mechanics skills and knowledge of instrumentation and automation and functional effects.

(4) The number of significant contributing cause "lack of knowledge" shows the need for specialist understanding and experience of a particular component on utility and crew, supervision and perform specific maintenance activities.

7. CONCLUSION

(1) Systems or equipment have critical events caused by human error are generally influenced by mistake. Shown from figure 2, according to the review of most of the analysis of a single error in given result that engine over heat as a critical events more involved in human error from intended actions and unintended actions to failure than any other critical events.

(2). Involvement dominates in single failure.

Single failure could be considered a starting point for maintenance culture, thus reducing the impact of latent failure that often used as the issue for cause of the accident under investigations that planning maintenance can be done in an integrated problem between knowledge of maintenance, design and skill instruments from technician.

(3) Variations of maintenance

Variations of maintenance from critical events is very demanding task because of complex environmental planning different goals, safety requirements and instructions, and technical needs of multifunctional plans, maintenance and operation knowledge.

(4) Quality of maintenance planning and verification of operation

Overview of the second set was analyzed single and multiple errors at both locations showed that most errors in relation to the maintenance comes from the use of machines. That are not less in accordance with the standards prescribed, although initially only a factor of common non-critical failure but the period of maintenance and less attention so that their use leads to multiple failure.

(5) Critical demands

From maintenance and instrumental demands needed to respond to critical demands drafted by the core analysis of maintenance tasks. This model describes the maintenance of a balance between three critical demands to anticipate, react and monitoring and reflecting as well as between the demands of equipment.

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Initial Assessment of Phytoplankton and Zooplankton Composition in Ballast Water Tanks of an Inter-Island Passenger-Cargo Vessel in the Philippines

Brian Gil S. Sarinas
Faculty, John B. Lacson Foundation Maritime University
bg_sarinas@yahoo.com

Lorna D. Gellada
Administrator, John B. Lacson Foundation Maritime University
lorna.gellada@jblfmu.edu.ph

Alfonso G. Garingalao
Faculty, John B. Lacson Foundation Maritime University

Lovell O. Baria
Faculty, John B. Lacson Foundation Maritime University
aquamarine_273@yahoo.com

Danny B. Tirazona
Faculty, John B. Lacson Foundation Maritime University

Lynbelle Rose D. Sorio
Senior Technical Assistant, Southeast Asian Fisheries Development Center
lynbellerosesorio@yahoo.com

Abstract: Numerous studies have been conducted on ballast water species composition and diversity in other countries but not in the Philippines. Thus, this study aimed to provide baseline information on the species composition of ballast water in the inter-island passenger-cargo vessel in the Philippines. Specifically, this study aimed to determine the presence of phytoplankton and zooplankton composition in ballast water tanks water in the inter-island passenger-cargo vessel and determine the species density of the phytoplankton and zooplankton composition measured in cells/ml using the haemacytometer technique. Composite sampling was employed having one liter of ballast water was used per ballast tank. A total of 15 genera of phytoplankton and one genus of zooplankton were observed. Chroococcus sp., Nannochloris sp. and Protococcus sp. had the highest cells/ml while Ankistrodesmus sp., Micromonas sp. and Synedra sp. had the lowest cells/ml. The most common phytoplankton observed in ballast tanks were Nannochloris sp. and Protococcus sp. Neocalanus sp. (copepods) are

almost seen in all ballast tanks. The phytoplankton and zooplankton composition was found to be non-invasive in nature showing their ubiquity in the marine environment. This study provides an initial assessment or preliminary list of phytoplankton and zooplankton composition in the passenger-cargo vessel in the Philippines.
Keywords: phytoplankton, zooplankton, ballast tanks, ballast water, vessel

1. INTRODUCTION

A ship is a huge sea-going vessel [Layton, 2002] with three or more masts, square-rigged on all except for submarines [Bowditch, 2002]. It may either be passenger, oil, bulk or any dry goods. Through its continuous sailing, it requires proper stability, improved trim and maneuverability [Marrero and Rodriguez, 2004]. Thus, in order to achieve this goal, sailors or mariners use water known as ballast water. The process of taking in ballast water in the ship through pumps located in the hull, just below the waterline is called ballasting and this is located in the lower portion of the ship. This is usually done during cargo discharge when the ship is at the port. The common ballasting practice is that, during the voyage of the cargo vessel, the captain exchanges ballast at the open ocean by pumping out the existing ballast water and taking in new or fresh ballast [Deacutis and Ribb, 2002; IUCN, 1994]. The counterpart of ballasting is called deballasting. This refers to the pumping out of existing ballast water usually at the port, when cargo loading is done. Oftentimes, deballasting is done to reduce the weight of the ship, thus, raising the ship especially when entering a shallow channel area in the port [Deacutis and Ribb, 2002].

Ballast water operation is viewed as the most pressing marine environmental issue [IUCN, 1994]. Approximately, 10-12 billion tons of ballast water is transferred across the globe annually [Popa, 2009]. Due to ballasting, deballasting and ballast exchange, as well as hull attachments, marine or aquatic plants; animals, invertebrates and bacteria are transported around the world [Global Ballast Water Management Programme-IMO, 2010] which makes them exotic, alien, invasive, non-native or non-indigenous species [Carlton and Butman, 1995]. These species are considered pests in the marine environment [Global Ballast Water Management Programme-IMO, 2010]. Carlton [2005], states that international shipping industries served as primary vectors of these species accumulating to about 30, 000 species, transported and carried everyday through ballast water. These species when discharged in a new environment can out-compete the normal or indigenous species for food [U. S. EPA, 2005], evolve and develop mechanisms to spread and increase their population tremendously [Deacutis and Ribb, 2002]. Thus, these species can be considered as *r species* because they have high reproductive rates, rapid development, predominantly small body size, large number of offspring and make use of temporary habitats [Smith and Smith, 2004]. These species also disrupt ecological balance and destroy economy [Deacutis and Ribb, 2002; Global Ballast Water Management Programme-IMO, 2010]. The worst is, they can cause illness and death to humans [Global Ballast Water Management Programme-IMO, 2010], invade the native communities, and may harm the economy [Olenina *et al.,* 2010].

Meanwhile, Popa [2009] said that majority of the marine species found in ballast water can not survive the long journey thus difficult for their survival in ballast tanks while those that can adapt in the voyage inside the ballast tanks have a very small chance in surviving due to predation and competition.

The Global Ballast Water Management Programme-IMO [2010] listed ten unwanted species in ballast water. These are bacterium cholera (*Vibrio cholerae*), cladoceran water flea (*Cercopagis pengoi*), mitten crab (*Eiocheir sinensis*), various species of toxic algae, round goby (*Neogobius melanostomus*), North American comb jelly (*Mnemiopsis leidyi*), North Pacific sea star (*Asterias amurensis*), zebra mussel (*Dreissena polymorpha*), Asian kelp (*Undaria pinnatifida*) and the European green crab (*Carcinus maenus*). On the other hand, the Prince William Sound Regional Citizens' Advisory Council [2007] identified fifteen non-indigenous species (NIS) which are transported by ballast water of tanker oil, on the hulls of the vessels and in the sediment taken in the ballast tanks during the process of ballasting. These are boring sponge (*Cliona thosina*), rockweed (*Fucus cottoni*), dead man's fingers (*Codium fragile*), single horn bryozoan (*Schizoporella unicornis*), Pacific oyster (*Crassostrea gigas*), tunicate (*Botrylloides violaceus*), giant sea kelp (*Macrocystis integrifolia*), foraminiferan (*Trochammina hadai*), softshell clam (*Mya arenaria*), tube dwelling amphipod (*Jassa marmorata*), capitellid worm (*Heteromastus filiformis*), red algae NW Pacific (*Chroodactylon ramosum*) and Atlantic salmon. Olenina *et al.,* [2009] revealed that the dinoflagellates, *Prorocentrum minimum* (Pavillard) Schiller is an invasive species causing significant impact on plankton community, habitat and ecosystem community as a result of assessment period from 1980-2000 in the 11 sub-regions of the Baltic Sea. Other species found in ballast water are mussel (*Mytilopsis sallei*) found in India [Global Ballast Water Management Program, 2010], heterogeneous zooplankton [Murphy, Ritz and Hewitt, 2002; Choi *et al.,* 2005; Gollasch *et al.,* 2000; Selifinova, Shmeleva and Kideys, 2008; Williams *et al.,* 2004; Mingorance *et al.,* 2009; Kasyan, 2010; Chu *et al.,* 2006], phytoplankton species [Martin and LeGresley, 2008; IUCN, 1994; Gollasch *et al.,* 2000] and macroalgae [Flagella, 2007].

1.1 Objectives of the study

This study is conducted to determine the species composition of the inter-island passenger-cargo vessel in the Philippines. Specifically, it will identify the presence of phytoplankton and zooplankton composition in ballast water tanks and determine the species density of the phytoplankton and zooplankton composition measured in cells/ml using the haemacytometer technique. Furthermore, there is no information on the ballast phytoplankton and zooplankton composition in the Philippine setting, hence this study will serve as baseline information.

2. MATERIALS AND PROCEDURE

2.1 Materials

15 L thick plastic container, 5 sterile plastic containers with a volume of 1000 ml, ice bucket filled with ice and binocular compound microscope (Olympus BX51) was used to identify the genera of phytoplankton and zooplankton composition.

2.2 Procedure

2.2.1 Sampling

Sampling was done only once. It was in the mid of December 2010. The researchers asked permission to conduct the study from the Philippine Ports Authority (PPA), operation officer and the deck officers primarily the master and the chief officer of the ship. An inter-island passenger-cargo vessel with the route Manila to Bacolod to Iloilo, Philippines served as source for ballast water samples which refilled its ballast tanks from Cebu port. Five different ballast tanks were chosen alternately (Table 1). A manhole with a removable cover tightened with screw was removed to provide access to each tank for sampling. Composite sampling was used to collect ballast water samples, that is, it was first collected by a 15 L volume of plastic container was stirred, then, after stirring, about 1 L ballast water sample was collected at the surface of the ballast water in the container. After sampling, the ballast water samples were placed inside the ice bucket with ice and transported immediately to the Southeast Asian Fisheries Development Center-Aquaculture Department (SEAFDEC-AQD) - Fish Health Laboratory, Tigbauan, Iloilo, Philippines for the identification and counting of cells/ml (density profile) of phytoplankton and zooplankton composition. The keys used in the identification of genera were Prescott [1944] and Smith and Johnson [1996].

2.2.2 Haemacytometer computation

The analysis of phytoplankton and zooplankton density (cells/ml) was computed using the haemacytometer technique with the formula [Andersen, 2005]:

$$D = X/V \tag{1}$$

where: X = total count/4; V = X/1.0 x 10^4

3. RESULTS

3.1 Phytoplankton and zooplankton composition

A total of 15 genera of phytoplankton and one genus of zooplankton were identified in five ballast tanks. Table 2 shows the phytoplankton genera and these are: *Amphora* Ehrenberg sp., *Ankistrodesmus* Corda sp., *Chlorella* Beijerink sp., *Chroococcus* Nageli sp., *Closterium* Ralfs sp., *Cyclotella* (Kuetzing) Brebisson sp., *Gomphonema* Ehrenberg sp., *Grammatophora* Ehrenberg sp., *Isochrysis* Parke sp., *Loxodes* Ehrenberg sp., *Micromonas* Manton and Parke sp., *Nannochloris* Naumann sp., *Nitzschia* Hassall sp., *Protococcus* Cohn sp., and *Synedra* Ehrenberg sp. Only one genus of zooplankton was recorded which is *Neocalanus* Omura sp., a copepod (Table 2). For ballast tank 1 (fore-peak tank), nine genera of phytoplankton was identified and recorded and these are *Ankistrodesmus* sp., *Chlorella* sp., *Chroococcus* sp., *Cyclotella* sp., *Gomphonema* sp., *Grammatophora* sp., *Nannochloris* sp., *Nitzschia* sp. and *Protococcus* sp. In ballast tanks 2 and 3 (port side tanks), six and five genera were identified and recorded, and these are *Chroococcus* sp., *Closterium* sp., *Nannochloris* sp., *Protococcus* sp., *Synedra* sp. and *Neocalanus* sp. then *Grammatophora* sp., *Loxodes* sp., *Nannochloris* sp., *Protococcus* sp. and *Neocalanus* sp. For ballast tanks 4 and 5 (starboard tanks), four and eight genera were classified and these are: *Nannochloris* sp., *Nitzschia* sp., *Protococcus* sp. and *Neocalanus* sp. then *Amphora* sp., *Chroococcus* sp., *Isochrysis* sp., *Loxodes* sp., *Micromonas* sp., *Nannochloris* sp., *Protococcus* sp. and *Neocalanus* sp. In this study, *Neocalanus* sp. are almost seen in all ballast tanks (Table 2).

3.2 Phytoplankton and zooplankton density using haemacytometer (cells/ml)

In ballast tank 1 (fore-peak tank), a total of 245, 000 cells/ml were found. The genera with the highest cells/ml using haemacytometer are: *Chroococcus* sp. (137, 500), *Nannochloris* sp. (52, 500) and *Chlorella* sp. (17, 500) while in ballast tank 2 (port side tank), a total of 205, 000 cells/ml were found. The genera with the highest cells/ml are: *Nannochloris* sp. (105, 000), *Chroococcus* sp. (72, 500) and *Protococcus* sp. (17, 500). In ballast tank 3 (port side tank), a total of 50, 000 cells/ml were found. The genera with the highest cells/ml are: *Nannochloris* sp. (30, 000), *Neocalanus* sp. (12, 500) and *Grammatophora* sp. (10, 000) while in ballast tank 4 (starboard tank), a total of 85, 000 cells/ml were observed. The genera with the highest cells/ml are: *Protoccoccus* sp. (47, 500), *Nitzschia* sp. (27, 500) and *Nannochloris* sp. (10, 000). Ballast tank 5 (starboard tank) had 165, 000 total cells/ml. The genera with the highest cells/ml are: *Chroococcus* sp. (60, 000), *Nannochloris* sp. (52, 500) and *Amphora* sp. (20, 000) being recorded (Table 2).

Table 1 shows the type of ballast tanks and the corresponding number of ballast samples were taken for each tank.

Table 1. Ballast tank type and their corresponding number of samples.

Tank type	No. of ballast water samples (L)
Fore-peak	1
Port side	2
Starboard	2
Total	5

Table 2 shows the population density (cells/ml) of phytoplankton and zooplankton composition among ballast tanks of the passenger vessels in the Philippines.

Table 2. Plankton profile from five ballast tanks of passenger-cargo vessel in the Philippines using haemacytometer in cells/ml.

