# IFSMA

Annual Review 2015 – 2016

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The IFSMA Annual Review is an independently produced magazine, published by IFSMA, the International Federation of Shipmasters‘ Associations.

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IFSMA, supported by its National Member Associations and Individual Members, is the Serving Shipmasters‘ International Voice with Consultative Status at both, the International Maritime Organisation (IMO) and the International Labour Organisation (ILO).

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# Contents

# An Introduction to IFSMA

IFSMA SECRETARIAT

**IFSMA**, the International Federation of Shipmasters' Associations, was formed in 1974 when eight Associations of Shipmasters decided to unite their members from across the world in a single professional co-ordinated body. This non-profit apolitical organisation dedicates itself solely to the interests of the serving shipmaster, almost 15,000 of whom make up this federation. They come from about 65 countries either through their National Associations or as individual members.

**IFSMA** exists to uphold international standards of professional competence for seafarers. The federation's policy is to ensure safe operational practices, to prevent human injury, protect the marine environment and safety of life and property at sea.

**IFSMA** maintains its headquarters in London, close to IMO, the International Maritime Organisation.

**IFSMA** gained Consultative Status as a non-governmental organisation at IMO in 1975, which enables it to represent the unfiltered views of its members and protect their interests in an unfettered way. A Secretary General and a team of active or former shipmasters represent IFSMA at IMO and help the federation to function effectively there. These agents of IFSMA attend the four main IMO committees, namely the Maritime Safety Committee, Maritime Environmental Protection Committee, the Legal Committee and the Facilitation Committee. This team is also active in the nine sub-committees of IMO, the organisation's working and drafting groups, council meetings and assemblies. ■

# Welcome to Istanbul, Turkey

## OPENING ADDRESS BY CAPTAIN HANS SANDE, IFSMA PRESIDENT, TO THE 42ND ANNUAL GENERAL ASSEMBLY

We are very grateful to the Turkish Ocean-Going Masters' Association for inviting us to this beautiful city of Istanbul. On behalf of IFSMA I welcome you all to Istanbul, Turkey, especially to our new Secretary General Jim Scorer and others who are attending an IFSMA AGA for the first time.

I also take this opportunity to once again thank last year's host Nautilus Chile, for their hospitality in Viña del Mar, beside the port of Valparaiso, Chile. A long way to travel for those not based in South America, but I'm sure you will agree, well worth the effort.

All is not well in the world, I am sure you will join me in sending our deepest condolences to those countries recently subject to terrorist attacks, including France, Belgium, Pakistan and Turkey, I sincerely hope there is no need to expand this list of countries between the time of writing and giving this address.

2016 is a year of renewal for IFSMA. We have a new Strategic Plan which we will introduce to you later, a new Secretary General, and new IFSMA Members, including KPIP Association from Indonesia.

### IFSMA 42 years on

The International Federation of Shipmasters' Associations (IFSMA) was founded in 1974 by eight National Shipmasters' Associations to unite the world's serving Shipmasters into a single professional co-ordinated body.

IFSMA is today the only fully international professional organisation that unites and represents the world's serving Shipmasters. IFSMA is a non-profit making, apolitical organisation, dedicated solely to the interests of the serving Shipmaster. Our objectives as a Federation are to ensure safe operational practices, to prevent human injury, to protect the marine environment and to ensure the safety of life and property at sea.

*Captain Hans Sande, IFSMA President*

At the AGA this year we have, what some might call, a couple of futuristic presentations: "Technology Integration in Modern Ship Management Practices" and "Smart Ships", I hope these, and the other subjects presented, will promote useful discussion amongst you, or at least make you think carefully about these subjects.

It gives me great pleasure to open the IFSMA 42nd Annual General Assembly. ■

# Recognition for the Professional Mariner

BY CAPTAIN JOHN MCCANN & CAPTAIN ANTHONY PATTERSON,
COMPANY OF MASTER MARINERS OF CANADA (CMMC), CANADA


### Abstract

Recognizing the need to encourage professionalism within the Canadian maritime industry, the Master Mariners of Canada implemented a professional development program for its members in 2015. This paper describes the program as well as the benefits to the broader maritime community in having such a program in place.


### Background

A key objective of Master Mariners of Canada ("Company of Master Mariners of Canada") is to maintain the high and honourable standards of the nautical profession. Established in 1967, the MASTER MARINERS OF CANADA hosts a wide variety of activities, such as seminars, workshops and conferences, to help maintain a high standard of professionalism within the Canadian maritime industry.

Canada has a long tradition of training and certifying seafarers. In 1867, with the formation of the new Dominion of Canada, one of the first acts of the new Parliament was to implement a certification system for Masters and to have the Canadian certificates recognized by the United Kingdom as being equivalent to those issued under the Merchant Shipping Act. By 1870 the Canadian system was recognized and Canadian shipping companies were able to trade with Great Britain using Canadian crews. This was a major milestone in the development of the Canadian economy and in the establishment of its merchant service.

146 years later, Canada with its harsh operating conditions and long coastlines of environmentally sensitive areas, continues to rely upon high standards of excellence in seafarers to meet public expectations regarding maritime safety, protection of the environment and the economic transportation of goods by sea.

Since its early days, training and certification of seafarers in Canada has grown and evolved into the internationally recognized system established by the International Maritime Organization ("IMO") through the International Convention on Standards of Training Certification and Watchkeeping for Seafarers ("STCW"). STCW is one of the three primary instruments used by the IMO to address the 'Human Factor' which is viewed as a key element in maintaining a safe, secure and environmentally sound maritime transportation system.

STCW evolved from the competence verification systems which began in the 1800's and is primarily focussed on the assessment of the 'knowledge, understanding and proficiency' of a seafarer to perform their job. Over time, it has been recognized that non-technical skills like leadership and professionalism have a profound impact on managing the human element. While the Manila Amendments to STCW introduced more non-technical elements to the mandatory syllabus, e.g.: Bridge Resource Management, improving professionalism within the industry is not a mandatory element of the Convention.

That is not to say that professionalism is not viewed by IMO as an important part of addressing the human element. Indeed Resolution 7 (Promotion of technical knowledge, skills and professionalism of seafarers) and Resolution 12 (Attracting new entrants to, and retaining seafarers in, the maritime profession) of the Manila Amendments to the STCW both encourage the industry to do its utmost to "instil pride in the maritime profession and encourage the creation of a safety culture and environmental conscience among all those who serve on their ships". Indeed, Resolution 7 goes one step further by recommending that companies establish criteria for selecting seafarers who exhibit the "highest practicable standards of technical knowledge, skills and professionalism".

Although international conventions have evolved over time, they lag behind the leading edges of the maritime industry. Shipboard practices and technologies used within ▶

the industry are being implemented at a rapid rate. There is a requirement for practitioners within the industry to keep abreast of new developments so that the overall productivity of the sector can keep pace with the needs of modern society. MASTER MARINERS OF CANADA believes that it is very easy for a practitioner to get left behind if they do not spend efforts to keep up to date. Unfortunately there are no explicit requirements under the certification system for seafarers to engage in professional development activities.

MASTER MARINERS OF CANADA reflected on the desires by the international community to improve professionalism amongst seafarer and the need to encourage voluntary efforts to engage in professional development activities. In the view of MASTER MARINERS OF CANADA, there was a need to implement a program to encourage - and recognize - voluntary efforts by its members to engage in professional development activities.

### Description of the Program

On October 6, 2013 MASTER MARINERS OF CANADA initiated a project to develop a professional development program, and on April 16, 2015 the program was approved by the Board of Directors. The fist letters of acknowledgement were issued to members in February 2016. When developing its program, MASTER MARINERS OF CANADA reviewed similar programs in Canada employed by the legal, medical, engineering, education and financial management sectors.

All members of MASTER MARINERS OF CANADA, in good standing, are eligible to participate in the professional development program. The program is voluntary and there are no requirements for members to participate.

MASTER MARINERS OF CANADA adopted a broad definition of the maritime industry for the purposes of the program in recognition that many of its members are working in shore positions. The fundamental criterion for defining the maritime industry is as follows:

> *"the maritime industry is defined to include all activities connected with ships and shipping in which the specialized competencies, or the sea-going background, of the Member is used to provide professional services."*

Professional activities are subdivided into the following four main categories:

#### Professional Practice:

Professional practice includes all activities undertaken by participating Members working in the maritime industry. If the primary work of the participating Member also includes elements from the other categories of professional activities, then the activities in question shall be considered as part of professional practice.


*Captain John McCann (seated 1st from right) and Captain Anthony Patterson (standing 2nd from right)*

#### Education Activities:

Education activities include all activities undertaken by participating Members to increase their own personal knowledge of the maritime industry. Education activities paid for by a participating Member's employer are eligible to be counted as credit towards the Professional Development Program.

Contribution to Knowledge. Contributions to Knowledge include all activities undertaken by participating Members to increase the overall knowledge base within the maritime industry. The writing of this paper is an example of a professional activity which would receive credit under the 'Contribution to Knowledge' category.

