ΠΤΥΧΙΑΚΗ ΕΡΓΑΣΙΑ

SAFETY AND ENVIROMENTAL ISSUES

ΑΚΑΔΗΜΙΑ ΕΜΠΟΡΙΚΟΥ ΝΑΥΤΙΚΟΥ ΜΑΚΕΔΟΝΙΑΣ

ΣΧΟΛΗ ΠΛΟΙΑΡΧΩΝ ΕΤΟΣ 2018 – 2019

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Ημερομηνία ανάληψης της εργασίας: 02/05/2018

Ημερομηνία παράδοσης της εργασίας: 30/05/2019

Α/Α	ΟΝΟΜΑΤΕΠΩΝΥΜΟ	ΕΙΔΙΚΟΤΗΤΑ	ΑΞΙΟΛΟΓΗΣΗ	ΥΠΟΓΡΑΦΗ
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Ο ΔΙΕΥΘΥΝΤΗΣ ΤΗΣ ΣΧΟΛΗΣ:

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SUMMARY

This dissertation paper deals with safety and environmental issues. It begins with an introduction to the IMO organization and its value to the mariners and the safety on board ships. It also analyzes the impact of SOLAS and her chapters. It makes a reference to the L.S.Appliances on board vessel and the role of the ISM code for the good function of the ship and the cooperation between the ship and the shore office. Environmentally begins with the several forms of pollution that affects the environment and its creatures living in it. Pollution caused from ship's ballast, noise pollution, collisions with animals, air pollution, oil spills, oily bilge waters and garbage are some of these well-known examples of pollution caused by the ships and their voyages around the world. Last but not least it makes a reference on the MARPOL it's beginning as an organization and analyzes the chapters and their role to the maritime antipollution project.

INTRODUCTION

Wondering what makes people care about working safely? Safety culture does; the term was first used in INSAG's (1988) 'Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident'. Since then, several definitions of safety culture have been published. Today, safety culture is defined as attitude, beliefs, perceptions or values that employees share with respect to safety in every industry's workplace. The U.K. Health and Safety Commission developed one of the most commonly used definitions of safety culture:

"The product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management. Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures.

For the shipping industry, safety culture is in the professionalism of seafarers that the safety culture must take root."

IMO mentions. Furthermore the organization has pointed out that in addition to ethical and social responsibilities, shipping operators practice a safety culture because:

- Senior managers that cannot manage safety will be unlikely to manage a profitable shipping company
- A dedicated approach to safety is a cost saving not a cost
- Safety culture provides a means of maximizing the benefits and cost savings that can be derived from implementing the ISM Code.

The role of management

Lack of safety culture means lack of training, changing conditions in the workplace, ineffective communication, and cultural inertia and may lead to safety policies and procedures breakdown in an organization. Many studies have stressed the importance of safety-related attitudes and behavior among management. It goes without saying that management's role for the safety culture is of paramount importance; management has a responsibility to demonstrate the importance of safety culture, remove any obstacles and keep ships and employees safe. Developing safety culture is perhaps the single greatest investment a leader can make in an organization.

Steve Clinch, chief inspector of marine accidents for the Marine Accident Investigation Branch (MAIB), said in a presentation to the UK Chamber of Shipping's recent Safety Culture at Sea event.

"When even the master doesn't bother to look out of the bridge windows when leaving port, you probably have a problem with your safety culture."

How to effectively implement safety culture

1. Understand it: appreciate the concept of safety culture
2. Define safety responsibilities: identify policies, goals and plans for the safety culture
3. Share organization's safety vision: Safety Culture should be everyone's concern across the organization.
4. Communicate it: Misunderstanding, no information or incorrect information is often a cause for incidents and accidents
5. Train, Train, Train: Educate employees on the importance of reporting injuries, first aids and near misses.
6. Set targets for continuous improvement, with a goal of zero accidents and ISM Code non-conformities: Safety culture must be nurtured every single day.
7. Build trust: Encourage and motivate personnel ashore and afloat: Senior management should show commitment from to safety.

How to measure safety performance

Some vessels show good performance statistics, but they generally have a poor safety culture on board. In order to effectively implement safety culture, it is essential to have the means to monitor its performance. The internationally recognized specialist in resilience engineering and safety thinking, Erik Hollnagel, has presented the Safety I vs Safety II model. According to the first one, we learn from our errors, safety defined by absence and not the presence of a thing; it is a reactive approach which helps understand what goes wrong, the accident causation and avoid errors to reduce losses. At the other end of the spectrum, in Safety II is a proactive Approach according to which we learn from our successes. Safety is defined by presence; we understand what goes right and repeat it to enforce successful behaviors and develop the ability to create new process on them. The key player behind Safety II is resilience; progressing despite adversity. In other words, operators need to have a goal orientation and be both pragmatic and proactive.