	Ballast tanks				
	1	2	3	4	5
A. Phytoplankton					
1. *Amphora* Ehrenberg sp.					20,000
2. *Ankistrodesmus* Corda sp.	2,500				
3. *Chlorella* Beijerink sp.	17,500				
4. *Chroococcus* Nageli sp.	137,500	72,500			60,000
5. *Closterium* Ralfs sp.		7,500			
6. *Cyclotella* (Kuetzing) Brebisson sp.	15,000				
7. *Gomphonema* Ehrenberg sp.	5,000				
8. *Grammatophora* Ehrenberg sp.	2,500		10,000		
9. *Isochrysis* Parke sp.					17,500
10. *Loxodes* Ehrenberg sp.			5,000		2,500
11. *Micromonas* Manton and Parke sp.					2,500
12. *Nannochloris* Naumann sp.	52,500	105,000	30,000	10,000	52,500
13. *Nitzchia* Hassall sp.	7,500			27,500	
14. *Protococcus* Cohn sp.	5,000	17,500	5,000	47,500	10,000
15. *Synedra* Ehrenberg sp.		2,500			
B. Zooplankton					
16. *Neocalanus* Omura sp.		2, 500	12, 500	7, 500	2, 500
Total number of cells/ml	245, 000	205, 000	50, 000	85, 000	165, 000

4. DISCUSSION

4.1 Phytoplankton and zooplankton composition

The phytoplankton and zooplankton genera found in this study can also be found in other studies [Klein *et al.,* 2009; Choi *et al.,* 2005; Kasyan, 2010; Chu *et al.,* 2006]. The following phytoplankton genera could only be found in one of the any ballast tanks (Table 2): *Amphora* sp., *Ankistrodesmus* sp., *Chlorella* sp., *Closterium* sp., *Cyclotella* sp., *Gomphonema* sp., *Isochrysis* sp., *Micromonas* sp. and *Synedra* sp., *Nannochloris* sp. and *Protococcus* sp. occupy all of the tanks as well as the *Neocalanus* sp. except in ballast tank 1 (fore-peak tank) (Table 2) which implies the ubiquity of this copepod in ballast water as supported by the studies of Williams *et al.,* [2004]; Mingorance *et al.,* [2009]; Chu *et al.,* [2006]; Kasyan [2010]; Selifinova *et al.,* [2008]; Murphy *et al.,* [2002]; Choi *et al.,* [2005]; Gollasch *et al.,* [2000]. In the present study, *Cyclotella* sp., *Nitzschia* sp., *Grammatophora* sp. and *Synedra* sp. could also be found in the study of Klein *et al.,* [2009]. *Grammatophora* sp., can also be gleaned in the study of Martin and LeGresley [2008] not in ballast water but in the bay of Fundy, Western isles region. Most of the phytoplankton and zooplankton genera found in the present study could be found in the marine and freshwater environments which speak of their ubiquity in nature [Prescott, 1944; Smith and Johnson, 1996].

4.2 Phytoplankton and zooplankton density using haemacytometer (cells/ml)

Ballast tanks 1 and 2 (fore-peak and port side tanks) had the highest total cells/ml that is, 245, 001 and 205, 002, respectively. The tremendous increase of plankton density maybe attributed to the increase of the cells of *Chroococcus* sp. and *Nannochloris* sp.in these two ballast tanks. These genera might have the capacity to adapt and survive in the ballast tanks' environment. The planktonic composition found in this study can be attributed to seasonal variation [Marshall, Burchardt and Lacouture, 2005], successional patterns [Marshall, Burchardt and Lacouture, 2005; Laamanen, 1997]; nutrient availability such as nitrogen and potassium ratio [Marshall *et al.,* 2005; Laamanen, 1997; Badylak and Philips, 2004]; environmental conditions such as temperature [Laamanen, 1997], salinity and grazing rates [Badylak and Philips, 2004].

5. CONCLUSIONS

In conclusion, this study serves as baseline information on the plankton composition found in ballast tanks of a passenger-cargo vessel in the Philippines and thus found 15 genera of phytoplankton and one genus of zooplankton. Since this study is a preliminary assessment of the planktonic composition of ballast water in the Philippines, it is difficult to conclude that these taxa of phytoplankton and zooplankton are indeed normal or native in the Philippine waters because there was no baseline information. Nevertheless, the plankton composition found in this study is non-invasive based on or supported by other studies and are normal plankton composition in marine and freshwater environments. Thus, it is strongly to recommend that there should be a quarterly sampling of ballast water in the inter-island and foreign-going vessels in the Philippines to determine what planktonic taxa can be considered as native or non-native, invasive or non-invasive.

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Cleaning Equipment for Ships Machine Parts UT-JETWASHER 500

Le Huu Son
Prof. Dr, Ho Chi Minh City University of Transport
lehuuson@hcmutrans.edu.vn

Le Van Vang
Dr Ho Chi Minh City University of Transport
lvvang@hcmutrans.edu.vn

Abstract: Jetwarsher is an equipment used to automatically maintaining and cleanning parts of marine engines. The paper introduces activity principle and function of UT-JETWASHER 500 made by lecturers of Marine Engineering department of Ho Chi Minh city Univercity of Transport, Vietnam.
Keywords: UT-JETWASHER 500

1. INTRODUCTION

The removal of contaminants in the marine machine parts aims to improve the technical status of the details, ensuring equipment working safely and the economically. The cleaning of machine is usually taken placed during maintenance and repair of machinery and equipment.

Not only the elements are assembled into machine in the repair process requires cleaning; but in many cases, the removed one is also needed to be cleaned to avoid polluting the environment.

To design and manufacture the automatical industrial cleaning equipment for marine engine parts is aimed to apply the automatical technical cleaning in industrial maintenance and repairing technology, especially in fields of marine propulsion system.

Automatical Cleaning equipment UT-JETWASHER 500 is designed, and manufactured to satisfy the requirements of cleaning procedures for marine engines.
UT is short for ‘Ho Chi Minh city University of Transport’.
500 is sign for the parts in kilograms can be washed.

2. OPERATION PRINCIPLE AND STRUCTURE OF THE UT-JETWASHER 500

Machine parts are automatically washed by mixture of water and solvent inside the device. Hot cleaning solution of 50 - 800C with pressure of 16 bar is sprayed into the part surface, in addition with the effects of chemical solvents allowing separation and washing of all dirt, grease, soot.

The UT-JETWASHER 500 also allows rinsing with fresh water and blowing hot air to dry parts.

The UT-JETWASHER 500 is suitable for automatic cleaning of equipment, machinery details, details of electric motors, diesel marine engine ...

Device is controlled automatically for setting a washing cycle including process of rinsing with water, soaking in solvent, washing with solvent, and drying with hot air, in an optional appropriate order for different types of part. Solvent and used washing water is reused after being separated from oil and solid contaminants.

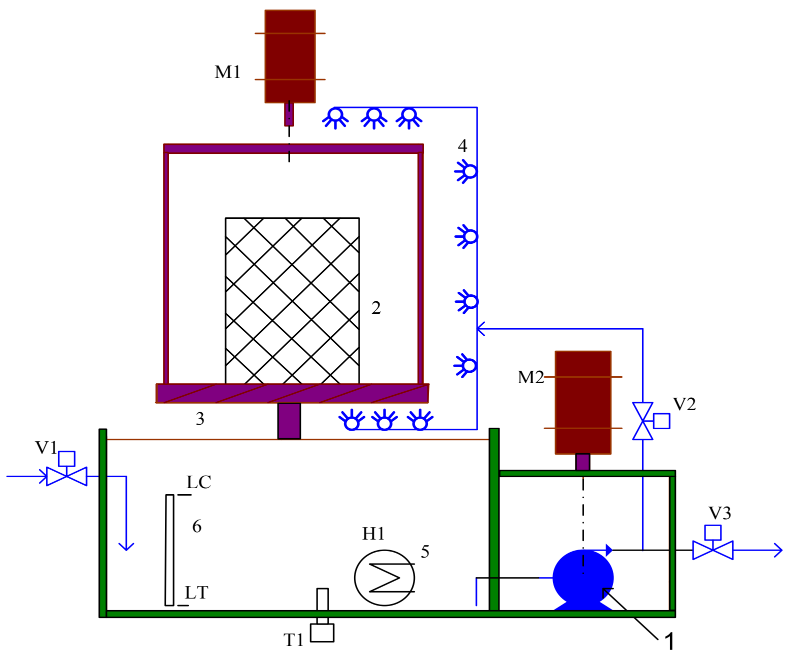


Figure 1. Principle diagram of the UT-JETWASHER 500

1. Feed pump;
2. Washed details;
3. Rotating tray;
4. Nozzles;
5. Heater ,
6. Level sensor equipment;

M1. Motor driving tray;
M2. Motor driving feed pump;
V1. Feed water valve (to tank);
V2. Feed solution valve (to nozzles);
V3. Drain valve;
T1. Temperature sensor;
H1. Heating resistance coil.

The washing equipment for machinery parts includes the main components as follows:

- Motor driving pump: AC motor type, 1 phase.
- Pressure pump: centrifugal pump type, made by stainless steel material, and able to create high pressure.
- Tanks, pipe lines, and filters forms a solution feed system with high pressure, and continuously in washing procedure.
- Solenoid valves are used to automatically drain off the solution, and feed fresh water into system.
- Main switch board: supply power for all necessary operation of automatic washing equipment.
- Motor driving tray, gear box, driving parts, and rotating tray form a system rotating the parts to be washed. Nozzles are used to jet the solution to the surfaces of parts in any different angles. Motor is AC type, 1 phase. The rotating tray is made by steel.
- Nozzles: include the jetting tips installed inside washing tank. They will create water flush jetting to the washed parts under different angles. The tips are simple in structure with descending cross sections, and cause the kinetic energy of liquid flowing out nozzles. Moreover, the nozzle tips can be changed according to the characteristic of washed parts.
- Washing chamber: made by stainless steel, and closed to prevent solution leaked outside. Door closes interlock forward.
- Heating coil: non-reactive type, includes resistance, insulating substance, and non-corrosive protected cover.
- Tank level sensor.
- Automatic control system: central LPC unit controls the modes of washing equipment automatically. Operating parameters can be monitored and adjusted from the display.
- Moreover, the automatic washing equipment also includes other elements such as valve, drain pipes, brackets …

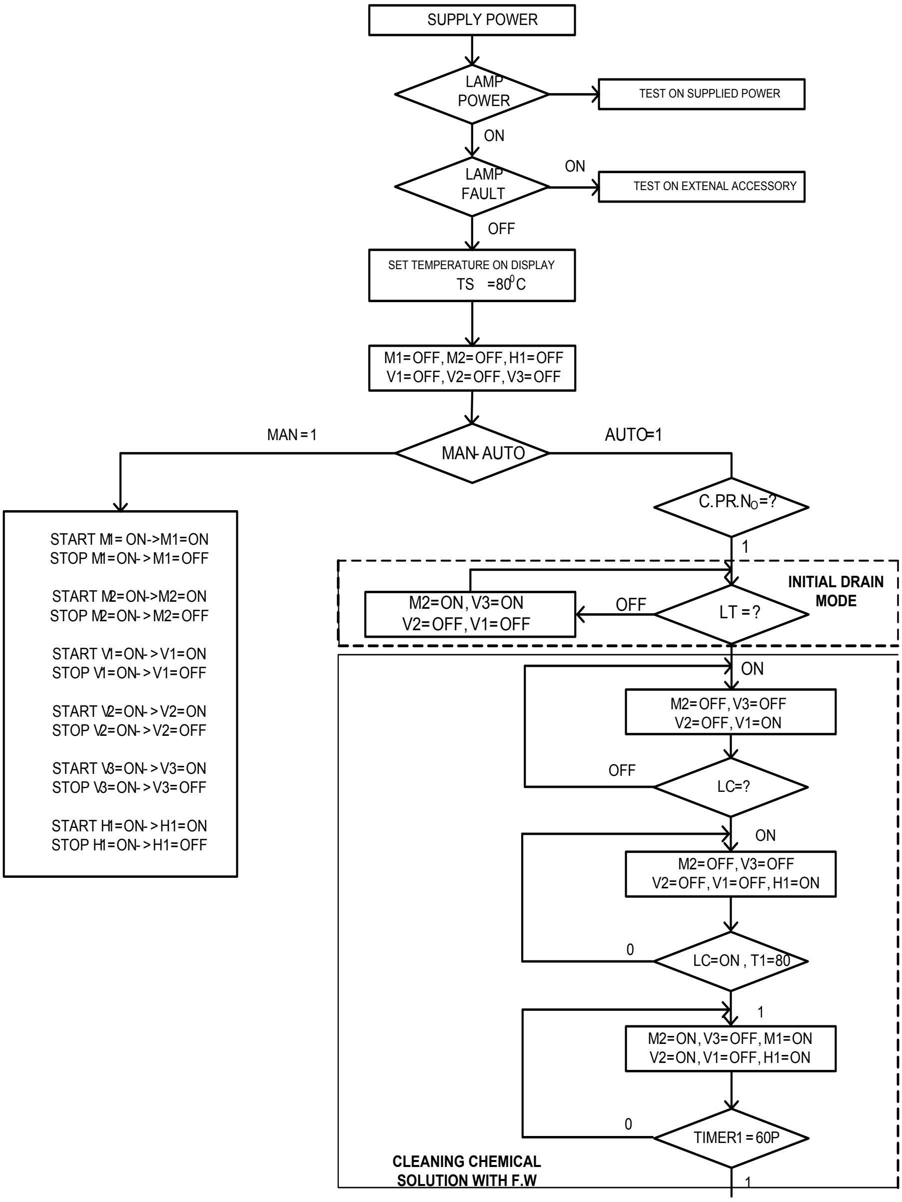
An operation cycle of washing equipment will contain basic stages as follows:

- Flushing: spraying hot water to the surface of parts. It enables to select temperature, pressure, spraying and break time, and number of iteration.
- Soaking: spraying solution to the surface of parts, and then soaking. It enables to select temperature, pressure, spraying and soaking time, and number of iteration.
- Washing with solution: spraying hot solution to the surface of parts. It enables to select temperature, pressure, spraying and break time, and number of iteration.

3. PROGRAM AUTOMATICALLY CONTROLS THE PROCESS OF THE UT-JETWASHER 500

The program automatically controls operation of the UT-JETWASHER 500 includes processes such as cleaning, soaking, washing and drying. Depending on the actual needs of washing and detailing methods for cleaning details that can make the machine work for the regime include:

1. Washed with chemicals.
2. Rinse with clean water and chemicals.
3. Rinse with clean water.



SUPPLY POWER
LAMP POWER
TEST ON SUPPLIED POWER
ON
LAMP FAULT
ON
TEST ON EXTENAL ACCESSORY
OFF
SET TEMPERATURE ON DISPLAY
TS =80⁰C
M1=OFF, M2=OFF, H1=OFF
V1=OFF, V2=OFF, V3=OFF
MAN=1
MAN-AUTO
AUTO=1
C.PR.NO=?
1
INITIAL DRAIN MODE
M2=ON, V3=ON
V2=OFF, V1=OFF
OFF
LT=?
ON
M2=OFF, V3=OFF
V2=OFF, V1=ON
OFF
LC=?
ON
M2=OFF, V3=OFF
V2=OFF, V1=OFF, H1=ON
0
LC=ON , T1=80
1
M2=ON, V3=OFF, M1=ON
V2=ON, V1=OFF, H1=ON
0
TIMER1=60P
1
CLEANING CHEMICAL SOLUTION WITH F.W
START M1=ON->M1=ON
STOP M1=ON->M1=OFF
START M2=ON->M2=ON
STOP M2=ON->M2=OFF
START V1=ON->V1=ON
STOP V1=ON->V1=OFF
START V2=ON->V2=ON
STOP V2=ON->V2=OFF
START V3=ON->V3=ON
STOP V3=ON->V3=OFF
START H1=ON->H1=ON
STOP H1=ON->H1=OFF

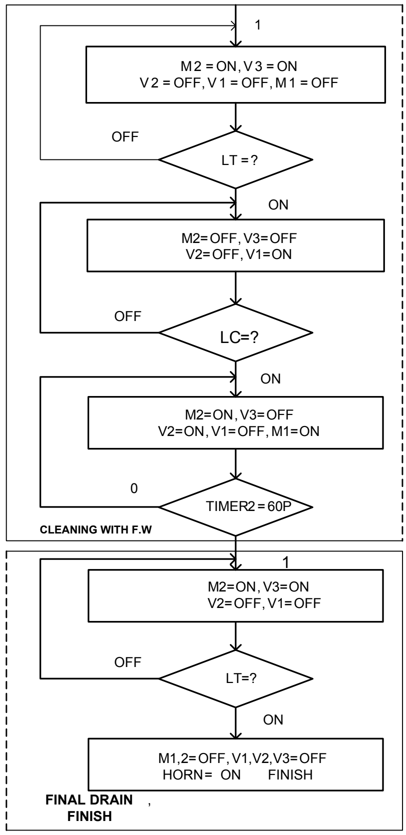


Figure 2. CT1 program automatically controls the cleaning of ship parts of the UT-JETWASHER 500

Center equipment of the process control automation system is Siemens S7200 PLC. PLC programming in STEP7 software on your computer and download MicroWin down to make the process automatic.