#### Community Participation:

Community participation includes all activities undertaken by the participating Member to increase the overall awareness of the maritime industry within the general public and to enhance the dignity and prestige of the maritime profession.

The professional development program recognizes two professional categories. The first category is Members who are currently working in the maritime industry ("Practicing Maritime Professional"). The second category is Members who are no longer active in the maritime industry ("Non-Practicing Maritime Professional"). To be considered active, the Member must have completed three months of full-time employment within the maritime industry within the calendar year. ▶

In order to receive recognition of professional activities, certain minimum criteria must be met. In developing its program, MASTER MARINERS OF CANADA opted for a credit system as opposed to an hours based system. Guidelines have been developed to assign credit values to different examples of activities under each of the four (4) broad categories listed above. For example, submitting a paper to the IFSMA AGA has been assigned a value of 10 professional credits. To encourage continual professional development, surplus professional credits cannot be transferred from one calendar year to the other.

The table below outlines the minimum criteria for recognition under the program:

<table>
<tr><th>Activity</th><th>Practicing Maritime Professional</th><th>Non-Practicing Maritime Professional</th></tr>
<tr><td>Professional Practice</td><td>Minimum of 3 month of full-time employment in the maritime industry</td><td>Not Applicable</td></tr>
<tr><td>Education Activities</td><td rowspan="3">A total of 20 professional development credits in the calendar year</td><td rowspan="3">A total of 20 professional development credits in the calendar year</td></tr>
<tr><td>Contribution to Knowledge</td></tr>
<tr><td>Community Participation</td></tr>
</table>

### Benefits

The overall benefit of the professional development program is to enhance safety, security, environmental protection and the overall efficiency of maritime industry by maintaining high professional standards through the enhancement of professional practice.

MASTER MARINERS OF CANADA and its members also receive tangible benefits from the program such as:

1. Providing participating members with documentary evidence that professional development activities have been undertaken;
2. Provides opportunity for peer recognition;
3. Provides opportunity for knowledge transfer to others;
4. Builds and strengthens MASTER MARINERS OF CANADA as a professional body; and,
5. Establishes and maintains a professional relationship with the maritime industry.

Industry also benefits by enabling them to improve their operations by enhancing their ability to implement the recommendation contained in Resolution 7 of the Manila Amendments to STCW. Through participating in the voluntary program created by MASTER MARINERS OF CANADA, seafarers will be able to provide evidence that they are exceeding the minimum standards set by legislation and have set a high standard of professionalism for themselves. MASTER MARINERS OF CANADA believes that the combination of competence and professional attitudes help in the formation of high reliability organizations with strong safety cultures.

Finally, the profession itself benefits from a program of professional development. Before embarking of the development of its program, MASTER MARINERS OF CANADA identified the lack of a professional development program was a gap in the nautical profession. Implementing our program in 2015 addresses the gap and provides a critical mechanism through which the profession as a whole can be improved. With a cohort of members seeking opportunities to undertake professional development activities, we envision that we will be able to make progress in other critical areas such as the enhancement of the current Code of Ethics and the enhancement of maintaining the body of knowledge upon which the profession relies. ■

# BWM Convention and BW Treatment

BY CAPTAIN A. TUĞSAN IŞIAÇIK ÇOLAK,
TURKISH OCEAN-GOING MASTERS' ASSOCIATION (TOGMA), TURKEY

## 1. Introduction

Across the globe marine and freshwater ecosystems are being invaded by non-native organisms. These invasions are referred to as 'bioinvasions'. Bioinvasions consist of the transport of plants, animals, bacteria, viruses and fungi to new environments where these newly introduced organisms have the potential to detrimentally affect ecosystems.

There are a number of ways in which organisms have successfully spread to new environments and this is possible due to easy transport routes, both natural and human-aided, throughout the oceans.

Most transport vectors are associated with human activity and those which are currently responsible for the most introductions are related to the shipping industry i.e. through hull fouling communities and the water in ballast tanks and sea chests.

Ballast water is ambient water which is loaded into ballast tanks and is required by vessels for stability and trim when the ship is empty of cargo to keep the propellers submerged when the ship is not fully loaded and to compensate for the altering weight of the vessel as cargo is loaded and unloaded at different ports. The uptake of ballast water generally occurs as cargo is being unloaded from the vessel, water is pumped from the immediate water surrounding the vessel into the ballast tanks through filters which remove larger, adult organisms but do not prevent the uptake of plankton. There is a vital need for adequate treatments to be developed to prevent this constant movement of organisms to new areas where they are establishing populations to the detriment of the local flora and fauna.

## 2. Ballast Water

When ships were first built years ago, they carried solid ballast, in form of rocks, sand or metal. However, since around 1880, ships have used water as ballast principally because it is more readily available, much easier to load on and off a ship, and is therefore more efficient and economical than solid ballast. When a ship is empty of cargo, it fills with ballast water. When it loads cargo, the ballast water is discharged.

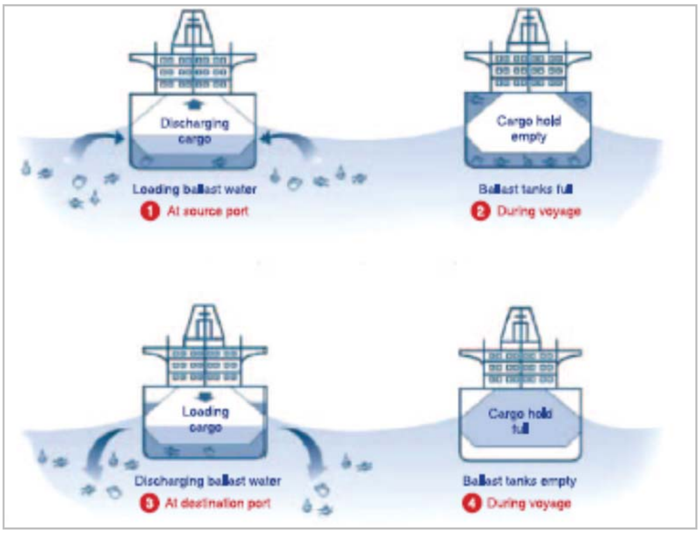



*Figure 1: Ballast Operations*

### 2.1 Ballast Water Features

Ballast water, in a simple explanation, is seawater. Analyzing of the physical, chemical and oceanographic composition of seawater means, to scrutinize the ballast water. Seawater is defined as "a complex solution of dissolved mineral, elements and salts" and it contains all of the known stable elements in various concentrations.

The world seas have different characteristics. Living organism profiles in seas vary according to different salinity rates, pH degrees, temperatures, current factors and nutrient densities. As of the species living in seawater with high salinity have difficulty in surviving in brackish water environment, also they can adapt to a different form (resting stage) or not able to survive. ▶

### 2.2 Why Ships takes Ballast?

The reasons of taking ballast water for the ships are to ensure safety of the voyage, by providing similar stability and strength values of laden condition, to enable efficient and effective operation of their propellers, to increase the draft and change the trim to regulate the stability, to maintain stress loads within acceptable limits, to ensure the structural integrity, to ensure that the vessel stays upright. vessels have special tanks for the ballast. Locations and shapes of these tanks vary according to vessel types. In many vessels, double-bottom tanks, side tanks, forepeak and aft-peak tanks, hooper tanks and wing tanks are used as the ballast tank. In some exceptional cases, vessels can also take in ballast water in their cargo spaces (holds or cargo tanks).

### 3. Effect of Ballast Water to the Marine Enviroment.

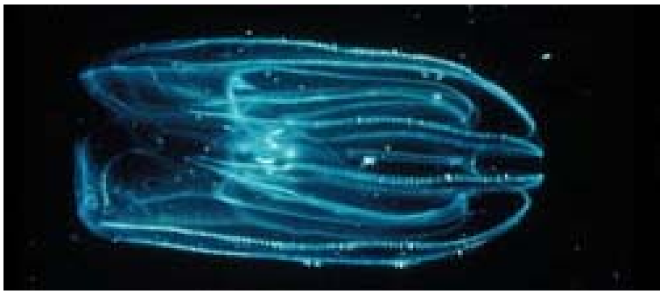
Ballast water serves as a vector for the transfer of species from one part of the world to another. Where this new area is outside of its natural geographic range, the species which has been transferred is commonly known as an alien species (alternative terms are non-native or non-indigenous). If the environmental conditions in this new geographic area are suitable, the alien species may then not only survive, but may establish and spread, in many cases causing, or with the potential to cause, harm to the local environment, economy, or human health. Such species are generally called invasive alien species.

According to the BWM Convention; Harmful Aquatic Organisms and Pathogens' means aquatic organisms or pathogens which, if introduced into the sea including estuaries, or into fresh water courses, may create hazards to the environment, human health, property or resources, impair biological diversity or interfere with other legitimate uses of such areas.