In addition to programming, download and upload software program also features online support directly to the PLC to cater to the programming and diagnostics.

In the program I supervise three parameters of temperature, water level in the tank and time to implement automatic control washing process.

The network connection the washer system between S7-200 PLC and monitor TD200 is connected to the PLC to perform the installation parameters and display the operating status of the automatic washing process.

In the program We supervise three parameters of temperature, water level in the tank and time to implement automatic control washing process.

Automatic Control Program for cleaner UT-JETWASHER 500 is programmed in four different control programs, as circumstances require cleaning laundering scheme was chosen accordingly:

CT1: water-supply and discharge of chemicals - fan - turn wheels - cleaning chemicals - use fan-wheels stop turning - and the discharge of chemicals - clean water - back plate - water spray - wheels stop turning - discharge – end.

CT2: water and chemicals - fan - turn wheels - cleaning chemicals - use the function - stopping back-stopped washing tray - finished.

CT3: water and chemicals - back plate - clean-water rinse stops rotating wheels-stop - the end.

CT4: exhaust - water and chemicals - water - back plate - clean - stops rotating wheels - stopping wash - rinse - end.

In addition to change the control program needs by using the PLC programming through the connection to the computer.

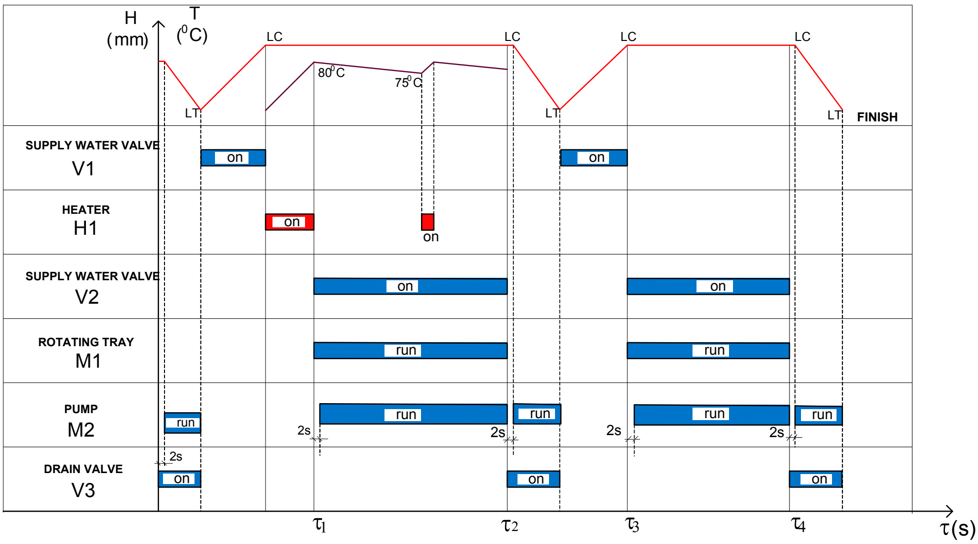


Figure 3. Time diagram of control devices in the control program CT1

Figure 4. UT-JETWASHER 500

4. CONCLUSION

UT-JETWASHER 500 is used to clean industrial equipment, machinery details, especially the details of electric motors, diesel engines of vessels ...

The program automatically clean the ship parts to ensure optimum efficiency of the cleaning process.

Cleaning cycle are combined from the four basic operations, allowing fully automated cleaning equipment, manpower savings, the environment, energy and time.

Automatic equipment cleaning machine parts ship UT-JETWASHER 500 also contributed a small part of environmental protection, so we can collect the dirt, chemicals to bring home to be stored or destroyed , not the status of dirt, chemicals strewn around the environment, such as manual cleaning

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An Assessment of the Current Status of North American Industry's Commitment to Green Shipping

John Tucker
M.Eng., P.Eng.,Faculty, Fisheries and Marine Institute, Memorial University of Newfoundland,
john.tucker@mi.mun.ca

Abstract: The Greenship movement has been underway for several years and is still gaining momentum in Scandinavia, Europe and Asia, yet it is just beginning to take hold in North America. There have been efforts to encourage industry participation in promoting greener shipping which have focused primarily on shipowners, seaways, terminals and ports. To this end, Green Marine Management Corp. was formed to promote and facilitate environmentally friendly shipping activities and policies in Canada and the United States. The objective of this paper is to detail environmentally friendly shipping policies and programs instituted by the Green Marine participants in Canada and the United States.

This paper will first give a short history of Green-Marine, focusing first on its goals and objectives and then on the membership of the program and membership growth. Green Marine uses a series of performance indicators developed from the goals and objectives which are used by the participant companies in a self-evaluation. These self-evaluations with respect to the Green Marine objectives are externally audited on a bi-annual basis. The results of these self-evaluations are compiled and analyzed and each of the 51 industry participants in North America are then interviewed. The interview questions are designed to discern the impact on the respective industries of following the Green Marine philosophy, and to discern what programs are currently in place or planned to be implemented to improve their self-evaluation scores. A synopsis of these interviews is presented.

Keyword: Green Shipping, Industry, North America, Green Marine

1. INTRODUCTION

Green Marine is a joint Canada-United States initiative in which voluntary participants strive to improve their environmental performance beyond the level of minimum regulatory compliance. The overall goal of the initiative is to implement a marine industry environmental program throughout North America.

1.1 Program Background

Green Marine was officially founded in 2008 by the major industry associations in both Canada and the US. Although the program's original focus was on the Great Lakes and St. Lawrence corridor, in the short time span since its inception it has evolved into a bi-national program[1] covering North America in its entirety.

The program started with a minimal staff mandated to coordinate and facilitate environmentally friendly practices in the marine industry. The concept was that Green Marine would be an umbrella organization which would bring together environmentally conscious industry partners so that they could participate in and demonstrate environmentally responsible practices in the marine sector. Green Marine's goals are to:

- Strengthen environmental performance through a process of continuous improvement;
- Build strong relations with marine waterway stakeholders; and
- Heighten understanding of the industry's activities and environmental benefits.

The author has reviewed public self-assessment results from the member participants of Green Marine and also interviewed several members of Green Marine in an effort to gauge their level of commitment and to be able to cite some examples of what these members do to strive beyond the limits of simple regulatory compliance. This paper will present some results of the Green-Marine group and will also present some of the information obtained from the interviews conducted with individual marine industry members. Green Marine was established to focus on six original priorities:

- Aquatic Invasive Species;
- Pollutant Air Emission;
- Green-house Gases;
- Cargo Residues;
- Oily Water; and
- Conflicts of Use in Ports and Terminals

In order for members to be able to demonstrate responsible practices in these priority areas, Green Marine established a set of criteria that could be used to determine a participants level of performance in each of the applicable categories. Performance indicators are reassessed annually to ensure that the latest government regulations are taken into consideration and to also ensure that new technologies can also be incorporated into higher performance levels. The environmental performance level as well as the applicable criteria are given in Table 1.

Table 1. Green Marine Performance Levels and Criteria

Green Marine Environmental Performance Levels	
Level	Criteria
1	Compliance with applicable regulations and adherence to Green Marine guiding principles
2	Systematic use of a specific number of best practices
3	Integration of best practices into an adopted management plan and specific understanding of the issue's impact
4	Introduction of new technologies
5	Excellence and leadership

In 2009 there were 45 industry participants in the program including ship owners and operators, ports, terminal, seaway authorities, stevedores and other enterprises from both Canada and the United States. Participants in Green Marine perform an annual self-assessment, evaluating their respective practices in each of the applicable priority areas using the above criteria. At that time, the average rating was a level two based on the above criteria. The average rating of industry participants hadn't changed from the launch of Green Marine to 2009, but that is attested to an ambitious set of criteria. The average rating did increase from 2.0 to 2.3 in 2010, however. How an industry participant rates based on performance level criteria is measured based on a review of verifiable documentation within the company.

By 2010 all of the Green Marine participants had released individual results of their environmental performance evaluations and the ship-owners had their results verified by an independent auditor. Port and terminal operations were planning to have their evaluations audited externally over the next year. By 2010, the total number of members reached 100, including all participants, partners and supporters.

2. SELF EVALUATION PROCEDURE

There are two sets of self evaluation guidelines being used by Green Marine participants to rate their participation level in the program. The first set of guidelines is specific to ship-owners [2] and describes in detail how a company can address the following priority environmental issues:

- Aquatic Invasive Species (AIS)
- Pollutant Air Emissions: Air Emissions (SOx), Air Emissions (NOx)
- Greenhouse Gases (GHG)
- Cargo Residues (CR) (Ship-owners Operating In The Great Lakes And The St Lawrence Only)
- Oily Waters (OW) (Ship-owners Only)
- Conflicts Of Use (CU) (Ports And Terminals Only)

The second set of guidelines is designed for use by Ports and Terminals [3] and is structured to tangibly and measurably strengthen their environmental performance with respect to the priority environmental issues of:

- Greenhouse Gases (GHG)
- Dry Bulk Handling And Storage (CR) (Dry Bulk Terminals Only)
- Conflicts Of Use (CU) (Ports And Terminals Only)
- Environmental Leadership (EL) (Port Authorities And St. Lawrence Seaway Only)

In both cases the program is structured to permit participants to self-evaluate their environmental performance. The process was structured to be as transparent and motivational as possible:

"Each year, participants evaluate their environmental performance with the help of a self-evaluation guide. During the first year, companies receive a logo indicating that their certification is “in progress.” Starting in their second year, performance results must be verified by an independent third party, and receive a “certified” logo. The results of the environmental performance of all companies involved are published in Green Marine’s annual progress report, enabling the participants to publicize their involvement in the Green Marine initiative."[4]

The evaluation is performed by identifying written documentation that can objectively and verifiably prove the level of performance by each participant for each of the objectives. In this way, the process was initially structured to support an external auditing process to lend additional credence to the process.

It was determined that auditing of the members self-assessment results would occur biannually, and the process was officially started in 2010 with auditing of ship-owners 2009 self-assessment reports taking place. Ship-owner results were verified by an independent assessor from Lloyd's Register Quality Assurance (LRQA). Members of Green Marine who are listed as Ports and Terminals will have their 2010 performance results assessed in 2011. Future audits for all participants will take place every second year.[5]

2.1 Self Evaluation Results

Self evaluations are made public by the Green Marine organization to promote transparency of the assessment procedure as well as to let members gauge how their assessments compare to those of their peers. Recall that each of the groups have a distinct set of evaluation criteria that they gauge themselves against. A good indicator of the success of the overall program is the measure of average levels attained over all of the self-assessment criteria.

The results in Figure 1 below clearly indicate an improvement in the self assessment results from 2008 to 2009. This table shows the average overall score for each of the shipowner and ports and terminal groups as well as a global average score for all groups. A rationalization for this result becomes evident from the interview results presented in section 3. Note that the scores for self assessment are from one as a minimum to a maximum value of five.

Figure 1. Average Levels Attained by All Green Marine Participants for 2008-2009

A strong indicator of how performance of each of the industry groups of Green Marine can also be inferred. Specific results of average levels attained (in each of the assessment categories) by ship-owners from 2008 to 2009 indicate an overall improvement in all self-assessment areas:

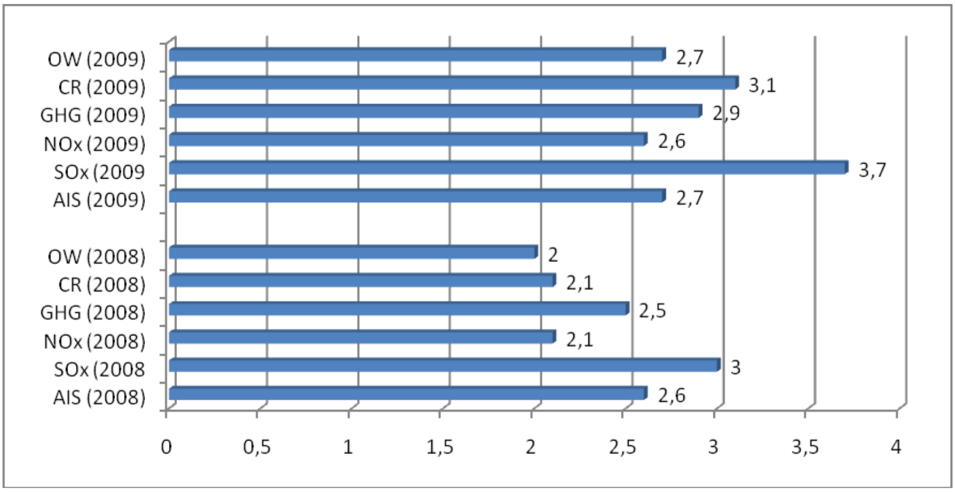

Figure 2. Average Levels Attained by Ship-owners Participating in the Green Marine Environmental Program for 2008-2009

Similar results can be observed for the Ports and Terminal industry participants, where improvements in self-assessment scores were observed in every area that was assessed in each of the two years:

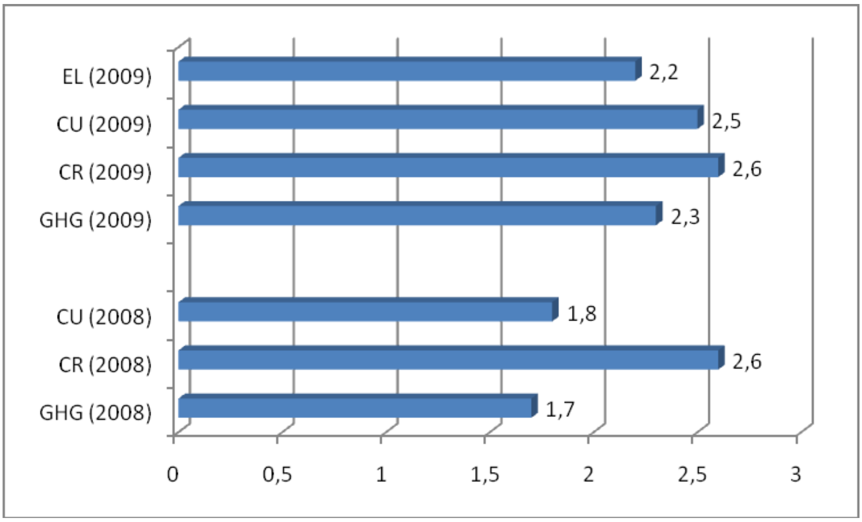

Figure 3. Average Levels Attained by Ports and Terminals Participating in the Green Marine Environmental Program for 2008-2009

Note that Environmental Leadership was only assessed in 2009.

3. DISCUSSIONS WITH INDIVIDUAL PARTICPANTS

Individual participants in Green Marine were contacted to discuss their personal involvement and commitment to the program. As a guideline, the following questions were asked in order:

- When did you enter the Green Marine program?
- Why did your company enter the Green Marine program?
- What is the effect of the Green Marine program on your company?
- Is there a cost associated with participation in the GM program?
- Do you feel motivation to excel in your self evaluation? Why?
- Do you feel a sense of community within the Green Marine organization?

In addition, the participants being interviewed were encouraged to provide any other anecdotal information which might demonstrate their organizations commitment environmentally friendly shipping and the precepts of the Green Marine philosophy.

3.1 Fednav

The first industry participant to be interviewed was Fednav Group. Fednav Limited is a privately owned company and is Canada's largest ocean-going, dry-bulk ship owning and chartering group. [6] The interview was conducted with Mr. Marc Gagnon.

When asked when Fednav entered the Green Marine program, Mr. Gagnon informed the author that they (Fednav) were one of the founding participants of the program, and his manager is the current co-chair of the program. Mr. Gagnon has been with Fednav for 3 years, and prior to that, he was involved in managing Green Marine. In that regard, Mr. Gagnon and Fednav were involved with the initial development of the Green Marine program.

Initially, the Green Marine program was very regional. Mr. Pathy (Fednav's CEO) first met with other CEOs and it was agreed that this kind of effort had to be made. It was collectively agreed that they wanted to show the public, environmental groups and industry that they are committed to working to help the environment.

This also answered the second question as to why their company entered the Green Marine program.

When asked how their efforts in the Green Marine list of priorities now compares to what they were doing prior to joining Green Marine, Mr. Gagnon stated that the Green Marine Program is having a significant influence on how Fednav does its business.

Mr. Gagnon stated that at the end of 2008, they were the first marine entity in Canada to make their environmental policy available online. They now have an environmental policy that is public knowledge. This is not only due to their membership in Green Marine. Green Marine encouraged them to do this work in house, but they were also driven internally to establish these policies. The policy simply stated what Fednav was already doing.

A good example of this is exchanging ballast water everywhere they sail in the world....and they are telling everyone that they are doing that. The policy states the actions they are already doing. Mr. Gagnon stated that if they commit to new actions then they will establish new standards to which they will hold themselves.[6]

As to the effect of Green Marine on their company, Fednav believes that there is a very good relationship between participants and the Green Marine organization. He stated that they meet often and that the companies have the technical knowledge which they feed into Green Marine, and Green Marine is a mechanism for sharing this knowledge with the other participants. The members have a say in how Green Marine operates and Fednav believes that this ensures that Green Marine will continue to deal with what they feel are the important issues.

One of the biggest impacts of Green Marine on Fednav is the inventory of exhaust emissions. Prior to Green Marine, there was no inventory taken of exhaust emissions, but now it is taken regularly. This effort is a lot of work for participant members but they now know the volume of greenhouse gasses emitted on every voyage. Mr. Gagnon strongly believes that to control your environmental footprint, you need to know what your emissions are.

As to the costs of participation, Mr. Gagnon has observed two direct monetary costs. The first is the cost of participation, which now includes an audit cost, and the second is the cost of hiring staff and dedicating existing staff to maintaining the program. When asked how this compared to the benefits of the program, Mr. Gagnon simply stated that environmental impact is very much more important than the monetary cost.

When asked if Fednav feels motivation to excel in their self evaluation, Mr. Gagnon stated that there is no ego in a company, but there is satisfaction in what they do to protect the environment and they wish to maintain their reputation in this regard. Fednav wants to be the best and most environmentally responsible marine company, so they are driven to excel.

Mr. Gagnon is a believer in self regulation. He feels that when the industry is doing this themselves, the motivation is far stronger than if the regulation were externally imposed.

Mr. Gagnon stated:

"We are doing this because we feel it is the right thing to do...so the will to do it is strong."

When asked if Fednav feels a sense of community within the Green Marine organization, Mr. Gagnon said that this is a difficult question to answer on behalf of the company. Personally, Mr. Gagnon feel that the sense of community among participating executives is very strong. He stated that he has made contacts and even friends that meet regularly and it is extraordinary to see the (unexpected) strong feeling in other organizations that this (the Green Marine program) is the right thing to do.

3.2 Montreal Gateway Terminal Partnership

Mr. Wayne Smith of Montreal Gateway Terminal (MGT) Partnership was also contacted by the author and interviewed. As a prelude to the questions, Mr. Smith cited the fact that as of July 20, 2009, MGT was Certified ISO14001 (certification number EMS538384). To the present day MGT has gone through internal audits for maintenance by BSI as the companies certification body.

The first discussions and interest shown by Montreal Gateway Terminals Partnership in the Green Marine program was on October 9th, 2007 when they were introduced to the Environmental Policy of Green Marine. At that time they were in the starting phase of ISO14001 Certification so working with the voluntary initiative of Green Marine was subsequently a good working tool for their future ISO certification with BSI.

As to why their company entered the Green Marine program, Mr. Smith stated that a very positive exchange of information applicable to Green Marine had taken place in the months between October of 2007 and January of 2008 when they received access to use the Green Marine logo as a participant. They used this logo (non-certified logo) in most of their environmental communiqués. It was on January 8th, 2008 when they received the Green Marine logo instructions. In January of 2008, MGT opened their Green Marine account for all related costs and expenses. This was a true sign of their commitment to Green Marine.

When asked how their efforts in the Green Marine list of priorities has changed since joining the program, Mr. Smith stated that MGT was already in the process of the aspect stages of ISO14001, so the transition was quite transparent although the requirements in Green Marine further enhanced an already densely populated list of aspects and impacts.

Mr. Smith stated that MGT's belief in the Green Marine initiative was so strong that they made it a part of the objectives for ISO14001 which in turn meant being audited by an external body (BSI) that had to review their commitment and accomplishments to Green Marine.

As to the effect of the Green Marine program on their company, Mr. Smith stated that Green Marine associates MGT with commercially viable companies willing to share procedures and policies in place that might create a better working environment (Environmental Sustainability) which bodes well with the Board, stakeholders and neighbours also associated with Green Marine.

When asked to comment on the cost compared to the benefit of participation, Mr. Smith stated that he had used the words in the previous response; Environmental Sustainability, which if used as a stand alone sentence says it all.

When asked about MGTs motivation to excel in their self-evaluation, Mr. Smith stated that he believes the record and participation on the part of MGT speaks for itself. He stated that they are always looking for ways to assist when it comes to technical committee meetings. In addition, the sharing process works two ways, so all parties benefit.

4. CONCLUSIONS

The Green Marine program is a powerful and worthwhile effort in North America which is spearheading the promotion of environmentally friendly shipping practices. Members provide full disclosure as to their environmentally friendly practices and policies and are encouraged to excel in those practices by virtue of their disclosure.

In addition, Green Marine is an opportunity for industry to share what they are doing to make their marine enterprises more environmentally friendly as well as the technology that may be applicable to other partners in the Green Marine organization.

Furthermore, Green Marine is fostering a culture among marine industries which is supportive and collectively caring for the environment and each other.

Discussions with participants in the Green Marine program as well as discussions with the executive director of the program, David Bolduc, have clearly demonstrated the strength of commitment of the administrators as well as the participant members of Green Marine. All participants consulted spoke of the strength of their commitment and their willingness to commit to the Green Marine program. Participants are proud of their efforts and are glad to have a forum to demonstrate what they are doing to be environmentally responsible, and they are prepared to help others in the group by sharing their protocols and technologies in an open way. Their commitment is further demonstrated by their willingness to be audited by an external auditing agency and to have the results of their self assessments made public.

Green Marine is an effort to step beyond government regulation and permit the industry to establish even more demanding self-regulation standards. These standards are established because they are the right thing to do, and this is the right time to do it. The membership of Green Marine has swelled to over 100 shipping companies and ports and terminal agencies as well as other types of organizations including suppliers, shippers, government agencies, environmental groups, municipalities, and others.. David Bolduc has stated that many of the new entrants into the program have policies and standards in place which already exceed minimal requirements for entry, as these organizations participate in the self-evaluation and audit process, it will be interesting to see how standards and self regulation are influenced. At the top of their website the banner says it all...Green Marine is a Wave Worth Riding.

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Pollution Generated by Ships – an Issue That Should be Kept Under Control

Anastasia Varsami
Assistant Professor, Constanta Maritime University
anastasia.varsami@yahoo.com

Corina Popescu
Assistant Professor, Constanta Maritime University
corypopescu25@yahoo.com

Eugen Barsan
Professor, Constanta Maritime University
ebirsan@inbox.com

Radu Hanzu-Pazara
Lecturer, Constanta Maritime University
raduhanzu@yahoo.com

Abstract: Ships pollute the world's oceans in different ways. Oil spills coming from merchant ships can have devastating effects to the marine environment. It is well known that the components in crude oil are very difficult to clean up, and last for years in the sediment and marine environment. Also, accidental or intentional discharge of cargo residues from bulk carriers can pollute the world's oceans. In many of the cases of water pollution, vessels intentionally discharge illegal wastes despite foreign and domestic regulations that prohibit these particular actions. Another kind of pollution coming from merchant ships that also should be taken into consideration is represented by the noise pollution that disturbs natural wildlife, and water from ballast tanks which can spread harmful algae and other invasive species.

Ships' pollution has become a problem ever since shipping trade has become increasingly global, posing an increasing threat to the world's oceans and waterways as globalization continues. Due to a high rate of commercial traffic in ocean ports, pollution from ships also directly affects coastal areas.

In this paper we are trying to point out several important issues related to pollution as a result of ships' operations but also to give several solutions for reducing the amount of pollution coming from vessels.

Keywords: ship, pollution, solution, oil spill, ballast water, ocean

1. INTRODUCTION

Ships' pollution is represented by the pollution of air and water by shipping. Due to shipping globalization, it is expected a great amount of pollution generated by this industry. It is also expected that shipping traffic to and from USA will double by 2020. Because of increased traffic in ocean ports, pollution from ships also affects directly the coastal areas. The pollution produced affects the biodiversity, the climate, the food, and human health. However, the degree to which shipping is polluting and how it affects the world is highly debated and has been a hot international topic for the past 30 years.

Spills from oil tankers and chemical tankers, and ejection of sulphur dioxide, nitrogen dioxide and carbon dioxide gases into the atmosphere from exhaust fumes have a great impact on environment worldwide. Discharge of cargo residues from bulk carriers can pollute ports, waterways and oceans. Ships create noise pollution that disturbs natural wildlife, and water from ballast tanks can spread harmful algae and other invasive species. In many instances vessels due to a variety of reasons intentionally discharge illegal wastes despite foreign and domestic regulations prohibiting such actions.

2. SOURCES OF POLLUTION FROM SHIPS

2.1 Ballast Water

When a large container ship or a tanker unloads cargo, seawater is pumped into compartments in the hull. Similarly, when a larger vessel is being loaded it discharges seawater from these compartments. The sea water is meant to help stabilize and balance a ship. Ballast discharges from ships are responsible for tar balls in the open oceans and seas, and can cause problems for navigating tanker routes. Nevertheless, the discharge of ballast water only accounts for a small percentage of oil pollution in the marine environment.

Ships are also responsible for transporting harmful organisms in their ballast water. This is one of the worst cases of a single invasive species causing harm to an ecosystem.

In addition to introducing non native species into new environments, ballast and bilge discharges from ships can spread human pathogens and other harmful diseases and toxins potentially causing health issues for humans and marine life alike. Discharges into coastal waters along with other sources of marine pollution have the potential to be toxic to marine plants, animals, and micro-organisms causing alterations such as changes in growth, disruption of hormone cycles, birth defects, suppression of the immune system, and disorders resulting in cancer, tumours, and genetic abnormalities or even death. They may also have the opposite affect upon some marine life stimulating growth and providing a source of food. Sources of seafood can become contaminated and unhealthy for consumption. As the demand for waterborne transport increases in the future, the potential for loss of critical or valuable regional species will increase as well.

2.2 Exhaust Emissions

Exhaust emissions from ships are considered to be a significant source of air pollution, with 18-30% of all nitrogen oxide and 9% of sulphur oxide pollution. The 15 biggest ships emit about as much sulphur oxide pollution as all cars combined. By 2010, up to 40% of air pollution over land came from ships. Sulphur in the air creates acid rain which damages crops and buildings. When inhaled the sulphur is known to cause respiratory problems and even increases the risk of a heart attack. The fuel used in oil tankers and container ships is high in sulphur and cheaper to buy compared to the fuel used for domestic land use. A ship lets out around 50 times more sulphur than a lorry per metric tone of cargo carried. Increasing trade between the U.S. and China is helping to increase the number of vessels navigating in the Pacific and exacerbating many of the environmental problems. The number of voyages is expected to continue increasing. 3.5% to 4% of all climate change emissions are caused by shipping.

2.3 Oil Spills

Most commonly associated with ship pollution are oil spills. While less frequent than the pollution that occurs from daily operations, oil spills have devastating effects. While being toxic to marine life, polycyclic aromatic hydrocarbons (PAHs), the components in crude oil, are very difficult to clean up, and last for years in the sediment and marine environment.

Marine species constantly exposed to PAHs can exhibit developmental problems, susceptibility to disease, and abnormal reproductive cycles. One of the more widely known spills was the Exxon Valdez incident in Alaska. The ship ran aground and dumped a massive amount of oil into the ocean in March 1989. Despite efforts of scientists, managers, and volunteers over 400,000 seabirds, about 1,000 sea otters, and immense numbers of fish were killed.

2.4 Aiding Cloud Formation

For most of the rest of the northern hemisphere oceans, ship emissions are responsible for greater than 30% of the predicted SO2. And in the southern hemisphere, ship contributions are generally less than 5%, except over large areas north and east of Australia where they contribute between 10 and 20%. The researchers say that comparison of their modelling results with actual SO2 observations strengthens their conclusion. Emissions from shipping can also have a marked effect on land, particularly in the form of acid rain. This is no surprise, as nearly 70% of ocean-going ship emissions occur within 400 km of land.

An important effect of ships' sulphur is the increase in the available nuclei upon which cloud drops form. The researchers say the change in global atmospheric heat balance caused by the clouds which result from shipping emissions is appreciable. They put it at 14% of the estimated change caused by all sulphate from human activities. Sulphur emissions have a large role in the formation of aerosols, or tiny particles, on which water condenses to form clouds. The interactions of aerosols and clouds have been identified as one of the most important uncertainties in understanding the rate of climate change. This is because clouds reflect energy and thereby reduce the net warming effect of long-lived greenhouse gases.

Aerosols survive in the atmosphere for about a week, compared with decades and centuries for greenhouse gases. The researchers think their work on the contribution of shipping emissions may shed light on how aerosols behave.

2.5 Dredging for Vessel Access

There is an additional environmental problem that might be considered an infrastructure issue, but it is linked directly to the superstructure requirements of the waterborne mode. For vessel access to the port or terminal facilities a depth of water in excess of the draught of the vessel is required. In all ports but those benefiting by naturally deep access, or where currents continually scour the bottom preventing the build-up of sediment, the dredging of the access, usually on a recurring basis, is necessary. This process significantly alters the natural balance of the marine ecosystem over the length of channel or berth that must be maintained in this way. As deeper draught vessels are developed as a response to carry greater quantities of freight, and as the need is felt to allow such vessels to sail further up shallow estuaries or rivers, the issue of dredging takes on an increased importance and there are other aspects of dredging that are cause for concern. The sediments that are deposited along the bottom of rivers that flow through industrialized regions have through the years been contaminated with toxic residue-most notably heavy metals. These residues in the past have been responsible for the contamination of the waterways has been curtailed by the elimination or control of point source discharges from industries that produce such harmful by-products. Over time the natural sedimentation process at work in many waterways has buried these toxic materials at sufficient depths to shield the bottom dwelling marine life from the toxic effects, allowing a natural recovery. To now dredge up these areas exposes the marine life in the area again to the same habitat destroying toxins. Even though the sediment may be removed from the bottom of the waterway, the process releases this toxic material to the downstream areas that are not dredged. The environmental problems associated with the dredging process extend beyond the concern for the bottom of the water course. Once this material has been removed, it must be disposed of in an environmentally acceptable manner. This material is normally used for landfill applications ashore. However, when this material is contaminated with toxins and heavy metals, the leaching of the materials to ground water sources or inland streams, lakes or reservoirs spreads these persistent forms of contamination to new locations. It is estimated that more than 200 million of tones of dredged material is dumped at sea each year.

2.6 Marine Growth on Vessel Hulls

Related to the problem of toxic materials in bottom sediments is the contribution from the materials applied to the bottom of vessels to retard or prevent the accumulation of marine growth. For maritime transport to be able to move efficiently and avoid the unnecessary burning of fuel, the build-up of marine growth must be avoided. In the past, this problem was intended to be solved by adding to the paints arsenical or mercurial compounds or even pesticides such as DDT. By the 1970s, the industry developed more effective anti-fouling paints using other metallic compounds, in particular the Tributyltin (TBT) considered at that time less harmful than the arsenical and mercurial compounds (the DDT had been banned in many countries by 1973).