Invasive alien species are now generally recognized as one of the greatest threats to biodiversity globally. They also have serious economic, environmental and health impacts and, as a result, place major constraints on development. An example for Human health impacts; There is evidence that cholera epidemics can be directly associated with ballast water discharges. While Vibrio cholerae and other pathogens are normal constituents of coastal waters, they do not ordinarily occur in high enough concentrations to cause human health problems. However, with expanding world trade and an increasing number of ships moving among international ports, the transfer of microbes could well be the most insidious threat related to ballast water discharge. In addition to bacteria and viruses, ballast water can also transfer a range of species of microalgae, including toxic species that may form harmful algae blooms or 'red tides'. The public health impact of such outbreaks is well documented and includes paralytic shellfish poisoning, which can cause severe illness and even death in humans.

Worst Examples and Their Harmful Effect on Marine Environment some of the worst invaders recorded, such as:

- North American comb jellyfish that helped to virtually wipe out anchovy and sprat stocks in the Black Sea in the late 1980s and that has now spread to and continues to expand in the Caspian Sea as well as in the North Sea and the Baltic Sea



- Red mysid shrimp, a native to fresh and brackish waters around the Black and Caspian Seas, now in the Baltic Sea, the Rhine River (Germany) and discovered in the North Sea spreading from the Netherlands in 1997 to Belgium, France, England, and Ireland. Within two years of its 2006 arrival in US Lakes from Europe,. Significant impacts on the ecosystem are feared due to its wide diet that includes zooplankton and algae
- Chinese mitten crab, now found in estuaries and rivers bordering the North Sea, Baltic Sea and the North American Atlantic and Pacific coasts, causing greatly altered habitats and erosion of river banks due to its extensive burrowing habits, as well as clogging of industrial water systems.

- Zebra mussel, first found in the Great Lakes in 1988. This mussel is native to the Caspian Sea region of Asia. Colonies of zebra mussels (as many as 1500 individuals per square meter) may accumulate and clog water-intake pipes and screens of drinking water facilities, industrial facilities, power generating plants, golf course irrigation pipes, cooling systems of boat engines, and boat hulls. ▶

- o <u>Harmful Algal Blooms</u>, harmful algae which can cause red tides, were transported to Austrialian waters from Southeast Asia. Some species can cause paralytic shellfish poisoning and harm local shellfish industires.

- o <u>Vessel Fouling</u>, Community of organisms that attach or associate with submerged portions of structures. On vessels, highest density in "niche" areas: sea chests, around rudder, dry dock strips.

## 4. Ballast Water Convention

Ballast Water Convention's purpose is specified by IMO as follows: "to prevent, minimize and ultimately eliminate the risk of introduction of Harmful Aquatic Organisms and Pathogens which use the ballast water as a hub.

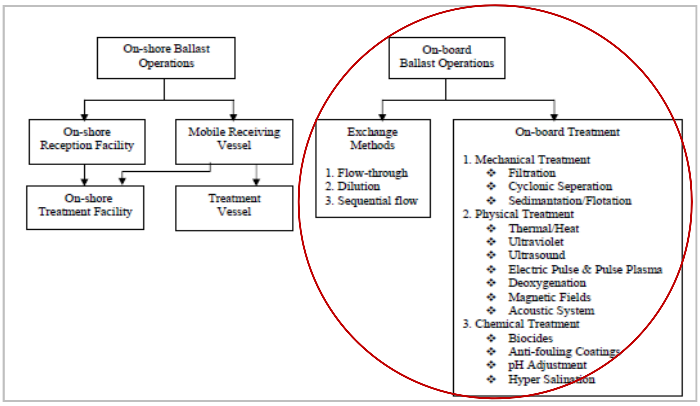
### 4.1 Methods Recommended in the Convention

The Convention suggests two different methods, in order to minimise the problems caused by the transfer of ballast waters: the exchange method and treatment alternatives. Ships will be required to treat ballast water in accordance with the timetable, as shown in Table. According to this table, the first key milestone was in 2009, when ships under construction during or after that date having less than 5,000 m3 ballast water capacity were required to have ballast water treatment installed to meet the D-2 Standard in the Convention. However, as the Convention is not yet in force internationally, these dates cannot currently be enforced.

| Ballast capacity | Year of ship construction* | | | |
|---|---|---|---|---|
| | Before 2009 | 2009+ | 2009-2011 | 2012+ |
| < 1,500 m³ | Ballast water exchange or treatment until 2016 Ballast water treatment only from 2016 | Ballast water treatment only | | |
| 1,500 – 5,000 m³ | Ballast water exchange or treatment until 2014 Ballast water treatment only from 2014 | Ballast water treatment only | | |
| > 5,000 m³ | Ballast water exchange or treatment until 2016 Ballast water treatment only from 2016 | | Ballast water exchange or treatment until 2016 Ballast water treatment only from 2016 | Ballast water treatment only |

### 4.2 On Board Ballast Operations

After the adoption of International Ballast Water Convention, many scientific and technological researches were held and proposed management alternatives. The main headings of these alternatives are ballast water exchange, on-board treatment and onshore treatment. The diagram below provides information on the contents of Ballast Water Management options.




The first step of the ballast management is to take in as clean as possible ballast.

Not Ballasting;

- o in areas that are known to contain harmful organisms or phytoplankton blooms, in areas with local outbreaks of infectious water-borne diseases, with poor tidal flushing, with high sediment loads, near sewage discharges, dredging operations in shallow water, where propellers may stir up the sediment, not ballasting at seasons when harmful plankton are abundant,

Also;

at night when many types of organisms - benthic, epibenthic and planktonic organisms - migrate closer to the surface,

- o ballasting through intakes located high on the ship's hull when in shallow water, to avoid entraining bottom sediments or organisms living near the bottom ▶

- loading fresh water as ballast when expecting to deballast in salt water; and salt water as ballast when expecting to deballast in fresh water.

Not disposing / deballasting;

- of ballast tank sediments,
- near aquaculture areas, seafood harvesting areas, marine sanctuaries or parks, coral reefs or other sensitive sites.

### 4.2.1 Ballast Exchange Method

The main method suggested by IMO in the Convention is the exchange method. Careful and attentive practice of this method is necessary, in order to maintain it as an alternative until 2016. By using exchange method, the species taken in from coastal environment thru ballast water and exchanged via exchanged method during the voyage, are no longer coastal species, therefore exchanged species due to the different ecosystem shall not be able to survive at the environment of the destination port. Negative weather/sea conditions cause the stability of the vessel and pressurizing ballast tanks damage the ship during the exchange operation. there are many restricting factors of the ballast water exchange operation, the most important effect is stabilty due to low GM, exceeding limits of BM and SF and free surface effect. Three different types of exchange methods are stated in the Convention: **Sequential Method**, **Dilution Method**, and **Flow-through Method**.

**Sequential Method** as “a process by which a ballast tank intended for the carriage of ballast water is first emptied and then refilled with replacement ballast water to achieve at least a 95 per cent volumetric exchange.”

**Dilution Method** is “a process by which replacement ballast water is filled through the top of the ballast tank intended for the carriage of ballast water with simultaneous discharge from the bottom at the same flow rate and maintaining a constant level in the tank throughout the ballast exchange operation.”

**Flow-through Method** as “a process by which replacement ballast water is pumped into a ballast tank intended for the carriage of ballast water, allowing water to flow through overflow or other arrangements.” The flow-through method involves pumping open-ocean water into a full ballast tank. Ballast equal to approximately three times the tank capacity must be pumped through the tank to achieve 95% effectiveness in eliminating aquatic organisms.

### 4.2.2 Ballast Water Treatment Systems

Mechanical, physical and chemical types of process technology used in ballast water treatment. This section 'Ballast Water Treatment System' is citation from PhD Thesis, İnmeler C., Ballast Water Management In Tankers.

Mechanical Treatment

Filtration, cyclonic seperation and sedimentation/flotation are among the alternatives of mechanical treatment.

- Filtration:
  Inactivation Process: Ballast water can be filtered before it enters the tanks or while it is being discharged. The advantage to filtering as water is pumped into the tanks is that organisms that are filtered out may be retained in their native habitat. If ballast water is filtered while being discharged, proper disposal of organisms is required to eliminate accidental introductions. A back washing mechanism cleans the filters and collects organisms to prevent their accidental release.
- Cyclonic Separation:
  Inactivation Process: The system basically vortexes the water, forcing the heavier particles to the outer portion of the pipe. Once this occurs, then the outer portion of the water can be separated out or the particles can be collected in some type of collection system.

Physical Treatment

Thermal (heat), ultraviolet, ultrasound, electric pulse & pulse plasma, deoxygenation, magnetic fields and acoustic systems are among the alternatives of physical treatment.

- Thermal (Heat) Treatment:
  Inactivation Process: Heat kills aquatic organisms by denaturing cellular proteins and/or increasing metabolism beyond sustainable levels. Death by metabolism shutdown generally occurs quicker and at lower temperatures for more complex organisms. Thermal treatment effectiveness is a function of species’ tolerances, temperature, and exposure period. Most microorganisms are able to tolerate relatively high temperatures for short periods, and lower temperatures for longer periods.
- Ultraviolet (UV):
  Inactivation Prosess: UV treatment triggers photochemical reaction of cellular nucleic acids. When a microorganism is exposed to UV radiation, the energy is absorbed by the organism’s DNA. If the organism receives a sufficient number of UV photons in a short period, covalent bonds form between adjacent bases in the DNA. The formation of these bonds prevents the organism’s DNA from being "unzipped" for replication, and the organism’s cells are unable to reproduce.
- Ultrasound:
  Inactivation Process: Acoustic systems use transducers to apply sound energy of specified amplitude and frequency to water to be treated. Ultrasonic systems use transducers to convert electrical energy into vibratory energy of a specific amplitude and frequency. ▶

When this energy is passed through liquid, microscopic gas bubbles quickly form, expand, and implode. In the area immediately surrounding the bubbles, there are extreme temperatures and pressures, which increase chemical reactivity, polymer degradation, and free-radical production. Exposure of aquatic microorganism to ultrasonic treatment results in cellular disruption and organism death.

- Electric Pulse:
  Inactivation Process: In pulsed electrical field technology short burst of energy are used to kill organisms in water. In pulsed electrical field technology, water is passed between two metal electrodes. The water is subjected to an electric pulse which produces short energy bursts at a very high power density and pressure. The energy generated, and transferred to the water, is strong enough to electrocute an organism. If used in a ballast water application, the transfer of energy would theoretically kill the non-indigenious species.
- Deoxygenation (Oxygen Deprivation):
  Inactivation Process: This treatment accomplishes the removal of ballast water organisms by extracting the dissolved oxygen from ballast water. One of the method is purging the oxygen from the ballast tanks with nitrogen through the use of chemical additives,
- Magnetic Fields:
  Inactivation Process: Strong magnetic forces interfere with organism pH levels, which in turn support the cell's organelles and proteins. Magnetic forces also interfere with the flow of ions in the cell membrane, resulting in death. A typical magnetic system consists of a magnet or electromagnet attached to the piping system.

### Chemical Treatment

Biocides, anti-fouling coatings, pH adjustment and hyper salination are among the alternatives of chemical treatment.

- Biocides:
  Means of Application: Biocides could be applied in two ways:
  1. Concentrated solid or liquid chemicals could be added to ballast water in certain ratio. The amount of pre-mixed liquid biocide could be added via feeding lines to the main line with the main ballast pumps.
  2. It could be generated electrolytically from sea water.
- Oxidizing Biocides:
  Inactivation process: Oxidizing biocides act by destroying cell membranes which leads to cell death is hazardous for organisms. Oxidizing biocides include, but are not limited to, chlorine, bromine, iodine and their multiple compounds, chlorine dioxide +-(ClO2) and hypochlorites (e.g., NaOCl), hydrogen peroxide(H2O2), ozone (O3) and Paraclean® peroxy acetic acid.
- Non-oxidizing Biocides:
  Inactivation process: Non-oxidizing biocides act by interfering with a necessary life function such as metabolism or reproduction (the physiological and metabolic processes of organisms). Non-oxidizing biocides include, but are not limited to, such compounds as Acrolein®, Seakleen®, Peraclean® Ocean, tributlytin, dissolved copper, dissolved silver, glutaraldehyde, and organic acids.
- Ph Adjustment:
  Inactivation Proccess: Sudden changes in pH, and the addition of an acidic or alkaline compound to increase or decrease the pH of ballast water has been considered as a method of disinfecting ballast water. The corrosion rate of carbon steel is not influenced by pH over the range of 4.5 to 9.5 in distilled and tap water. Below pH 4.0, hydrogen evolution begins and corrosion increases dramatically.
- Hyper Salination:
  Inactivation Proccess: Hyper salination involves the addition of large quantities of sodium chloride (salt) to ballast water to create a super-saline environment. The sudden increase to extreme levels of salinity destroys cells through dehydration.

## Conclusion

IMO Ballast Water Convention is essential to prevent further spread of invasive species and their potentially devastating impacts on ecology and economy in areas where they do not belong. Various systems were developed under mechanical, physical and chemical treatment categories that address to various vessel types, sizes and ballast capacities. Nowadays, compact treatment systems are developed which use the state-of-the-art technology, having relatively lower costs, with minimum human factor, owing to the experiments conducted both in laboratories and on-board.

Each of the ballast treatment alternatives eliminates different living organisms with different methods. While the living organisms that are affected by each system are different, the systems have many advantages and some drawbacks within themselves. In short, no system is perfect stand-alone. The most used combination systems and the comparasion of the systems will be briefly explained with presentation. ■

Please note: The references have been removed from this paper. To receive a copy with the references included please send an email request to hq@ifmsa.org.

# Electrostatic Discharges on Board Ships Tanks

BY CAPTAIN DOMINIQUE PERROT,
ASSOCIATION DES CAPITAINES ET OFFICIERS DE LA MARINE MARCHANDE (ACOMM), FRANCE

Does this kind of discharge present a real danger in ships tanks transporting dangerous goods? Indeed it does, this kind of discharge is present each time a cargo is loaded or discharged due to: tank washing, the speed of the fluids in the pipes, the decantation, and the wear of materials against others. The atmosphere of a tank could reach a very high potential of load. To keep it, then to dissipate it with time, or to bring on a disaster if the mixture of air and hydrocarbon is within the limit of explosiveness and an external element allows the discharge of energy contained in a tank atmosphere.

The causes of this risk are known:

- The flow of the fluids in the collectors or in the filters
- The settling of solid particles or another not miscible liquid, has fault a liquid.
- The passage of solid or liquid particles has fault a buzzard of reduced diameter.
- The projection of a fluid of wash on partitions and elements of structure.
- The abrasion of certain synthetic substances, following frictions extended.

The electrostatic load accumulates over time, it needs a favourable atmosphere and a source of ignition, such as a spark. To determine the risk a metallic probe, acting as a type of lightning conductor, can be used as.

A number of accidents on tankers that take place are caused by this problem, although the exact number is unknown, a large number are likely to be caused by electrostatic discharge.

We now have a good knowledge of this phenomenon, so we are able to determine on which factor to act, to limit the creation of electrostatic charge and avoid electrostatic discharge or modify the gaseous characteristics of the atmosphere of tanks to avoid combustion.

Further to the loss of human lives, the risks of pollution and the financial losses which such accidents involve, OCIMF (Oil Companies International Marine Forum) created a department to regulate and so reduce the risks of explosions as a consequence to electrostatic discharges in flammable atmosphere. The ISGOT Guide (International Safety Guide for Oil Tankers and Terminals) is approved by the IMO (International Maritime Organization) and serves as a reference internationally. Although private or public bodies and shipping lines conduct research and publish their own safety instructions, the benchmark is the IMO Guidelines.

## RISK OF EXPLOSION: Required Conditions

The development of an electrostatic charge does not alone present a risk of fire or explosion. There should also be a discharge or recombination of separated positive and negative charge which we name Electrostatic discharge. For this to be at the origin of a fire or an explosion, four conditions must be met:

1. The necessary conditions for the development of a static load
2. It has to exist in such a away as to accumulate the electrostatic charge
3. There should be an electrostatic discharge of sufficient energy
4. The discharge takes place in an environment with and explosive atmosphere.

## DEVELOPMENT OF STATIC LOAD

### Flow in the conducts

The presence of solitary ions resulting from impurities and the corrosion inside the collectors are examples at the origin of the losses of electronic potential of the fluid. The flow of electrons in the liquid results from the oxidation ▶

of the metal. Often, it is the conduct which gains electrons and takes charge negatively to the detriment of the hydrocarbon which loses electrons and takes charge positively. This action is marked all the more as the speed of the fluid is high.

### Use of vapour or water of wash

The clouds of steam formed during the tank washing, using hot or cold water, can be charged electrostatically. The risks are all the more important if the tank is big. These charges in the vapour cloud can be strongly increased with the use of products in the wash. The steam creates a cloud of vapour highly charged very quickly, much more than a simple wash using water; we call this the cracking.

### Load by the dome

When the fluid is loaded by the dome and when it falls from the height of the tank, it acquires a sufficient potential energy so that in the shock against the top of the ballast, molecules break up and create an ionized cloud. We find ourselves then in the configuration of a cloud of vapour emitted by characteristics appropriate to the fluid loaded. If it has a low conductivity, the risk of electrostatic discharge is real.

### Introduction of air or inert gas at the bottom of the tank

The action of the surfacing bubbles when we introduce a gas in the bottom of the tank will shake the fluid which risks changing its molecular structure along the column of gas by ionizing. The gives a high risk of a difference in electrical potential.

### PVC pipes

Pipes made of PVC being of use for the stripping of the cargo were implicated during the explosion of a barge. Plastics or pipes in polyethylene used for the ventilation of tanks generate a high static charge.

### Crude oil washing

During crude oil washing, a jet of 12 bars collides with the bulkheads and the bottom of tank. The energy of the water pressure converted to kinetic energy by the reduction of diameter of nozzles is big enough to break the molecules in the crude oil residues and so to charge the wall and the cloud of hydrocarbon which results from it.