While these materials have proven rather effective in providing a clean underwater hull, they have contributed steadily to the accumulation of the toxins from the paint in the surrounding waters where vessels transit, moor and undergo repairs. The toxins from these paints steadily leach into the environment and are deposited whole scale into the surrounding waters when the adhesion of the paint to the hull breaks down or the bottom paint is mechanically removed without the collection of the residue. The result has been a steadily expanding plume in the water around port areas rendering the water and sediments unable to sustain the basic components of marine life that are critical to the marine food chain. Options are needed to reduce the introduction into the water of such toxins. Safe hull cleaning methods are needed as well s the introduction of coming technology to employ coatings that are naturally resistant to selected marine growth without the potential for overall harm to the surrounding marine ecosystem.

2.7 Chemicals in Portable Tanks

Portable tanks that have been designed for maritime transport of hazardous materials present a significant concern. As the industrialization process gathers momentum in the countries now regarded as having developing economies, there will be an increased need for a large variety of Chemicals that pose significant environmental threats when transported by such tanks in concentrated forms. This includes the chemicals needed to support agricultural growth through pesticides, herbicides and fertilizers and the chemicals needed to support manufacturing and fabrication processes. The safe and sensible use of such chemicals is beyond the purview of those who are supplying the means of transport. However, there is an obligation on the part of those supplying the means of transport to see that the transportation process does not stimulate harmful environmental practices. The cleaning of chemical tanks once they are emptied to reduce the hazard they present is a common practice. It is also done to allow the return shipment of a tank at a reduced rate if it does not contain a hazardous material. The prospect exists for tremendous numbers of such tanks to be cleaned in hinterland areas where there exists no means to dispose of highly toxic and polluting residues.

In many parts of the world the common practice is already to dispose of the residues directly onto the ground or into the waterways.

2.8 Reception Facilities for Vessels

The movement of hydrocarbons and chemicals by the waterborne mode poses an inherent risk to the marine environment. This risk arises not just from the potential for a massive accidental discharge, but also from the more routine discharges associated with operational activities. It has been estimated that only one quarter of the oil introduced into the water from ships is the result of accidental discharges. To address the pollution potential from operational discharges an extensive regulatory system has been established. At the heart of the approach has been a prohibition for the discharge of hydrocarbons and chemicals into the water from vessels. They have been required to retain such accumulated wastes aboard until they can be discharged ashore. Vessels that must have the permission of governments to operate have been forced to make the alternations to vessel design and equipment to comply with such regulations. However, these same governments that should provide facilities ashore for the reception of these accumulated materials have failed to make such facilities available in many port areas. Part of the reason for this is the failure of some governments to back voiced environmental concern with budget actions to support the key element of the environmental protection system they have established for vessel operators. Other approaches have been to provide facilities only in the port areas that receive large enough volumes of vessel traffic to justify the investment in reception facilities. The result has been that a global mechanism to preserve the marine environment has actually worked to the environment's disadvantage. Hazardous residues that previously were discharged in open waters are now retained until the more environmentally sensitive near-shore waters are reached and, in the absence of adequate reception facilities, are often eventually discharged nearer to shore on the approach to or departure from many of the world's ports. As numbers and size of ships increase to meet future consumer transport demand, this lack of reception facilities becomes a problem of ever increasing proportion. While the increasing traffic levels may mean that more ports will begin to justify the provision of facilities, this approach also ensure that newly developed ports, or small growing ports will not receive the facilities to protect their environment until such time as vessel traffic levels have already increased to the point where they have sustained significant environmental degradation. So far the reception facility issue has only been discussed in terms of residues of hydrocarbons or chemicals. While these substances may represent the issue of greatest current concern, the same reception facility mechanism and problem associated with these materials also applies to shipboard generated garbage and sewage. For all of these materials a different systems approach is needed that will allow the preservation of the existing unpolluted and uncontaminated marine areas as they begin to develop in response to growing global transport needs.

2.9 Containerization of packaged hazardous materials

The growth in the movement of freight within containers has brought with it new environmental concerns. Very concentrated forms of toxins and other hazardous materials can be shipped in small packages and these more and more frequently within containers. Detailed regulations have been developed to try to ensure that such materials are not stowed or stacked next to other materials which could have serious results such as fire, explosion, or the release of poisonous vapours if the different types of materials become mixed. These regulations are very detailed, but also very complicated for untrained personnel to apply. The result has been a steady increase in detection of containers with improper stowage of such hazardous materials, and an increase in the number of hazardous material incidents that are taking place when such materials break free within a container. As the demand for transport of such goods increases, the potential increases for more and worse disasters that can have devastating effects on personnel and the environment. Response to these types of hazardous material incidents is most often by a local fire brigade; and, even in industrialized countries today it is only in the larger fire response organizations where trained expertise is readily available to make a proper and effective response. Where training and equipment is lacking, the normal response of persons trained to fight fires is to hose the scene down with water. While in some situations this may in fact be the best response, in other situations it may in fact be the worst response. Some materials may react with the water resulting in rapid oxidation of the material or the release of poisonous fumes. Perhaps the worst possibility for the environment is the tendency for such spilled materials to be flushed with fire hoses into the nearest ditch, stream or storm drain where, depending on the material, it can destroy any marine life over a large area for years. Persistent materials may infiltrate the human food chain and cause congenital problems that do not become apparent for decades.

2.10 Pollution by Dumping at Sea

On 13 November 1972 it was adopted in London, in the framework of an Inter-Governmental Conference the "Convention on the prevention of marine pollution by dumping of wastes and other matter", generally known as London Convention (LC). The main objective of this convention is to promote the effective control of all sources of pollution of the marine environment by the dumping of waste and other matter. For the purposes of the convention, dumping is defined as the deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms or other man-made structures, as well as the deliberate disposal of vessels or platforms themselves. The Convention has been amended to include the incineration at sea, list of substances concerned to incineration, the ban of dumping into the sea of low level radioactive wastes, the phase out of dumping of industrial wastes and the ban of the incineration at sea of industrial wastes. The main purposes of this convention are to prevent the pollution of the sea by the prohibition of dumping of the following substances and/or wastes: Organohalogen compounds, Mercury and its compounds, Cadmium and its compounds, Persistent plastics and other persistent synthetic materials, Crude oil, fuel oil, heavy diesel oil, and lubricating oils, hydraulic fluids, any mixtures containing any of these, High-level radioactive wastes or other high-level radioactive matter, materials in whatever form produced for biological and chemical warfare.

2.11 The Amount of Pollution from Ships

Britain and other European governments have been accused of underestimating the health risks from shipping pollution following research which shows that one giant container ship can emit almost the same amount of cancer and asthma-causing chemicals as 50000 cars.

Data from maritime industry based on engine size and the quality of fuel typically used by ships and cars shows that just 15 of the world's biggest ships may now emit as much pollution as the entire world's 760mill cars. Low-grade ship bunker fuel (or fuel oil) has up to 2,000 times the sulphuric content of diesel fuel used in US and European automobiles.

Pressure is mounting on the UN's International Maritime Organization and the EU to tighten laws governing ship emissions following the decision by the US government to impose a strict 230-mile buffer zone along the entire US coast, a move that is expected to be followed by Canada.

The setting up of a low emission shipping zone follows US academic research which showed that pollution from the world's 90,000 cargo ships leads to 60,000 deaths a year in the US alone and costs up to $330bn per year in health costs from lung and heart diseases. The US Environmental Protection Agency estimates the buffer zone, which could be in place by next year, will save more than 8,000 lives a year with new air quality standards cutting sulphur in fuel by 98%, particulate matter by 85% and nitrogen oxide emissions by 80%.

The EU plans only two low-emission marine zones which should come into force in the English Channel and Baltic Sea after 2015. However, both are less stringent than the proposed US zone, and neither seeks to limit deadly particulate emissions.

Shipping emissions have escalated in the past 15 years as China has emerged as the world's manufacturing capital. Ship pollution affects the health of communities in coastal and inland regions around the world, yet pollution from ships remains one of the least regulated parts of our global transportation system.

Shipping is responsible for 3.5% to 4% of all climate change emissions.

Ocean-going vessels are one of the largest mobile sources of air pollution in the world, powered by engines comparable in size to those that run power plants. Yet, regulation of these ships has lagged far behind other sources of air pollution.

2.12 Mitigations in Applying the Antipollution Legal Measures

For decades, the IMO has rebuffed calls to clean up ship pollution. As a result, while it has long since been illegal to belch black sulphur-laden smoke from power-station chimneys or lorry exhausts, shipping has kept its license to pollute.

For many years, the IMO has operated a policy agreed by the 169 governments that make up the organization which allows most ships to burn bunker fuel.

Bunker fuel is also thick with sulphur. IMO rules allow ships to burn fuel containing up to 4.5 per cent sulphur. That is 4,500 times more than is allowed in car fuel in the European Union.

Thanks to the IMO's rules, the largest ships can each emit as much as 5,000 tons of sulphur in a year – the same as 50million typical cars, each emitting an average of 100 grams of sulphur a year. With an estimated 800million cars driving around the planet, that means 16 super-ships can emit as much sulphur as the world fleet of cars.

Recently, the IMO belatedly decided to clean up its act. It said shipping fuel should not contain more than 3.5 per cent sulphur by 2012 and eventually must come down to 0.5 percent.

It should not be hard to do. There is no reason ship engines cannot run on clean fuel, like cars. But, away from a handful of low-sulphur zones, including the English Channel and North Sea, the IMO gave shipping lines a staggering 12 years to make the switch. And, even then, it will depend on a final 'feasibility review' in 2018.

Smoke and sulphur are not the only threats from ships' funnels. Every year they are also belching out almost one billion tons of carbon dioxide. Ships are as big a contributor to global warming as aircraft – but have had much less attention from environmentalists.

Two-thirds of the world's ships are registered in developing countries such as Panama. These are just flags of convenience, to evade tougher rules on safety and pay for sailors. But at the IMO, governments successfully argued that ships from developing countries should not have to cut carbon emissions. Although IMO promises to heavily and consistently engage in the fight of protecting and preserving the environment, carbon emissions from shipping could triple by 2050.

Burning low-sulphur fuel won't cut carbon emissions from ships. But there are other ways. More efficient engines could reduce emissions by 30 per cent. Cutting speed could reduce emissions by as much again. And there are even wackier ways, such as putting up giant kites to harness the wind as in the days of sailing ships.

As international accords and governmental actions have placed an increasing burden upon ship owners and operators to improve vessel safety and operations to preserve the environment, there has grown an increasing resentment toward the "environmentalists". It is often claimed, and can be seen to be true in many cases, that environmental proposals simply are not in tune with the realities of the global demand for maritime transport. An "environmentalist's" response to the great concern over significantly greater needs for the transport of oil by 2025 might well be that consumers must simply be educated that they must do without increased supplies of oil. An "environmentalist's" understanding of the "polluter pays principle" has often been interpreted to mean that the vessel carrying the oil that might be spilled is the potential polluter. Remedies to make sure that this polluting shipowner pays have been many. There are regulations in place to make the shipowner pay for programs for prevention and other regulations to make sure that the shipowner pays compensation for any environmental damage that might be sustained as a result of a vessel accident. But, this "failure" of the "environmentalist" to understand the perspective of the shipowner is only half of the problem. It is often true that the ship owner, the port operator, even the government regulators do not understand the importance of the "environmentalist's" message.

By 2025, hundreds of thousands of industries will be moving industrial goods through thousands of maritime transport facilities in an attempt to reach roughly 8,200 million people. In 2025, each isolated local pollution incident will have a global significance.

Environmentalists and maritime transport professionals must all find a better understating of the environmental and developmental aspects of maritime transport. The application of the "polluter pays principle" must be clearly understood and the mechanisms to make the polluter pay must in fact work towards sustainable development and not against it. It must be understood by all parties that the polluter is really the consumer; and, if the costs of dealing with the risks of pollution and the results of the pollution are borne by the consumer then there is hope for sustainable development in the maritime transport field. It is an economic pressure that brings damage and risk of damage to the marine environment from the maritime transport system. This economic pressure is generated by the consumer. Pollution and risks of pollution will continue until they are economically unacceptable to the consumer. As systems and programs are designed to reduce the threat of pollution from maritime transport, they can be expected to develop in comprehensiveness in proportion to the reality of the individual environmental threat. Costs of these systems and programs will likely be proportional to their comprehensiveness. If the developmental need for the environmentally harmful product or service is great enough, the consumer/polluter will be willing to bear this expense. If the need is not great enough, the costs of the environmental protective mechanisms will diminish the demand for the product or service.

As mechanisms are developed to address the environmental risk of the product or service, their potential for effectives must be measured against their ability to bring this economic pressure upon the consumer. If a regulatory mechanism directs the expense of a program or system at shipowners, the effectiveness may be defeated or minimized if some shipowners, under the pressure of competition, can find ways to "legitimately" or practically, avoid the mechanism. The shipper of the product will likely choose the ship owner who has found this less costly way of operating. The consumer will be able to avoid the cost of environmental protection by choosing the shipper that uses the ship owner that avoids the mechanism. If instead the regulatory mechanisms could be directed at all shippers who pass all costs along to consumers, the ship owners would not be seeking ways to avoid such costs and the consumer would receive the full economic pressure arising from the environmental risks of the product or service.

Most providers of transport services will not object to adopting environmental principles or regulated environmental standards, providing that these will be applied equally to all competitors and do not aggravate some natural disadvantage. If this can be done, competitive standing of an individual entity is not compromised; the cost of the environmental measure is merely passed on the customer. This is the necessary result if sustainable development is to be achieved. It is the customer, the user of the products or services, that should be expected to incur the cost of protecting the environment from that product or service. Without this, alternative products or services that are less threatening to the environment cannot compete with or replace existing products or services. This approach, to have the consumer bear the cost of protecting the environment, goes to heart of the "polluter pays principle".

From the aspect of the new or small businesses that are trying to find a way to increase market share against large or strong competitors, better product or service must be provided at lower cost. Too often today, a lower cost alternative is found by limiting or avoiding compliance with environmental principles or regulations. It is in this sector that regulation and enforcement will remain a necessary ingredient to achieve sustainable development.

However, the task of enforcement can be diminished if innovative and comprehensive approaches to government regulation are adopted.

A regulation that says that a vessel must discharge accumulated oily bilge waste to a shore based reception facility is simply not effective if no reception facility exists. The regulation must contain the solution to the problem of providing the facility. Perhaps movement of cargo by any waterborne mode must include a volumetric or tonnage tax that can be drawn upon to provide the needed facilities. The regulation is still not effective if it costs the vessel to discharge at the facility. A competitive edge can be gained if the waste can be successfully discharged at sea. The vessel must gain a competitive edge, or at least retain its competitive standing, by using the facility. Perhaps the vessel must be paid to use the facility - or can only recover a "pollution bond" if it can be shown that the facility is utilized on each port call.

Careful thought and planning on the part of all the entities in maritime transport is needed if the coming demand for increased transport capacity is to be met in a manner that supports sustainable development principles. Awareness of the problems and acceptance of the need for sustainable development of the global transport system form the basis for success. New and aggressive thinking can provide the right approaches. Coordination and cooperation among the diverse entities involved can bring together the sound principles of local actions into a comprehensive program of global effectives.

With maritime transport systems being developed in a fashion that requires co-operation between private entities, and in concert with the support and co-operation of governments, the basis already exists for finding solutions to the many and varied environmental problems that stand in the way of sustainable development.

3. CONCLUSIONS

Can antipollution measures achieve their goal?

We can identify some of the difficulties that make legal measures ineffective in achieving their goal, respectively to efficiently stop damaging the environment:

- They are difficult to be adopted
- Their efficiency in diminishing the pollution doesn't match the amount of development
- They are easily to be avoided by shipping companies
- They can eventually try to prevent pollution incidents, but not stop pollution to occur.

As for the companies, those who are the most profitable and therefore the most polluting companies, they can afford to pay the environmental costs from their profits, continuing to pollute the environment.