### Oil/Bulk ore carriers

Holds on these ships spread out over the width of the ship and offer a large surface area, if ships are not equipped with "stowage automatic tanks", this displacement of cargo can produce clouds of charged dust which present risks of explosion if they are blown in the direction of zones with explosive atmosphere. ▶

## HOW TO LIMIT STATIC GENERATION

1. During the conception of ships and terminals:

Oil tankers and chemical tanker are built in agreement with the existing regulations (ICS, ISGOTT, SOLAS)

- Cargo pumps must be designed in steel, or steel stainless mouldings. The use of pumps at variable flow rates is recommended in view of the highest loading flow and progress must be carefully monitored during the duration of the load.


- Immersed portable pumps used in case of break-down by the main pump or in case of anti-pollution measures must be carefully bonded to the ship before use.
- Filters must be also bonded to the ship

2. Precautions in the load:

For static accumulators, liquids such as natural gasoline, fuel, white spirit, jet fuel oil, naphtha, heating oil, solvents, aromatic products ... The percentage of oxygen in the tank must never exceed 8%. A reduction of the flow rate should be adopted at the beginning of the loading operation until the drop-line is covered. The same precautions should be taken during discharge operations.

3. Blowing of lines:

To avoid any contamination of cargo during subsequent commercial operations, the lines must be blown into the tanks at the end of every load or into shore tanks in for discharge operations.

4. Washing:

The use of steam for the tank wash should never be used in a tank that has not been inerted.
A wash using hot water will always be preferred to steam being used due to the risk of static electricity gene-ration.

Reference should be made to the procedures for “Tank Cleaning guides" for these operations.

Insulating flanges should be used between the ship/shore connection and also on the Vapour Return Line/ Vapour Treatment Unit.

## CONTROLLING VAPOURS

The control of the atmospheric composition in tanks was the most improved means to avoid the danger of explosion with the appearance of inert gas installations and nitrogen generators following the first accidents on tankers.

To avoid the risk of fire and toxicity for the crew, it is preferable that vapours are not left in the tank atmosphere but are returned to the shore tank by the use of a Vapour Return Line or a Vapour Treatment Unit. These 2 systems allow a high rate of transfer without overpressure or depression in the tank.

## CONCLUSION

This phenomenon on board ships cannot be avoided. Thus it is necessary to make every effort to guard against this kind of accident by respecting "Ship/Shore safety list", procedures for washing, degassing and not giving in to commercial pressures to the detriment of the safety.

Human life is very precious and must be protected at all times. ■

# Paper vs. Action, Theory vs. Experience

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This paper was produced after several cases of difficulties in my practice as a pilot when trying to obey all the rules and regulations and filling up all the documents connected with the ISM Code, ISPS Code, ISO and other standards and at the same time doing a real job safely and smoothly.

In modern shipping we have too many forms to be filled in and too many preparations for every activity which is carried out onboard ship. The ISM Code has already been compulsory for more than 18 years. Everyday, more and more documents are issued to guide us every minute we are onboard a ship. In this paper I will cover just one specific procedure in everyday life onboard ship, the procedure of approaching a port, embarking the pilot and coming alongside. It's really quite different in different ports of the world but still we have some common features we could generalise.

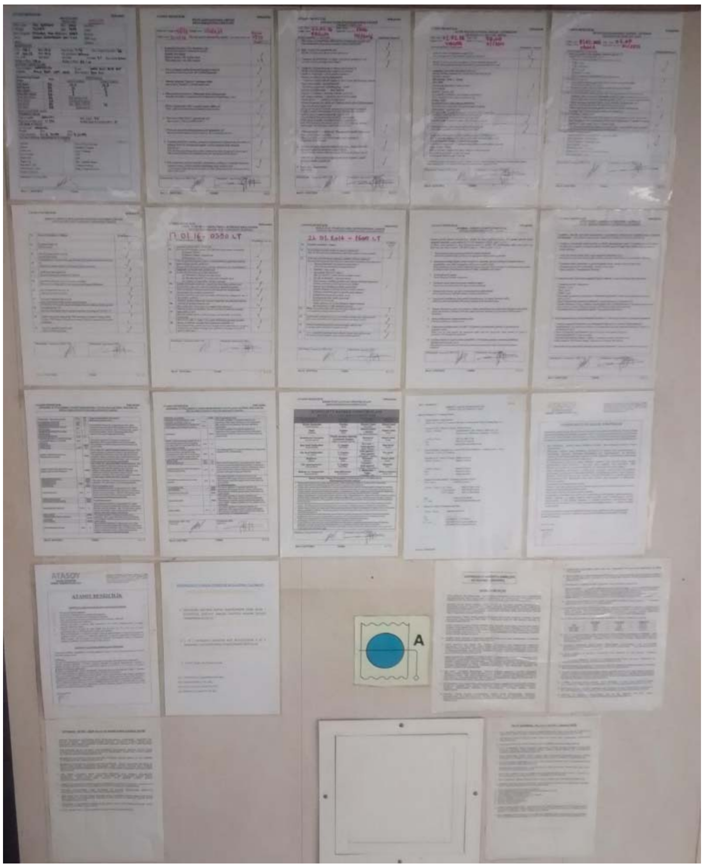

*Fig.1: Check lists posted on the bridge of a ship*

Each manoeuvre in the port is preceded by preparations from both the ship and the shore and each person engaged in such activities should do his job properly in order to ensure the entire venture is successful.

Let's start with the ship. Fig.1 shows one example of various checklists the officers on the bridge should use to prepare for an arrival or departure in port. Undoubtedly, each activity should be completed and every piece if equipment should be checked, starting from the wheel, radars, VHF stations, update of electronic charts, other navigational publications in use, etc. And if one forgets one item then the port state control officer, flag state control officer, ISM internal and external auditor, class surveyor or whoever else is inspecting the vessel, will make a remark or will record a deficiency, or non-conformity report, he will either detain the ship or make life on board more difficult with the corrective and/or preventive measures agreed.

In my practice as a pilot I estimate around 30 percent of the pilot cards are filled in with substantial information missing or remaining from a previous port. Sometimes the pilot card is just handed over to the pilot, after the passage, to be filed and to be available for inspection. The other side of the story is the pilot's preparation. With modern means of communication, the pilot is able to receive well in advance all the information for the ship – ship's particulars, the values of variables like drafts, air draft, dangerous cargo on board, any deficiencies, etc. Received well in advance that information is essential for the proper passage planning and preparation of master/pilot exchange form ▶

(MPAX form) with the disposition of tugs, the places where the tugs will be made fast, turning areas, communications with the VTS or terminal operators. It seems that everything is quite simple and smooth.

What is the reality? Very often ships receive information about ports at the very last moment and they have insufficient time to do all the preparations or as is the case with container ships, sometimes ports are coming one after another in a very short time and the crew, of 12 or 13, are carrying out the preparations and checklist inspections either formally, or they have the tick in the checklists permanently and most of the time inspections are simply not carried out at all. The usual excuses are “The ship is quite new and everything is in good order”, or “The passage from the last port is just few hours and there is no time and no need for something to be inspected as it had been inspected for the previous port”, etc. And it makes sense to be like that but when the problem comes, then that excuse does not work with the insurers, casualty investigators, administrations, or port state control inspectors. From the pilot’s point of view, it is not an unusual practice for the pilot to serve one ship after another and to prepare the MPAX form during the transportation from one ship to another. All the information is already on the web and the use of tablets or mobile phones is quite comfortable to review the information for the ship to be handled immediately online and to be able to plan the passage and manoeuvres properly. But sometimes the MPAX is also completed without the necessary care and attention.

What is the outcome if all the preparations are not accurate or if they are not done at all? The Shipmaster is not acquainted with the passage along the canals, speed restrictions, notifications or details of the berth and handling of tugs. On the other side the pilot is not aware of the ship’s characteristics and the transitory condition of the ship. If all is going well then there is no problem. But, if something goes wrong then the questions start to come out. In most of the cases the tasks could be completed properly if we sacrifice just a few minutes sleep or rest. However, if we should prioritize which one is more important, to fill in the form or other action, which to consider as priority?

Let’s consider the procedure for entering the port of Varna. The Pilot meets the ship east of the meridian of Cape Galata (see Fig.2). Normally, ships approach the pilot boarding area with minimum speed, usually six or more knots. Distance between the pilot boarding area and the position of meeting the tugs and entering confined waters is less than 1.5 nautical miles and the time available to exchange information is just few minutes.

In such circumstances it is more important to communicate with the tugs to give them instructions, to arrange lines for the tugs, to give commands to the engine and to arrange proper heading than to check and fill in papers. In that case signing of pilot cards, and other forms available especially on board tankers and other sophisticated ships, is not reasonable as one could lose situational awareness and any disturbance of attention could be crucial for the future development of the manoeuvres.

The same is valid for the Shipmaster regarding pilot papers. But if an accident happens then everybody would start asking why this and that form had not been filled in or signed. Generally, actions are more important than papers and papers should be done when time is available and nobody should be blamed if the pilot directs operations instead of filling up and signing papers. But one is blamed for not filling in papers in time and that is the reason of filling in forms without any actions behind the tick.

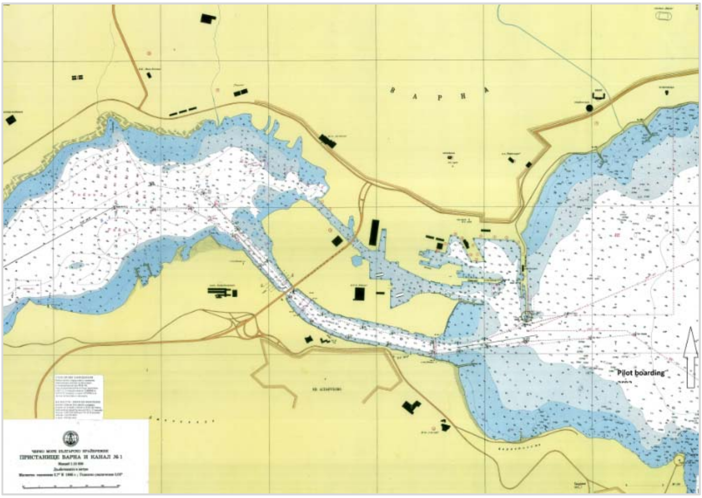


*Fig. 2: Port of Varna approaches*

The other important matter is qualification for the job. There are professions where the knowledge of theory is of prime importance like pure sciences, teaching and many others. Others are more experience dependent like weaving, embroidering, painting, shoe making. But most of the professions require either theory or experience. Nowadays, conning modern ships could not be done without mathematics, physics and a lot more knowledge. At the same time experience on board is without alternative. One could be an excellent mathematician or know all the forces applied to the ship when in motion but still not be ready to command a ship. Experience is necessary and when manoeuvring in port should have a feeling for the motion coming automatically. So, is theory or experience more important? Could we be successful professionals with just one of them? I would say we need both in balanced proportion and if one has more from any of them it is a benefit to the overall performance. ▶

In most ports of the world ships manoeuvre in confined waters. As the maritime industry is developing very fast, ships are becoming bigger and bigger and if one plans a terminal today in a few years time the terminal is already not comfortable for future generations of ships. Pilotage is the art of navigation. As an art it is dependent on the physical laws of motion of a vessel in a liquid. All ships sail the oceans because of the Archimedes principle but nobody on board the ship is even thinking of this when doing his every day job. So, we manoeuvre a ship in confined waters. We know that if we put the rudder hard to port the bow of the ship will start moving to port while the entire ship at the beginning will shift easy to starboard. It is quite fundamental but nobody is thinking of fundamentals. Our reactions should be almost always in less than a minute and if we miss the moment then the situations could go beyond our control. More or less the situation is the same when entering or leaving a lock, a floating or dry dock or when coming alongside or leaving a berth with little space.

So, is theory or experience is more important. I would say theory is something we start with. It is something necessary, compulsory. Then the experience comes. Without theory one could do pilotage but with theory you are doing it better and situational awareness and control of the motion of the ship is better if one knows the fundamentals and understands the physical process developing around the ship.

Yet, there is always a fight between good practitioners and theoreticians. Who is better, the one who could explain everything or the one who could do everything. The key to success is that the best ones are those maritime professionals who could do everything and who could explain their actions and who do their job in time and do it either on paper or in reality. When something is missing there is always risk of doing something wrong. Very often the act of god is of importance for the success or failure of any maritime venture. Let's say we are entering into a dry dock where on each side of the ship there are fifty centimetres available, which is not unusual in modern shipping, and the approaching area is narrow. Suddenly a gust of wind is coming and an accident happens. Whatever you do you can hardly escape from the trouble. But if a tick in any of the checklists is missing then one is in real trouble. It is quite obvious that the problem comes from an act of god, but the investigators will blame the person responsible for the checklist and that will increase his guilt for not completing the paper work.

Finally, the balanced approach between theory and practice and between action and paper is the best approach in modern shipping. Bridge team and bridge resource management are assigned to ensure that the problem has to be discussed during safety meetings, prebriefings, training and qualification courses. ■

**Delegates of the 41st IFSMA Annual General Assembly held in Viña del Mar, Chile on 16th and 17th April 2015**

# Challenges & Potential of Technology Integration

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**ABSTRACT**

This paper is based on the research project that explores the challenges and potential of technology integration in current ship management practices. While technology advancements were designed to be contributing to minimising task complexity, issues such as fatigue, increased administrative burden and technology assisted accidents still plague the industry. In spite of the clearly recognisable benefits of using modern technology in the management of ships, in practice its application appears lacking by a considerable margin. The main driver of the study was to appreciate the cause of this disparity.

The study first reviewed a wide body of literature on issues involving the use of technology which included academic literature with empirical evidences and theoretical explanations of implementation of technology at work. With the help of the extant knowledge this research embarked on providing an explanation to the gap that existed in the application of technology in the shipping industry. By taking a case study approach the thesis looked into the induction and integration of technology in the management and operation of ships that primarily interfaced closely between the ship and its management unit on shore. Three companies with mutually diverse management setup were studied. The fourth case comprised of purposefully selected senior members of ships' staff.

The analysis of the data revealed that the manifestation of the gap in technology implementation is caused by deeper influences at work in the shipping industry. The un-optimised technology integration results in the seafarer, who is the keystone to the technology application, becoming a victim of the circumstances. The technology that was intended to ease operations and burdens ends up in controlling him, even leaving him under-resourced and causing fatigue. This was not an unintended outcome but the result of weak regulatory practices, short-term capital outlook and weakened labour practices in the shipping industry all caused by wider social and economic developments affecting not just this industry but businesses globally. The impact of such influences was however more acute in this industry resulting in such extreme consequence.

By bringing to light the limited application of some fundamental principles of human-systems integration, this study has attempted to expand the boundaries of research on the subject and contributed to the holistic understanding of the various underlying factors that influence technology integration in ship management processes.

**Keywords:** *human-machine interface, optimisation, technology integration*

## 1. INTRODUCTION

Along with the concerns for human safety and environmentally safe operations, the key dimensions of service quality of shipping industry include operations and management efficiency which are characterised by the outcomes of service performance and enabled by technology applications for process efficiency. However, in the maritime field there is very little evidence of any proper research on technology integration and management systems and the factors that make them or prevent them from working optimally [25], [5], [42]. Sharma [36], in his study of the understanding of a service management framework in the ship management industry, finds that it primarily runs on heuristics and thumb rules. While technology advancements were designed to contribute to minimising task complexity and to mitigating human errors, issues of fatigue, increased administrative burden, technology assisted accidents etc. still plagued the industry.

Shipping as the principal service providing industry within transportation, produces this service with the ship as its core constituent unit that operates geographically remotely and in a high risk environment. Yet, technology inclu- ▶

ding information communication technology infrastructure is now seen to be increasingly rendering the ship manager capable of holistically managing ship operations effectively [24], [31], [25]. The effects of technological change and information technology are now changing the processes involved in ship operation and management, and are seen to be so dramatic that it can be compared to the effect brought about by change from sail to steam that changed the management structures, the technical aspects and the staff development needs of processes [11].

In order to achieve the objective effectively, the thesis delves into relevant literature, follows a qualitative methodology and presents and discusses extensive findings from empirical research before drawing conclusions. With the objective to delimit the research project in the architecture of ship management system, the function of 'technical management' that has greatest influence on the ship management practice is scoped.

## 2. ECONOMICS OF TECHNOLOGICAL CHANGE

Maritime transport serves world trade. The driving force that guides the efforts of any transport system is the quest to win more business by providing cheaper transport and a better service [41]. Thus it is not hard to see that the choice of economic logic for value creation in shipping has always been lowering of costs.

Technological change poses some of the most important concerns for shipping management in the current time. Shipping has evolved into an aggressively competitive market driven regime. Charterers are often replaced by traders who take short term view and prefer to hire ships they need from the spot market rather than charter long term [40]. This is also the case with ship owners who are more of asset players and may sell their vessels and buy new ones or move them in and out of third party management, depending on fluctuating market situations, making it difficult to plan investment in technology [37].

Frankel [14] points out that technology change decisions are usually made on the basis of economic and performance advantage, but the choice, timing, scale of introduction, and utilization of old as well as new technology is becoming more difficult now as new technologies become increasingly available long before the expiration of the economic life of existing technologies.

However, the development and deployment of technology is intimately bound with the notions of progress and a natural societal advance from a lower state to ever higher ones, a necessity characterised by integration or change from less coherent to more coherent forms [22]. Being a safety-critical industry, the deployment of technology focused more on its capability to enhance safety; and since safety management is an integral part of overall ship management, this area then inter alia got partially addressed with technology interface, but lacked in holistic approach. Knudsen [23] empirically finds that efforts to reduce accidents in seafaring have led to proliferation of procedures such as workplace assessments and checklists which not only increase avoidable work load but also are perceived by many seafarers as counteracting the use of common sense, experience, and professional knowledge epitomised in the concept of seamanship.

This points out to the lack of any scientific approach in the practice of technology integration in ship operations and management.