If the big companies don't want to comply with the regulations, the governments have little power to enforce them, as the money from these companies is feeding the governments' budget.

As we know, huge oil spill disasters happened while the legal measures were in force and the penalties applied simply move the money from an account to another, while the environment remains greatly affected.

Conclusions should state concisely the most important propositions of the paper as well as the author's views of the practical implications of the results

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A Hybrid Marine Vessel – Supplemented by a Thermoelectric Generator (TEG) Power System – as a Case Study for Reducing Emissions and Improving Diesel Engine Efficiency

Paul A. Wlodkowski
Ph.D., Associate Professor of Engineering, Maine Maritime Academy,
paul.wlodkowski@mma.edu

W. Peter Sarnacki
Associate Professor of Engineering, Maine Maritime Academy
psarnacki@mma.edu

Travis T. Wallace
Graduate Student, University of Maine
travis.wallace@maine.edu

Abstract: A hallmark of the maritime transportation industry is efficiency. Estimates are that 90% of cross border world trade is accomplished by means of waterways while consuming only 7% of the energy for the total transportation sector. Nonetheless, marine diesel engines, which serve as power plants for most commercial, ocean going vessels, have long been identified as a major source of air pollution for port cities and coastal areas. Accordingly, the International Convention for the Prevention of Pollution from Ships (the MARPOL Treaty) has significant ramifications for the maritime industry, as exemplified by the stringent 2016 standard to lower emissions. Such realities, along with the rising cost of non-renewable petroleum fuels, necessitate the recovery of the wasted heat onboard marine vessels. Thermoelectric materials are an enabling technology that allows the recapture of this wasted energy from heat sources, such as exhaust and coolant systems, which account for nearly 50% of the total combustion energy. If a fraction of the marine diesel's wasted energy could be harnessed and stored with high power density batteries, an electric drive system could be utilized to transport ships quietly and cleanly into and out of congested ports and high population centers. Overall, a dramatic reduction of the maritime industry's carbon footprint could be realized, as a modest 10% increase in engine efficiency translates into a savings of approximately 180,000 barrels of fuel per day on a world-wide basis.
Solid state thermoelectric materials, when exposed to a thermal gradient, generate an electric potential according to the Seebeck effect. While the automobile industry has taken a lead in commercializing thermoelectric generators (TEG) as early as 2013, it is the marine industry that may well be the greater beneficiary of this technology.

Economies of scale, the ability to generate a higher thermal gradient, and fewer weight and volume constraints, all suggest a promising feasibility for marine applications. The successful development of a hybrid thermoelectric vessel (green ship) at Maine Maritime Academy is a promising first step in helping realize the theme of this year's General Assembly of the International Association of Maritime Universities (IAMU): Green Ships, Eco Shipping, and Clean Seas.
Keyword: thermoelectric, generator, hybrid, emissions, marine, diesel, efficiency

1. INTRODUCTION TO THE GLOBAL ENERGY CHALLENGE

According to the United States Energy Information Administration (USEIA), the world's consumption of oil and petroleum products is approximately 84 million barrels per day in 2009 [1]. The USEIA also forecasts a 49% increase in world marketed energy consumption by the year 2035, with much of that growth attributed to developing countries who are currently not members of the Organization for Economic Cooperation and Development, i.e. non-OECD. By 2035 liquid fuels will remain the largest source of energy. As fuel prices rise and alternative energy sources are developed, however, an anticipated decline of the liquids' share of world marketed energy consumption will fall from 35 percent currently to 30 percent in 2035. No foreseeable decline in dependence of liquid fuels is projected for the transportation sector, unless a significant technological advance is realized in improving engine efficiency [2]. The scope of this paper presents a solution to the energy challenge in the maritime transportation industry with the development of a thermoelectric waste heat recovery system.

2. AN ECONOMIC LENS ON THE MARITIME INDUSTRY

As trade among nations grows, the volume of freight transported by both air and marine vessels will increase. Consequently, a greater demand will be placed on the one sector which is expected to increase its reliance on liquid fuels – transportation. Pursuant to the theme of the 12th Annual General Assembly of the IAMU *Green Ships, Eco Shipping and Clean Seas*, let us analyze both the contribution of the maritime industry to the energy equation, as well as the anticipated benefits of employing a thermoelectric waste heat recovery system for the purpose of improving diesel engine efficiency.

According to researchers at Hofstra University, the economies of scale for the maritime industry qualify it as the most efficient mode of transportation. Marine vessels accommodate 90% of cross-border world trade while consuming only 7% of the total energy in the transportation sector [3]. By utilizing the aforementioned USEIA data tables – which allocate 30% of total energy consumption to the transportation sector – one can estimate the daily energy consumption for the maritime industry at 1.8 million barrels per day. As the demand for liquid fuel is generally inelastic with respect to price, shipping companies typically realize savings and reduce emissions by decreasing travel speed through slow steaming (20 knots) and super-slow steaming (12 knots) [4]. Lower speeds reduce drag forces thereby improving fuel economy. Notwithstanding the obvious impact to travel times and scheduling port of call visits, slow steaming is not the long-term elixir for high energy prices; the imperative for investing in more efficient ships is critical to meeting more stringent environmental regulations that are forthcoming.

In summary, while the efficiency of maritime transport is unrivaled by other modes, a technical perspective on the lost opportunity is warranted, not only to quantify that potential cost savings to the shipping industry but also to help prepare it for the foreseeable challenges outlined in the USEIA analysis. And so, one may naturally ask whether an enabling technology does exist by which a marginal increase of 10% efficiency in a marine diesel engine would result in an additional savings of 180,000 barrels per day. With geopolitical tensions in the Mideast and Northern Africa driving the price of oil over $100 per barrel, this 10% increase in power plant efficiency equates to an annual savings of $6.5 billion for the maritime industry.

3. ENVIRONMENTAL IMPACT

During the internal combustion process, approximately 50% of the total energy is lost to exhaust emissions, coolants, and internal friction, as illustrated below in Figure 1.

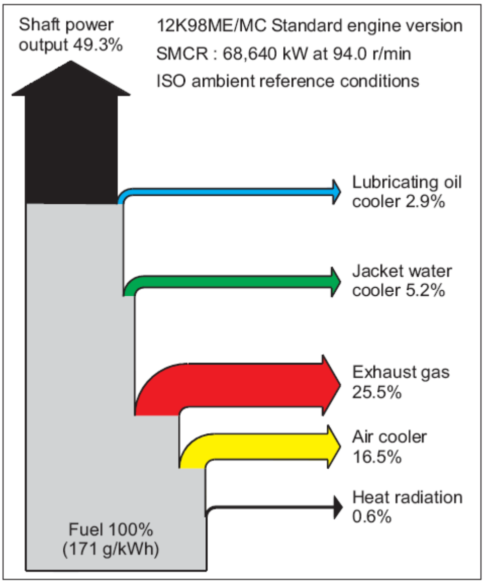

Figure 1. Marine Thermoelectric Heat Sources (Courtesy MAN/B&W Thermal Efficiency System)

The environmental impact, and resulting indirect cost to human life and coastal regions, is staggering. According to a comprehensive, epidemiological study of mortality from ship emissions, J. Corbett et al. conclude that the 1.2-1.6 million metric tons of particulate matter emanating from oceangoing ships are responsible for 60,000 cardiopulmonary and lung cancer deaths annually [5]. Moreover, 70% of those ship emissions occur within 400 kilometers of land. Their research further projects an escalation of the mortality rate concomitant with the increasing demand for liquid fuels and the growth of the shipping industry.

Such an environmental reality, coupled with the aforementioned economic forces, necessitate an innovative approach to designing the next generation of green ships. Reducing the maritime industry's carbon footprint will not only place it in compliance with the MARPOL treaty, but the approach makes a cogent business case as well. This technology development would augment the efficiency of a marine diesel engine, while simultaneously employing a hybrid propulsion system that would greatly mitigate emissions in ports and near coastal areas.

4. A GREEN SHIP SOLUTION

In 2010, a research team, comprised of Maine Maritime Academy (MMA) and the University of Maine (UMaine), designed and fabricated a unique, thermoelectric hybrid vessel from an encapsulated lifeboat to serve as a dedicated test platform. The lifeboat was retrofitted with a new diesel electric propulsion system featuring a C2.2 Caterpillar genset and a 22 kW electric motor. In order to meet the requirements of hybrid classification, the energy recovered by the thermoelectric generator (TEG) is reintroduced into the propulsion system thereby reducing the load on the generator set. Conversion of the variable DC output of the TEG to a stable AC source was accomplished with a specialized micro-inverter that accepts the low voltage DC, converts it to AC, and acts as a transformer by stepping up the voltage to a higher and more practical level for usage onboard ships. By the end of the summer of 2010, this hybrid vessel made her maiden voyage in a cruise around the harbor in Castine, Maine. An illustration of MMA's hybrid "Green Ship" is depicted below in Figure 2.

Figure 2. Maine Maritime Academy's Hybrid "Green Ship" Prototype

A complete technical description of MMA's green ship system is provided by Sarnacki et al. [6]. This research and development is noteworthy in a number of directions, not the least of which is the realization that the maritime industry may well be the greater beneficiary of this technology vis-à-vis the automotive industry which too is actively working to commercialize TEGs as early as 2013. In comparison to motor cars, ships are not as encumbered by size, weight and cost of a TEG system. Then, one must consider that the ability to generate electricity from a waste heat source is directly a function of the temperature gradient between the exhaust stream and a coolant. Here too, the maritime industry holds an unprecedented advantage in the differential existing with respect to the bountiful ocean, whose temperatures are well below that of any automotive coolant. Lastly, retrofitting existing ships with TEGs is a feasible option.

5. CASE STUDY FOR R&D MODEL AT IAMU

In the United States, a clarion call is sounding for institutions of higher learning to embrace and to integrate research and development (R&D) in some form within the undergraduate experience. The consequence of this trend has many implications for redefining the mission statement of a college or university. Maine Maritime Academy, like many of her counterparts within the International Association of Maritime Universities (IAMU), is primarily a "teaching institution." Yet today, few could argue effectively against the tangible benefits that this student-centered, and mission-specific, R&D has had in both enhancing the quality of teaching and augmenting the relevancy of the institution in the state and national economy.

The hybrid vessel, marine thermoelectric program at MMA serves as a successful case study for encompassing R&D into the curriculum of an IAMU institution. What began in 2009 as co-author Wallace's engineering capstone project has now grown into an on-going effort involving several engineering faculty, a chemistry professor, and numerous undergraduates. Working in design teams, these students have garnered first place prizes in paper competitions sponsored by the Society of Naval Architects and Marine Engineers held on the campus of the Massachusetts Institute of Technology.

To illustrate the nexus with industry and graduate education, Mr. Wallace, a 2009 MMA graduate in Marine Systems Engineering, has matriculated to an M.S./Ph.D. program at the nearby University of Maine where he has also demonstrated the entrepreneurial spirit by founding Thermoelectric Power Systems, LLC. Within a short period of time, his Company has garnered financial support from the Libra Foundation and has received a Small Business Technology Transfer (STTR) contract from the Department of Defense.

6. CONCLUSIONS AND FUTURE WORK

Maine Maritime Academy has successfully designed and built the first-of-its-kind hybrid marine vessel utilizing a thermoelectric generator for waste heat recovery. To accommodate the greater capacity of marine diesel engines, Thermoelectric Power Systems LLC, along with its partners at MMA and UMaine, is now designing and developing a TEG specific to maritime applications with a reliability to withstand the harsh operating environments. While the existing 180 watt TEG employed the reliable, benchmark material, bismuth telluride, the research team is now actively collaborating with materials developers who are reporting 20% conversion of thermal energy into electricity [7]. Realization of these gains will be a monumental achievement in both maritime emissions reduction as well as improvement in diesel engine efficiency.

ACKNOWLEDGMENTS

The authors of this paper would like to express appreciation to the American Bureau of Shipping and the Office of Naval Research for their support of Maine Maritime Academy's research and development efforts in the field of marine thermoelectric power generation. We also want to thank Hi-Z Technology, Inc. for the use of their thermoelectric generating unit and technical assistance in integrating their TEG with our equipment. Caterpillar Marine Power Systems are also recognized for the generous donation of one of their C2.2 generator sets. The Libra Foundation is also acknowledged for the support of laboratory equipment critical to Thermoelectric Power Systems LLC and to the graduate work done at the University of Maine.

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On the Evaluation of Berthing Training for Pilot Trainees Using a Ship Maneuvering Simulator

Hideo Yabuki
Professor, Tokyo University of Marine Science and Technology, yabuki@kaiyodai.ac.jp

Kazuki Inoue
Professor, Tokyo University of Marine Science and Technology, kzinoue@kaiyodai.ac.jp

Tadatsugi Okazaki
Associate Professor, Tokyo University of Marine Science and Technology, okazaki@kaiyodai.ac.jp

Abstract: After the introduction of a new pilot training and certification system by the Japanese government, Tokyo University of Marine Science and Technology started the education and training of a young pilot trainee with a limited amount of ship-handling experience. As the ship maneuvering simulator training is at the core of the above education and training, it is desirable to develop a new evaluation method of ship-handling performance that can be completed within a short period of time after each training session. From the above point of view, the authors propose a new evaluation method that compares, at the de-briefing, the time histories of ship's motion during berthing by trainees and those by instructors. The authors conducted experiments using a ship maneuvering simulator and confirmed that the proposed evaluation method is effective and helpful to improve the simulator training.
Keywords: Pilot education and training, SMS training, Evaluation of SMS training

1. INTRODUCTION

Due to the significant reduction in the number of Japanese seafarers, a shortage of pilots is expected in the near future. In 2007, the Japanese government introduced a new grade-base pilot education, training and certification system in order to keep a constant supply of experienced pilots. The career opportunity to become a pilot has long been open only to ex-masters with seagoing experience of at least three years. Experience as a master is not necessary in the new system. For pilots in the 3rd grade category, a career history that includes service on ships of 1,000gt or more for a period of one year or longer as a cadet or officer is necessary. To follow the above new government's policy, Tokyo University of

Marine Science and Technology started a new pilot training program as one of its master's programs under the Course of Maritime Technology and Logistics.

Ship maneuvering simulator (SMS) training is at the core of the technical training and is conducted by servicing pilots with abundant experience. Usually, ship-handling performance of a trainee is evaluated subjectively by instructors based on their ship-handling experiences. In order to improve SMS training for young pilot trainees with a limited amount of ship-handling experience, it is desirable to develop a new evaluation method of their ship-handling performance at the de-briefing of the training within a short period of time using objective indicators.

Okazaki et.al [1] proposed an evaluation method of berthing performance using the Minimum Time Berthing Solutions. However, the Minimum Time Berthing Solutions try to estimate the limitation of a ship's maneuverability for berthing by solving the minimum time berthing problem, and it is difficult to utilize them as the ship-handling performance evaluation indicators. In a recent paper, Okazaki et.al [2] proposed a method that aims at deriving the safety margins of the minimum time berthing problem such as speed, approaching angle and lateral distance to the berth by analyzing the berthing training data using a SMS. The authors paid attention to the output of the time histories of ship's motion during SMS training and propose a new evaluation method that compares the time histories of ship-handling by trainees and those by instructors.

This paper describes the above proposed evaluation method and the results of experiments using a SMS aiming at assessing the effect of the proposed method for improving SMS training.

2. DEVELOPMENT OF THE EVALUATION TOOL

2.1 Evaluation method

In the berthing training of pilot trainees (hereafter the trainees), the instructor makes a brief explanation on the training scenario and then demonstrates an exemplary berthing before pilot trainees. After that, the same simulator sessions are performed by the trainees under the same environmental conditions. During the training, the trainees tend to follow the sequence of maneuvers demonstrated by the instructor. The authors paid attention to the above and created an evaluation method that compares the output of the time histories of the ship's state variables (hereafter indicators) during the ship-handling by trainees and those by instructors.