## 3. THEORY OF TECHNOLOGY INTEGRATION

Most rational decisions are based on some form of theory. It provides a conceptual framework and gives a perspective for the practical study of the subject. Thus, theory and practice are inseparable. Together they lead to a better understanding of factors influencing patterns of behaviour in work organisations and application of the process of management [7].

The theoretical models that examine the interaction between technology and organisation have evolved over a period of time. Nevertheless, technology has always been the central variable in organisational theory, guiding research and practice [30].

Arvanitis and Loukis [4] point out that, while technology plays a key role in an organisation, existing literature in operations management still holds an organisation-centric or a process-centric view when studying business entities. Despite the significant impacts of technology, the three way technology-organisation-process interaction has largely been neglected in literature [48], [17]. Technology, organisation structures and business processes are closely integrated and in any technology-intensive environment, organisation structures and business processes need to be developed or modified in simultaneity with technology development application [9]. The study of interaction between technology and organisation highlights some key issues [32], [49], [33]:



Technologies are products of their time and organisational context. While they have flexibility in interpretation, design and use, they are a function of hardware, organisation context and human factors that can be summarised in the following maxims:

a) The temporal and spatial distance between construction of technology and its application affects its flexibility. The greater the distance, the lesser the flexibility. ▶

b) The workplace culture and interacting human element also plays a key role in the deployment and application of technology.
c) There is a simultaneous mutual impact among technology, organisation and process.
d) Technology today is a driving force that stimulates changes within organisations.

## 4. RESEARCH METHODOLOGY

A qualitative, exploratory research approach with case study as strategy was considered appropriate. The focus was on examining how the shore based managers and ship board staff who are at the two vital ends of the technical management process perceive and cope with the changing nature of work and skills as a result of the technology integration into the management and operation practices. Case studies typically combine data collection techniques such as interviews, observation, questionnaires, and document analysis which were all used as research tools [47].

Four case studies were selected, three of which were company settings undertaking technical management of ships in a mutually varied structure of constitution – third-party, own ships and State owned company. The fourth case study consisted of interviews with senior sailing staff that have had long sailing experience including sailing on-board fairly modern ships that were equipped with modern technology to enable giving meaningful insight and inputs to the subject of research in context.

Multiple case designs allow cross-case analysis and comparison, and the investigation of a particular phenomenon in diverse settings. Furthermore, an 'Explorative Integrative' form of case study approach was adopted in this project. 'Explorative integration' embraces both theory-driven research and an explanatory bottom up approach. It is an inherently cyclic design of several phases, explanatory, explorative, interpretative and understanding. As an analytical endeavour, it aims at generating facts in the field in order to create an integrative view of the case [26].

This research was based on the 'post positivistic' paradigm by Guba [15]. The paradigm, which is the basic set of beliefs that guides actions in connection with a disciplined inquiry, is characterised by the responses to ontological, epistemological and methodological questions. These are the starting points that determine what inquiry is and how it is practiced. In post-positivist research, truth is constructed through dialogue on issues raised during interviews, participants' reactions and researcher's own interpretations of these interwoven ideas [34]. Post positivism's empirical quest for knowledge emphasizes replicability across heterogeneous populations, settings, times, perspectives and deductive, critical refutation. Scientific generalisations gain warrant only through such replication and criticism.

## 5. THE TECHNOLOGY INTEGRATION GAP

The main drivers for technology uptake were seen to be more as a reactionary stance of compliance to the requirements of regulations and customer directives rather than a proactive initiative as a value preposition guiding organisation towards satisfied constituents and sustainable value creation. The economic logic of low cost operation underpins every technology change decision and the cost-benefit analysis remains myopic to short term financial returns on investment. The ship manager, in keeping to business objectives fails to undertake any initiative on technology implementation and is driven by the regulatory demands. As a result such implementation takes the shape of mere incremental advancement without considering its design, operational constraint or impact. The regulatory drive in turn originates from the business initiatives taken by the private entrepreneurial organisations promoting such technology without any in-depth understanding of usage circumstances. This technology push is largely proposed keeping in mind the need for greater safety in industry operations. Thus the need for enhancing safety in the industry is made to take the centre stage, which being a safety critical industry cannot be ignored. The concept and the scope of technology integration are largely drawn from similar form of technology already in use in other industries, but as compared to shipping industry the interventions in such industries were based on much more robust fundamental research application [32].

The industry's fragmented structure gives rise to split-incentives phenomenon. The ship owner, particularly if he himself is a mere asset player finds him not reaping the full benefits, with the ultimate beneficiaries of technology change being many other actors in the business. The fragmentation and lack of genuine interest in the value of technology implementation is then reflected in the way in which it is implemented and operated in practice. Not much attention is paid to whether such implementation benefits the operators or not but what was evident from the study that such implementation was seen as a cost and the management were keen to see its immediate benefits were realised. The reduction in crew size is thus considered as a natural and inevitable corollary as it is equated with the cost that needed to be recovered due to implementation of 'expensive' technology on ships. Arguably in some cases implementation of technology in this way is seen as a good return on investment and the implementation of technology itself is a ploy to reduce expenses on manpower. ▶

Skilling issues prevail within the industry which is left grappling with the up-skilling/deskilling dilemma in light of poor technology integration. It is seen that while technology intervention incentivises crew reduction and allows for a cheaper deskilled workforce, in reality poorly integrated technology integration demands placing up-skilled and not down-skilled shipboard workforce. In practice abnormality and emergency, even occasional technology failure demands highly skilled crew to be able to adequately respond to out of the normal operational needs.

What was also evident from the study was the technology aided panopticism of the shore based management which proves detrimental to independent and trustworthy work environment on-board ships, thus exacerbating the traditional ship-shore divide. The study showed that the application of technology was interpreted to the advantage of the management to the extent that it was felt that in practice the usage of technology is skewed to work largely for the managers. Poor considerations of socio-technical systems in the technology integration process involving ship-shore interface only exacerbated such divisive feeling. The critique of panopticism in organisational theory draws attention to the inevitable interrelationship between power and resistance, and also to that between capital and control, which may not work when applied in much concentrated form [8]. The seafarers thus felt undervalued and mistrusted and tended to perceive shore management as cunning even immoral that tried to fix liability on them.

The design of technology remained alienated from the operation function. It is acknowledged that all the principles of human factors engineering can if at all, find its most worthwhile application at the design stage. However, as evidenced from the findings, this aspect did not find visibility in the shipping domain, where design was seen as technology-led rather than design-for-use [3]. It led to non-standardisation and poor integration of equipment into work system without integrating human characteristics into its definition, design or development. Even the quality of assessment, type approval and certification of such interconnected systems by the approving authorities like classification societies was found to be inadequate and wanting. With operability hardly being considered at the design stage, it resulted into stress and fatigue for the operator even encouraging mistakes which no amount of training or management intervention can mitigate.

This research has further established that many a times over-reliance on technology crept into operation functions leading to reduced situational awareness, suspension of traditional seafaring skills and consequential enhancement of risk of accident. It was not hard to determine that the ▶

operator could be getting absorbed into technology overlooking its vulnerability and the need to treat it with healthy scepticism. It could be argued that such technology spawns a sense of over-confidence about the situational awareness inducing the seafarer to forego his core-competency skills, which in some scenarios could prove counter-productive. Furthermore, this study shows that the investment in appropriate training of crew in handling integrated technology finds no ownership in the growing disintegration between the owner, flag, operators, managers thus blurring the link between owners and those responsible for the crew. The short-term contracts afforded minimal obligations towards the seafarer and the economic logic in a split-incentive scenario afforded evading bearing of costs towards any such training [18], [2].

Another discernible outcome of such blinkered application of technology led to information clutter in the management and operation of ships. In the management function of ship-shore interface, the ease of communication afforded shore management to exercise excessive control by demanding documentary evidence from the seafarers resulting in the production of a plethora of paperwork. It is no surprise that the ship's staffs question the veracity of such exercise that adds to the administrative burden and diverts them from the main objective of running the ship safely. Many seafarers also perceived such top-down implementation practice as countering the use of their professional skills and experiences embraced in proven good practice of seamanship [23]. The study showed that in the operation of ships the un-optimised overload of information through poorly integrated operating systems puts greater demand on cognitive resources over-saturating the operator. The premise that automation reduces the workload thus remained an illusion.

In summation, the seafarers' attitude to technology integration is unequivocal. However, the economic short-sightedness of the split-incentivised industry operation totally ignores the seafarers. Bhattacharya's [6] seminal findings reveal that ineffective regulatory infrastructure, weak employment practices, the absence of trade union support and lack of organisational trust in the shipping context manifests deeper sociological issues and organisational weaknesses in the shipping industry.

## 6. INTEGRATION GAP RATIONALISED

This section reviews and explains the gap in technology integration in light of prevailing theories and framework of globalisation, neo-liberal capitalism, principal-agent theory, regulation of technology, socio-technical theory and community of practice. While these generalise across industry sectors however in the shipping industry due to its unique nature and structure, are found to be highly accentuated. This creates the paradox of immense potential of technology integration failing to be taken up and manifesting as the gap.

The highly fragmented structure of the industry as a result of globalisation gives rise to split-incentive problem that is akin to the principal-agent problem that is accompanied by a rich stream of theory and empirical research. Principal-agent theory premises that where parties have partly differing long-term goals, for example that they aim for profit maximisation in their respective companies, then market failure occurs [21]. There is then economising on bounded rationality while simultaneously safeguarding the terms of contract against the hazards of opportunism [44].

Guttal [16] among many others has argued that globalisation is a form of capitalist expansion that entails the integration of local and national economies into a global, unregulated market. Although economic in its structure, globalisation is equally a political phenomenon, shaped by negotiations and interactions between institutions of transnational capital, nation states, and international institutions. Its main driving forces are institutions of global capitalism, but it also needs the firm hand of states to create enabling environments for it to take root. Globalisation is always accompanied by liberal democracy, which facilitates the establishment of neo-liberal state and policies that permit globalisation to flourish. Contrary to the development theories, be they 'conservative, modernisation, or dependency theory' that conceived development as 'national development', present notions underlying neo-liberal economic development as are being pushed through globalisation, re-conceives development as global competitiveness within the global market place [29]. The neo-liberal freedom as a concept gets tied down to free markets where people are free so long as they submit to the dictates of deregulated free markets. Significantly, the race to the bottom hypothesis argues that states in their competition to attract mobile capital must converge to the lowest common denominator.

The extra-ordinary element for shipping industry is the fact that the law of the seas is grounded in the notions of freedom of the seas with underlying principle of navigation of the oceans freely, ship's national state having exclusive dominion over that ship and no other nation can exercise dominion over that ship. The fact that an international regulation is enacted upon a nation by nation basis who remain keen to make their states attractive choice as regulators, the sovereign privilege creates an unregulated environment where capital is free to act as it pleases [1].

In the global context, the policy making is seen to get politicised with self-serving agenda of the constituent ▶

members of policy making bodies belaying the notions of any common good for the industry. The issue, particularly in safety-critical industry like shipping becomes that the dividing line between social regulation on health, safety, environment and economic regulation of technology gets blurred when technology is passed off as enhancing safety. The regulation of technology follows the leading theory of interests lobbying to shield business profits. The theory that it is the subgroups of the industry that drive technology in the garb of social regulation on safety, health and environment, do so to serve own parochial advantage by raising rival firms' cost, endures [43].

Munck [27] had contended that globalisation combines several strands, such as the consensus among global economic policy makers who favour market-based development strategies over state-managed ones, the control of G7 states over global market rules, and the control of financial power in the hands of transnational corporations and banks to facilitate its implementation. Seen in this light, even the monopoly rights such as patents and copyright those are strengthened to encourage innovation arguably become counter-productive. They not only become barriers to shared common ideas of standardised operation that plague the shipping industry as seen in this study, but also with powerful state actors pushing the policy making in favour of their own technology suppliers wards off any competition. Stiglitz [39] has argued that the developed world has carefully crafted laws which give innovators the exclusive right to their innovations and the profits that flow from them. R&D intensity defined as the ratio of R&D expenditure to GDP is an important determinant of innovation. This is in excess of 4% in OECD countries with USA alone accounting for 41% in the OECD area gross domestic expenditure in 2009 [12], [28].

What comes out glaringly is that the seafarer, who manages technology for optimum performance of the sole productive unit – the ship, and on whose performance the profiteering of the myriad of actors in the industry hinge, finds himself at the bottom of priority. The explanation once again lies in the outcome of economic globalisation that underpins the state–capital–labour relationship. The increasing dependence of national economies on global economic flow of investments sees financial capital play off one territorial jurisdiction against another to gain optimum return including labour that is cheaper, more flexible and more easily subjected to hard work. As nations compete amongst themselves the content of their labour laws are watered down to the detriment of their workers including those that protect their rights [35]. Even ILO [19] has conceded that while there is improvement in global production systems, globalisation has impacted work and worker relations, compromising the observance of core labour standards. Growing amount of literature on social dimensions of globalisation shows that many are wary of the so-called benefits of globalisation [20], [35], [19]. While globalisation is about removing state restrictions on capital, it seeks also to control labour by making believe that social protection and job security are uneconomic and inimical to economic growth [20]. Stiglitz [38] asserts that such economic policies that purport to separate efficiency issues from equity treats labour as commodity and runs counter to the interest of workers. 'Labour market flexibility' and 'capital market flexibility' appears as symmetric policies but they have very asymmetric consequences – and both serve to enhance the welfare of capital at the expense of workers. It corresponds to the statements made earlier [6] of the shipping industry where widespread laissez-faire approach has resulted in significant restructuring of its labour market to the detriment of the seafarer.

There is thus no concerted effort or interest or ownership towards long term and organised development. Any development is then left to be driven by reactionary situations of accidents and incidents which in the maritime industry have severe limitations in getting to the root of the causal factors to drive meaningful change. Worse still, there is failure to see the seafarer coping with abnormalities and evolving practices then get built on this 'new normal' that even start defining rule-making practices. In complex systems, there are 'latent pathogens' normally tolerated in the system but 'awakened' by a specific situation and then create a causal link leading to an accident. The seafaring culture of 'making everything work,' as highlighted in this thesis and seen to be accepted by the organisation is a potent ground for harbouring such latent pathogens. As Wynne [45] has argued, contextual normalisation of working technologies takes place according to local rationalities but this fragments the overall social nature of technology while evolving its informal practical rules. A general perception remains that just before the accident everything was perfectly normal. Thus a holistic application of sociology of scientific knowledge in better understanding of technology remains stunted. Technologies get evaluated by their external effects or risks alone but not by the relationships that may be intrinsic to them.

Related is the causal factor of limited end-user participation in the design and development of technology integrated functions. This effectively means that the knowledge and experience of seafarer is scarcely entered into the information networks which inform the design process. Ethnography with participatory user analysis of contextual enquiry does not find a place in the design considerations, which is a critical factor in the success of any interactive ▶

systems function. The most important objective is to achieve usability which is defined by Fiset [13] as, "...the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a special context of use..." The focus remains technology, engineering and equipment rather than cognitive and social ability of operation in an integrated environment with due regard to human characteristics, limitations and the ergonomics. The traditional method as seen often leads to mediocre performance at high social costs [10]. The cause lies in the organisational context of rewards and sanctions in case of high technology systems. The shore based management finds appeals of speed, power and manoeuvrability in current sophisticated design winning over concerns of ease of operation or maintenance. The costs in excessive fatigue and workload are borne by the seafarers who make the systems work on daily basis as their feedback on poor design is judged as self-serving [32].

## 7. CONCLUSIONS

This section has analysed the technology potential gap in terms of theoretical framework generally applicable in other sectors. Exacerbated in the shipping industry environment due to its unique structure, the un-optimised technology integration results in the seafarer who is the driver of technology, become a victim of the circumstances. The technology that was intended to ease the seafarer's operations and burdens ends up in controlling him, even leaving him under-resourced with fewer crews and causing fatigue. Influences of strong community of practices then manifest his frustrations as resistance and hindrances to technology integration from the ship standpoint. There is a large gap in what seems technically rational in concept and intent and what actually gets implemented in the shipping industry.

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# Notes

# Notes

# Application Form for Association Membership

(Please type or complete in black ink, using BLOCK LETTERS)

Name of Association/Organisation: ______________________

______________________

Date Founded: ______________________

Permanent Address: ______________________

______________________

______________________

Phone: ______________________

Fax: ______________________

Email: ______________________

Name of President: ______________________

Name of Vice President: ______________________

Name of General Secretary: ______________________

Membership open to: ______________________
(i.e. Master Mariners only: Masters, Mates, Pilots)

Number of active serving Shipmasters (Afloat): ______________________

Number of active Shipmasters (Ashore): ______________________
(i.e. Marine Superintendents; Harbour Masters; Pilots; etc.)

Number of retired Shipmasters: ______________________
(i.e. not in any form of gainful employment)

Number of other Members: ______________________
(not Shipmasters)

Signature: ______________________
(President)

______________________
(General Secretary)

Date: ______________________

( Please note: This form must be posted to IFSMA as your original signature is required ! )

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# Application Form for Individual Membership

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Family Name: ______________________________

First Name(s): ______________________________

Nationality: ______________________________

Date & Place of Birth: ______________________________

Permanent Address: ______________________________

______________________________

______________________________

Phone: ______________________________

Fax: ______________________________

Email: ______________________________

Master Mariner's Certificate/Licence No.: ______________________________

Date & Place of Issue: ______________________________

Issuing Authority/Government: ______________________________

Other Qualifications: ______________________________

Number of years in command of sea-going ships: ______________________________

Are you a member of your national association? ______________________________

National association name & address / website: ______________________________

Brief details of career stating current trade: ______________________________

Brief details of general education: ______________________________

Details of nautical education: ______________________________

Signature: ____________________ Date: ____________________

( Please note: This form must be posted to IFSMA as your original signature is required ! )

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