In general, pilots conduct their berthing utilizing the following standard factors; approaching angle to the berth, speed, lateral distance at the berth front, which are determined for each of the ship type and of the berth. Therefore, the authors evaluate the ship-handling performance of each trainee by comparing the mean and standard deviation (SD) of each of their following indicators with those by instructors: speed, distance to the berth, approaching angle, lateral distance to the normal line of the berth (hereafter lateral distance) at the designated points on the planned track. The evaluation points of the indicators are arranged on the planned course line at 3L (L; ship's length), 2L, 1L and 0.5L away from the berth.

After finishing each SMS session, the ship-handling analysis is performed automatically using the software developed by the authors and a diagram like the one shown as Figure 1 in 2.2 is generated. This makes it possible to evaluate the ship-handling performance of trainees quantitatively within the short period of time and the instructor can give necessary advice on their ship-handling.

2.2 Effectiveness of the evaluation indicator

Experimental SMS berthing sessions to the Tokyo Ohoi No.4 berth were performed in order to confirm the effectiveness of the proposed method using a 70,000 G.T. container ship (300L×38.7B×12d). In the experiment, the instructor performed exemplary ship-handling 4 times and the same session was performed by 13 1st grade pilot trainees and one 3rd grade trainee. The 1st grade trainees had 2 years or more sea service experience as a master and the 3rd grade trainee had no sea service experience as a master. The ship-handling performance of the 1st grade trainees and the 3rd grade trainee were compared with that of the instructor.

The ship-handling indicators of the trainees were compared with those of the instructor, and the results are shown in Figure 1 and Table 1. In the figure, the horizontal axis shows the distance between the ship and the berth, the solid line shows the history of the indicator of the 3rd grade trainee, and the white marks and the half black marks show the mean and SD of the indicators respectively. In the table, minus sign of the approach angle means the targeted berth exists on her port side. When we pay attention to the indicators of the instructor's ship-handling, their standard deviations are generally small at all evaluation points. Therefore, it is considered that the instructor's exemplary ship-handling has reproducibility, and we can use it as the evaluation standard.

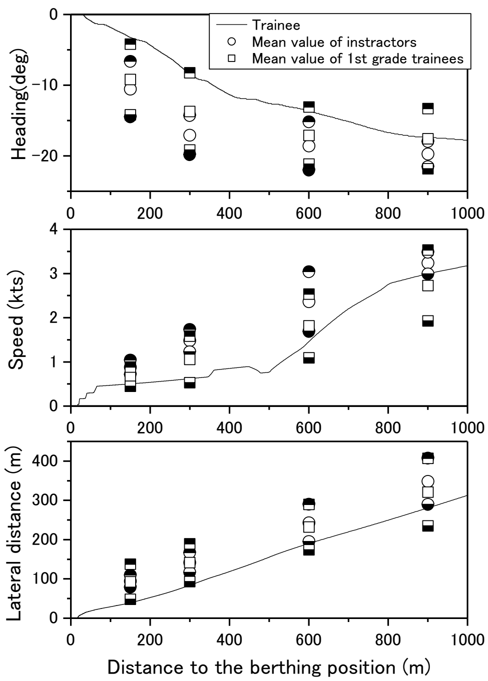


Figure 1 Ship-handling results of the 3rd grade trainee

Table 1. Comparison of indicators between instructor and trainees

Evaluation point	Instructor						1st grade pilot trainees						3rd grade pilot trainee		
	Lateral Distance(m)		Speed (kts)		Approach Angle(deg.)		Lateral Distance(m)		Speed (kts)		Approach Angle(deg.)		Lateral Distance(m)	Speed (kts)	Approach Angle(deg.)
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	—	—	—
3L	348.2	59.0	6.1	0.4	-19.8	1.8	309.6	100.4	5.1	1.9	-17.5	5.1	281.5	5.7	-17.4
2L	242.4	47.5	4.6	1.3	-18.6	3.4	225.5	58.7	3.2	1.7	-17.4	3.6	190.5	2.9	-13.7
1L	141.4	25.0	2.9	0.4	-17.1	2.8	136.1	39.9	1.9	1.1	-14.2	5.8	84.3	1.1	-8.5
0.5L	93.9	15.3	1.7	0.4	-10.6	3.9	88.9	37.1	1.3	0.6	-10.0	5.0	39.2	1.0	-3.3

On the training results of the 1st grade trainees, their SD of the lateral distance at 0.5L is two times greater than that of the instructor and speed mean value is generally smaller than that of the instructor. The above results mean that they needed more time to complete their berthing ship-handling than the instructor and seem to prove the fact that the trainees had less experience in berthing than the instructor.

Turning to the training results of the 3rd grade trainee, remarkable differences in the mean value of the indicators are observed compare with those of the instructor and the 1st grade trainees. The 3rd grade trainee was able to follow the speed reduction procedure in the exemplary ship-handling, however, the lateral distance at the 0.5L point is too close to the normal line of the berth and is dangerous.

2.3 Total ship-handling performance evaluation

Next we discuss an evaluation method of the total ship-handling performance of 3rd grade trainees. Table 2 shows the difference of the mean values of the indicators at each of the evaluation points between the instructor and the trainees. It can be seen that the value differences between the 3rd grade trainee and the instructor are greater than those between the 1st grade trainee and the instructor for all the indicators at all evaluation points. The approaching speed of the 3rd grade trainee is slower than that of instructor and his lateral distance is closer to the normal line of the berth than that of the instructor. These values in table 2 indicate that the 3rd grade trainee deviated too much from the planned track and that the speed was too slow. These results indicate the fact that the 3rd grade trainee's ship-handling skills are far less adequate than those of the 1st grade trainees. Therefore, we considered that the ship-handling training of the 3rd grade trainee is better to be started targeting the ship-handling performance of 1st grade trainees.

Table 2 Difference of the mean value of indicators between instructor and trainees

Evaluation point	1st grade pilot trainee			3rd grade pilot trainee		
	Lateral Distance (m)	Speed (kts)	Approach Angle (deg.)	Lateral Distance (m)	Speed (kts)	Approach Angle (deg.)
3L	38.6	1.0	2.3	-66.7	-0.4	2.4
2L	16.9	1.3	1.2	-51.9	-1.7	4.9
1L	5.3	1.0	2.9	-57.1	-1.7	8.6
0.5L	5.0	0.4	0.6	-54.7	-0.8	7.3

From the above discussion, we propose the following method of evaluating the total ship-handling performance of the 3rd grade trainee by utilizing the indicators. The indicators are put into scores as follows:

1. Score A (3 points); Indicator of the trainee is within 1 σ of that of instructor
2. Score B (2 points); Indicator of the trainee is within 1 σ of that of 1st grade trainee
3. Score C (1 point); Indicator of the trainee is within 2 σ of that of 1st grade trainee

These scores are weighted for the total evaluation of ship-handling performance in such a way that the weights at the 3L, 2L, 1L and 0.5L evaluation point are 1, 2, 3 and 4 respectively. The total ship-handling performance evaluation result of the 3rd grade trainee is shown in Table 3. In the table, "Grade" means the conversion of total points to 100 points.

In the case of this trainee, the scores from 3L to 2L evaluation points are mostly "B" and it can be evaluated that his ship-handling performance at the first stage of the approach is almost the same as the 1st grade trainees. However, his scores from 1L to 0.5 evaluation points are mostly "C" and these scores show that he could not adjust the ship's motion decisively by using sufficient engine and rudder commands when the ship deviated from the planned track. As his total ship-handling performance is evaluated to be 47 points, the instructor can judge that he needs further SMS training.

Table 3. Example of total ship-handling performance evaluation sheet

Evaluation point	Indicator	3rd grade trainee
3L	Speed	B
	Approach angle	A
	Lateral distance	B
2L	Speed	B
	Approach angle	B
	Lateral distance	C
1L	Speed	C
	Approach angle	C
	Lateral distance	C
0.5L	Speed	C
	Approach angle	B
	Lateral distance	C
Total points (90)		42
Grade		46.7

3. APPLICATION TO SMS TRAINING

We performed further experimental sessions in order to confirm the effectiveness of the proposed evaluation tool described in the previous section. The training scenario was the berthing of a 10,000 G.T. container ship (148L×23.3B×6.89d) to the Yokohama Honmoku D-4 berth using a tugboat. In this experiment, the ship-handling performance evaluation indicators of three 3rd grade trainees are compared with those of the instructor and the 1st grade pilot trainees. The standard statistics of the indicators shown in Table 4 were obtained from 6 exemplary ship-handling sessions by the instructor and the ship-handling results by 28 1st grade trainees.

Table 4. Standard statistics of the indicators

Evaluation point	Instructor						1st grade pilot trainees					
	Lateral Distance(m)		Speed (kts)		Approach Angle(deg.)		Lateral Distance(m)		Speed (kts)		Approach Angle(deg.)	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
3L	97.9	15.0	3.8	0.2	-0.8	1.9	122.3	38.0	3.8	0.6	-5.8	7.9
2L	95.6	15.2	3.4	0.0	-6.1	3.3	107.5	23.9	3.0	0.8	-8.8	6.1
1L	77.1	13.9	2.5	0.0	-10.2	3.3	77.7	26.0	2.1	1.0	-7.6	6.8
0.5L	57.8	12.8	1.5	0.4	-7.5	2.6	51.5	27.3	1.1	0.6	-4.2	6.8

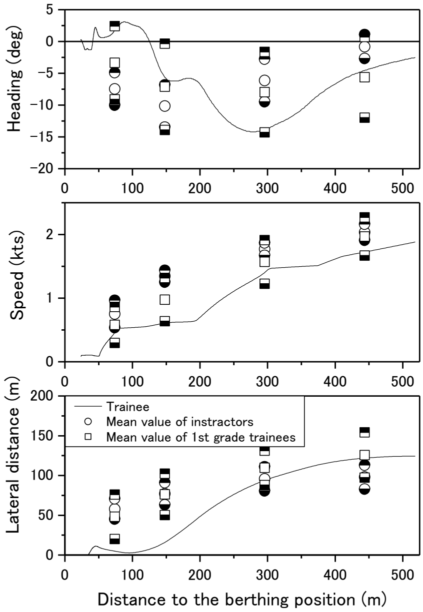
The ship-handling results of each of the 3rd grade trainees are shown in Figure 2 and their total ship-handling performance evaluation results are shown in Table 5.

Table 5. Total ship-handling performance evaluation results,

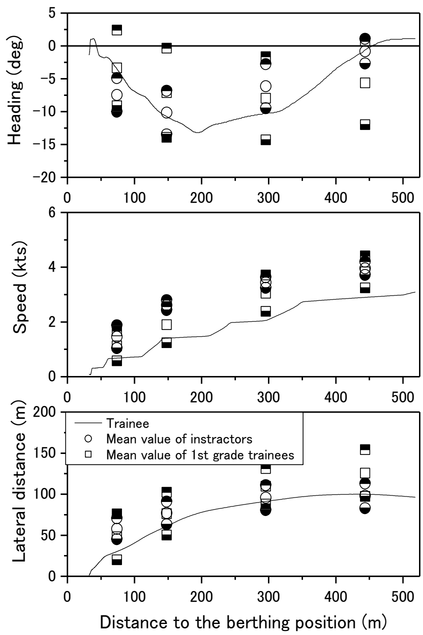
Evaluation point	Indicator	trainee		
		1	2	3
3L	Speed	B	C	A
	Approach angle	B	A	C
	Lateral distance	B	A	B
2L	Speed	B	C	B
	Approach angle	B	B	A
	Lateral distance	A	A	A
1L	Speed	C	B	B
	Approach angle	B	A	B
	Lateral distance	D	B	A
0.5L	Speed	B	B	A
	Approach angle	C	B	B
	Lateral distance	C	B	B
Total points (90)		45	64	71
Grade		50.0	71.1	78.9

Trainee 1 followed the exemplary ship-handling at the first stage of approaching and his ship's motion controlling at this stage is evaluated to be relatively good. However, the lateral distance at the final stage of approaching was too close due to the mishandling of the tugboat and the data like this indicate that advice on appropriate tugboat handling at slow speed by the instructor is necessary. The total ship-handling grade of this trainee was 50 points and it can be judged that the further ship-handling training using the same scenario is necessary.

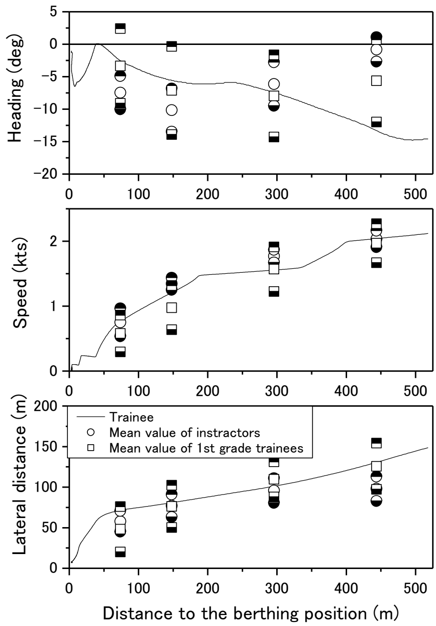
On the ship-handling of trainee 2, the approaching speed from 3L to 2L point was too slow compared with that of the exemplary ship-handling but at the last stage of approach her speed was sufficiently controlled and the lateral distance was kept wide enough for safe approaching. His total ship-handling grade was evaluated to be 71 points and the results suggest that the speed control training at the first stage of approaching is necessary.



Trainee 1



Trainee 2



Trainee 3

Figure 2. Ship-handling results of the 3rd grade trainees

The third trainee missed the setting of her approaching angle at the 3L point, however, he was able to adjust her heading at the 2L point by appropriate rudder control. His speed reduction procedure was appropriate and the safety range of the lateral distance was maintained through the approaching ship-handling. The indicators of this trainee were within the deviating range of the exemplary ship-handling on the whole and his total ship-handling grade was evaluated to be 79 points. His ship-handling performance seems to be almost the same as that of the 1st grade trainees.

From the above results of this experiment, the author considered that the proposed method is effective and useful for the evaluation of the ship-handling performance. The instructors can evaluate the ship-handling performance of a trainee within the short period after the training and identify the ship's motion controlling methods to be improved almost immediately.

4. CONCLUSIONS

The authors proposed a new method of evaluating the ship-handling performance by using the evaluation indicators obtained from the ship's motion analysis after SMS training. The effectiveness of the proposed method was confirmed by the ship-handling training experiments using a SMS. The results obtained by this study are summarized as follows:

(1) As the training of a trainee is performed after an exemplary ship-handling, a trainee can understand the ship-handling skill that are necessary to be mastered before hands.
(2) The mean value and SD of the indicators of the 1st grade trainees are obtained from the training results of trainees who have little actual berthing experience and considered to be a suitable scale to judge the ship-handling level of the 3rd grade trainee.
(3) The proposed method can evaluate the ship-handling performance of a trainee without disturbing his training because the evaluation indicators are calculated after SMS training from the ship's state variables that are obtained from the ship-handling results.
(4) The proposed evaluation method is effective and helpful to improve the SMS training. Instructors can evaluate the ship-handling performance and feedback the evaluation results to trainees almost immediately after training, thus making the SMS training more effective and useful.

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MET Systems Comprehensive Analyze as One of The Results ONMA-IAMU Project 2010

Capt. Dmytro S. Zhukov,
Senior Lecture,r Odessa National Maritime Academy (ONMA)
d_zhukov@mail.ru

Mykhaylo V. Miyusov
Prof. Dr., ONMA Rector, *Odessa National Maritime Academy (ONMA)*
rector@ma.odessa.ua

Abstract: IAMU was founded more then ten years ago. But for this moment there are any publications with compare information about IAMU Members MET system. One of the IAMU Projects 2010 was research Project - "Research of algorithm of collect valuable information MET system IAMU Members Institution and Human Resource Database of IAMU member Institutions". The research participants have prepared the questionnaire and algorithm for collect and analyze MET information. Information received from selected IAMU Member Institutions in questionnaires form prepared by Project participants. All this information converted in Database form.

The human resource database includes comparison indicators such as an academic degree, a license, a certificate, teaching subjects, research subjects and so on.

Human element is the core concept of the structure of the organization.

Shipping industry needs qualified human resources backed by the enough knowledge and skills for ship operation and for good maintenance based on the excellent seamanship.

Qualified human resources in the maritime society are always required by qualified teaching and researching staff members.

Keywords: MET, IAMU, IAMU Project, IAMU Member Institutions, Algorithm, IAMU Database, Human Recourses

1. THEORETICAL BACKGROUND.

1.1 Algorithm

In mathematics, computer science, and related subjects, an algorithm (derived from the name of mathematician al-Khwārizmī) is an effective method for solving a problem expressed as a finite sequence of steps. Algorithms are used for calculation, data processing, and many other fields. (In more advanced or abstract settings, the instructions do not necessarily constitute a finite sequence, and even not necessarily a sequence; see, e.g., "nondeterministic algorithm".)

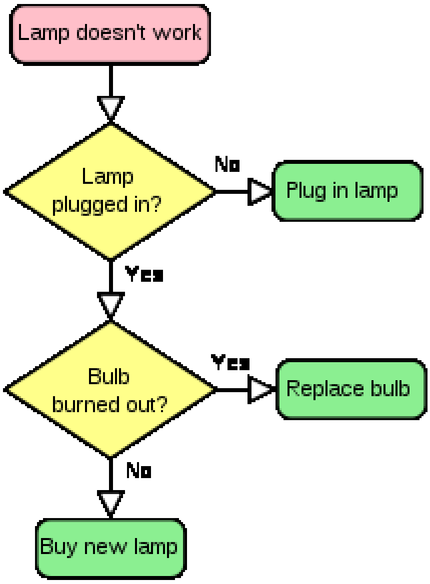

Figure 1. Example of algorithm and flow chart

Each algorithm is a list of well-defined instructions for completing a task. Starting from an initial state, the instructions describe a computation that proceeds through a well-defined series of successive states, eventually terminating in a final ending state. The transition from one state to the next is not necessarily deterministic; some algorithms, known as randomized algorithms, incorporate randomness.

1.2 Database model

A database model is a theory or specification describing how a database is structured and used. Several such models have been suggested. A database model is the theoretical foundation of a database and fundamentally determines in which manner data can be stored, organized and manipulated in a database system. It thereby defines the infrastructure offered by a particular database system. The most popular example of a database model is the relational model.

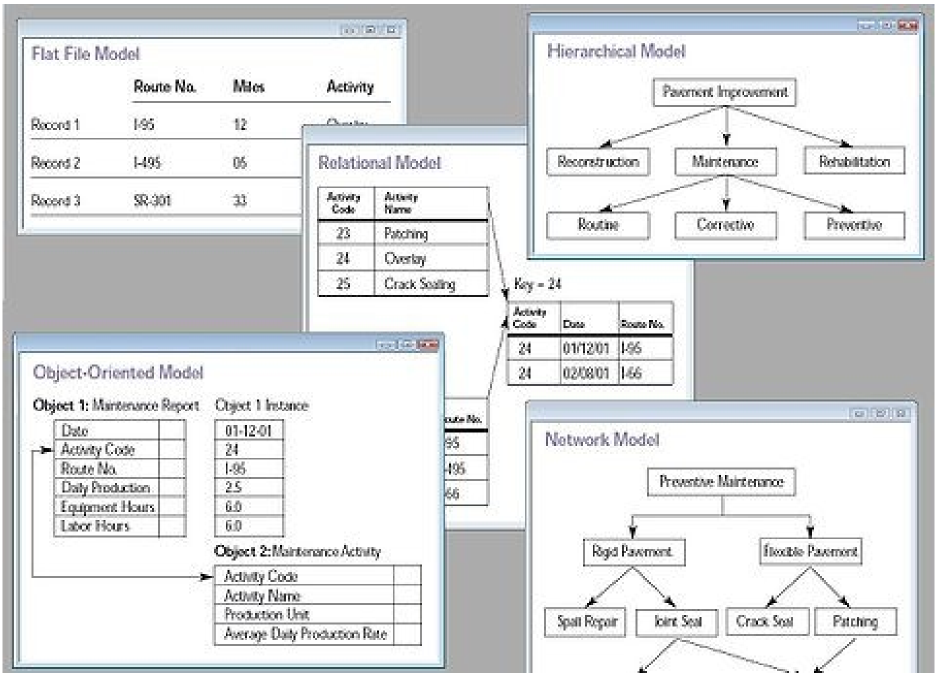

Figure 2. Collage of five types of database models.

A data model is not just a way of structuring data: it also defines a set of operations that can be performed on the data. The relational model, for example, defines operations such as select, project, and join. Although these operations may not be explicit in a particular query language, they provide the foundation on which a query language is built.

2. IAMU PROJECT OVERWIEV

One of IAMU 2010 Research Projects was "Research on algorithm of collecting valuable information MET system and Human Resource Database in IAMU Members Universities/Institution".

- Research Coordinator: - Capt. Dmytro Zhukov, d_zhukov@mail.ru
- Odessa National Maritime Academy, Rector Prof. Dr. Mykhaylo V. Miyusov ,
- Research Participants:
- Masao Furusho, Professor, Kobe University, Graduate School of Maritime Sciences, furusho@maritime.kobe-u.ac.jp
- Bogumil Laczynski, Professor, Master Mariner, Gdynia Maritime University, acamars@gd.pl

There were three Project Meetings during autumn 2010.

- Project Meeting #1. 15 -17 August 2010 Odessa National Maritime Academy
  Meeting results: Project Questionnaires and Flow – Chart Algorithm.

- Project Meeting #2. 16.10.2010 Korea Maritime University
  Meeting results: Three sets of the MET information by Project Participants were prepared, analyzed and presented during AGA11.
- Project meeting #3 (Final Meeting)16 -18 December 2010 Gdynia Maritime University
  Meeting Results: During Project meeting were analyze the received from IAMU Members and discuses the Project Results.

Necessary MET information was received from following IAMU Members Institution:

1. Kobe University, Graduate School of Maritime Sciences (Japan)
2. Tokyo University of Marine Science and Technology, Faculty of Marine Technology(Japan)
3. Gdynia Maritime University (Poland)
4. Szczecin Maritime University (Poland)
5. Polytechnical University of Catalonia, Faculty of Nautical Studies (Spain)
6. Admiral Makarov State Maritime Academy (Russia)
7. Admiral Ushakov Maritime StateAcademy (Russia)
8. Arab Academy for Science & Technology and Maritime Transport(Egypt)
9. Batumi State Maritime Academy(Georgia)
10. Istanbul Technical University, Maritime Faculty (Turkey)
11. Karadeniz Technical University, Faculty of Marine Science (Turkey)
12. Kyiv State Maritime Academy (Ukraine)
13. Odessa National Maritime Academy (Ukraine)
14. University of Rijeka, Faculty of Maritime Studies(Croatia)

Response ratio is:

$14 / 54 \times 100\% = 26\%$

26% response ratio (quarter of all IAMU Members) – is a very good result for such short time term of the collecting MET information.

All information was analyzing and converted it in e-format Database.

During the Meeting the e-version of the Project IAMU Database was presented by D. Zhukov.

Web-address of the Database is http://zhukov.seafarer.od.ua/ .

3. IAMU DATABASE PRACTICAL USAGE

3.1 IAMU Database

On the Fig.3 you can see Database structuring data for IAMU Members Institution..

1. GENERAL INFORMATION OF THE INSTITUTION
2. NATIONAL SYSTEM OF THE EDUCATION AND MET
3. ACADEMIC MARITIME EDUCATION
4. NON – ACADEMIC MARITIME EDUCATION
5. STRUCTURE OF INSTITUTION
6. DIFFERENCES IN NATIONAL MARITIME UNIVERSITIES IF ANY
7. STATISTICS OF NATIONAL MET
8. TRAINING SHIP
9. STRUCTURE OF MARITIME PROGRAMS
10. OBT SCHEME
11. ACADEMIC PERSONAL DATABASE

Figure 3. Proposed format of the collecting information

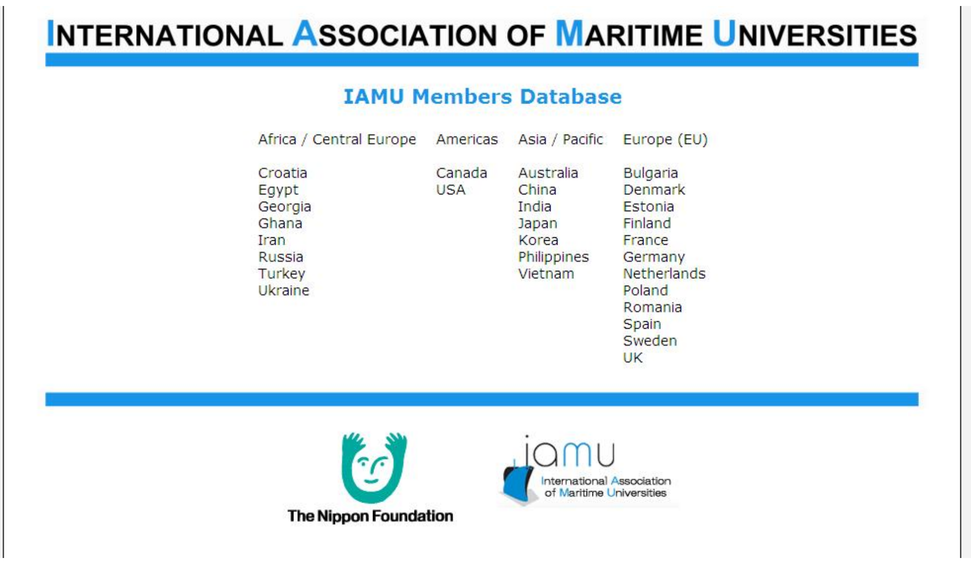

Figure 4. Page screen of the IAMU Database

3.2 Example of the IAMU database usage for comprehensive analyze of the MET Systems in Spain and Croatia

3.2.1 Polytechnical University of Catalonia, Faculty of Nautical Studies (Spain), IAMU Region 2

From the moment the Faculty was integrated into the Polytechnic University of Catalonia (UPC), the access to the different degrees taught is governed by the general rules in force in the country concerning the access to university.

The UPC academic and administrative standards of admission, registration, recognition and retention of students are applied.

The national system of education is as follows:

Infant Education		Primary school		
1st cycle	2nd cycle	1st cycle	2nd cycle	3rd cycle
Age 3	Age 6	Age 8	Age 10	Age 12
Secondary school		High school	Pre-registration	
1st cycle	2nd cycle		Exam to access	
Age 14	16	18		UNIVERSITY
	Or	Professional school		
Age	16	Maritime trying cycle		

From 2010, with the adaptation to the European Higher Education Area:

UNIVERSITY		
Degree	Master	Ph. D
1st cycle	2nd cycle	
4	2	
YEARS		

3.2.2 National system of the education and MET in the Republic of Croatia, IAMU Region 4

Through history, as well nowadays, people of Croatia have a strong connection with sea and with all activities within marine industry. Following aforementioned, MET system in Croatia has been developing for a long time. In 2009 it was 160 years since the establishment of the first nautical school in Croatia in Bakar.

Nowadays it follows international requirements laid down in the IMO STCW convention as well as in the EU educational obligations. The main objectives of such system are:

- to maintain highest standards in education, training and certification of seafarers,
- to apply highest standards of safety of navigation as well as highest living and working conditions on board,
- to create motivating environment for seafarer profession.

MET system in Croatia is established through umbrella of the Ministry of the Sea, transport and infrastructure (Administration) as well as Ministry of Science, Education and Sport.

Maritime education is divided into two stages. First stage includes vocational education within nautical schools follows by higher education at the Maritime faculties. Along the Croatian coast there are 6 nautical schools (875 pupils in 2010. have been graduated) and 4 faculties (Rijeka, Zadar, Split and Dubrovnik). In 2009. 327 pupils have been graduated at the nautical schools (nautical and engineering departments) and 281 at the faculties.

MET programs and curriculum are in accordance with STCW requirements, approved by the Administration and the functionality of the system is under constant control. Following graphs present MET system currently established in Croatia.

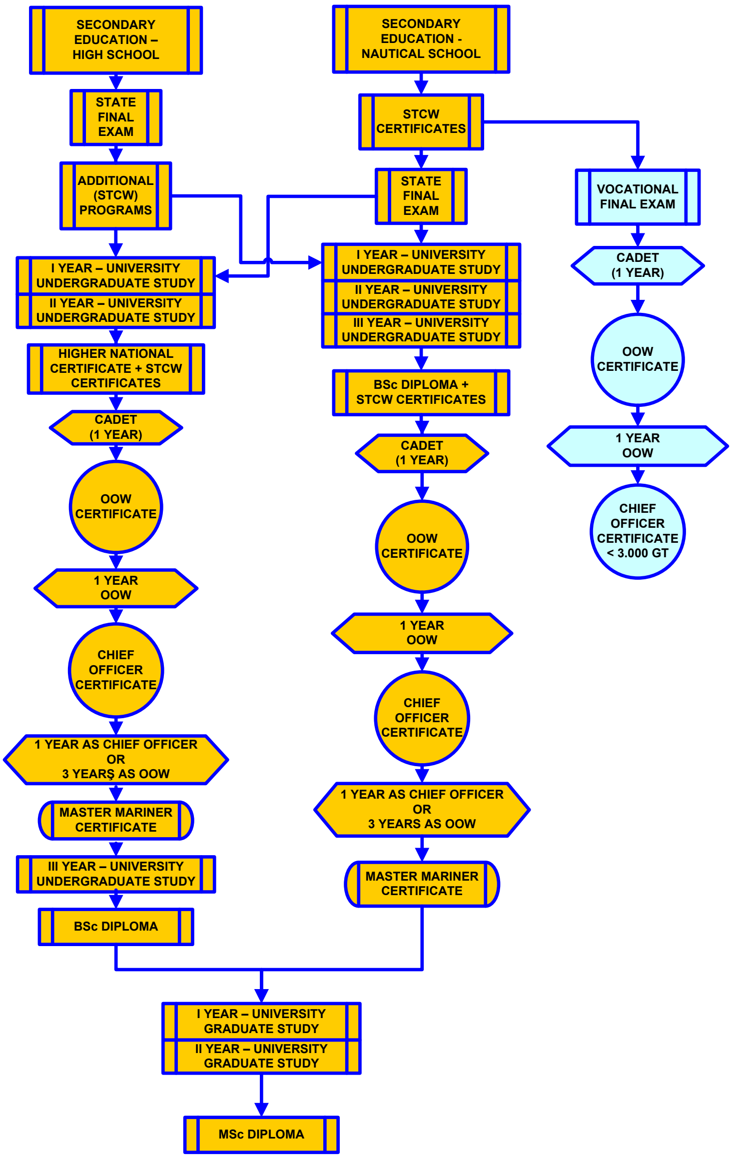

Figure 5. MET System on Croatia

4. CONCLUSION

This Project is an initial stage of comprehensive analyze of system of education and MET of IAMU Members Institution.

Tangible results of the Research Project

- Teamwork during the Project established a tight network between ONMA,GMU and KU GSMS
- Based on the theoretical background Project Flow-Chart and Algorithm were prepared
- Were collected, analyzed and converted necessary MET Information from 14 IAMU Members Institution
- **IAMU Database** in e-format was develop and open for user on following web- address
- http://onma.edu.ua/ and link to **IAMU PROJECT 2010**
- or direct address http://zhukov.seafarer.od.ua/
- Received MET information from 14 IAMU Members Institution input to **IAMU Database**
- **IAMU Database** MET information is in the process of continuous update.

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