Furthermore, the Safety Management System (SMS) is an important aspect of the International safety management (ISM) code and it details all the important policies, practices, and procedures that are to be followed in order to ensure safe functioning of ships at the sea. Indeed, there are four Key Performance Indicators (KPIs) to handle deficiencies and demonstrate SMS Resilience:

1. **<u>The number of deficiencies per ship per annum</u>**

   The average deficiencies per ship over a twelve months period reflects the transparency of the SMS in terms of registration of both internal & external sources of improvement. The bigger the number, the more chances that improvements will be affected.

2. **<u>Average days to close out deficiencies</u>**

   The average time to close our all deficiencies identified within the last 12 months reflects the promptness of actions. The percentage of the above deficiencies that have been closed out within the same day may be identified as a KPI! The bigger the number the chances are that the organization is not addressing problems in due time.

3. **<u>Percentage of audits with zero non-conformities (NCR)</u>**

   Internal Audits (IA) with 0 NCR reflect the actual work onboard ships. Specifically, a zero or a small percentage number indicates excellent work, while a vast number indicates that the IA work was not properly reflecting the actual operations onboard ships. In the case of 0 NCR we need three prerequisites; an extended checklist (against hrs. to complete the audit), auditor experience & training (against 0 % NCR Audits on his track record) and extended evidence (photos/videos) to demonstrate excellent condition of the ship.

4. **<u>Percentage of own against the TTL deficiencies</u>**

   The percentage of the operator’s deficiencies against the total deficiencies reflects the transparency of the SMS in terms of registration of both internal & external sources of improvement. The bigger the number the more chances that improvements will be affected.

   During the last SAFETY4SEA Conference, Mr. Erik Green, CEO, Green-Jakobsen A/S focused on meeting the requirements of safety excellence through building resilient safety cultures, suggesting the following lifestyles shown on board, also called “cultivators”, for evaluation and assessment. (see image below) ‘’It is the crew’s safety lifestyle that we need to look at and they need to be the ones to assess actual performance’’ highlighted Mr. Green.

Image Credit: SAFETY4SEA

In general, improving safety performance is about improving collaboration. Thus, shipping industry could learn from the aviation industry where transformation towards a more collaborative and open culture started many years ago by implementing what is called ‘threat and error management'. Certainly, there are various kinds of accidents; from injury fatality, fire explosions and weather damages, to environmental or machinery incidents, groundings and collisions. However, change in culture may bring better levels of motivation, staff retention and a more positive team spirit in order to eliminate risk at sea

CHAPTER 1

IMO CONVENTION AND ITS ROLE TO SAFETY ISSUES ON BOARD AND AT SHORE

It has always been recognized that the best way of improving safety at sea is by developing international regulations that are followed by all shipping nations and from the mid-19th century onwards a number of such treaties were adopted. Several countries proposed that a permanent international body should be established to promote maritime safety more effectively, but it was not until the establishment of the United Nations itself that these hopes were realized. In 1948 an international conference in Geneva adopted a convention formally establishing IMO (the original name was the Inter-Governmental Maritime Consultative Organization, or IMCO, but the name was changed in 1982 to IMO).

The IMO Convention entered into force in 1958 and the new Organization met for the first time the following year.

The purposes of the Organization, as summarized by Article 1(a) of the Convention, are "to provide machinery for cooperation among Governments in the field of governmental regulation and practices relating to technical matters of all kinds affecting shipping engaged in international trade; to encourage and facilitate the general adoption of the highest practicable standards in matters concerning maritime safety, efficiency of navigation and prevention and control of marine pollution from ships". The Organization is also empowered to deal with administrative and legal matters related to these purposes.

IMO's first task was to adopt a new version of the International Convention for the Safety of Life at Sea (SOLAS), the most important of all treaties dealing with maritime safety. This was achieved in 1960 and IMO then turned its attention to such matters as the facilitation of international maritime traffic, load lines and the carriage of dangerous goods, while the system of measuring the tonnage of ships was revised.

But although safety was and remains IMO's most important responsibility, a new problem began to emerge - pollution. The growth in the amount of oil being transported by sea and in the size of oil tankers was of particular concern and the **Torrey Canyon** disaster of 1967, in which 120,000 tons of oil was spilled, demonstrated the scale of the problem.

During the next few years IMO introduced a series of measures designed to prevent tanker accidents and to minimize their consequences. It also tackled the environmental threat caused by routine operations such as the cleaning of oil cargo tanks and the disposal of engine room wastes - in tonnage terms a bigger menace than accidental pollution.

The most important of all these measures was the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78). It covers not only accidental and operational oil pollution but also pollution by chemicals, goods in packaged form, sewage, garbage and air pollution.

IMO was also given the task of establishing a system for providing compensation to those who had suffered financially as a result of pollution. Two treaties were adopted, in 1969 and 1971, which enabled victims of oil pollution to obtain compensation much more simply and quickly than had been possible before. Both treaties were amended in 1992, and again in 2000, to increase the limits of compensation payable to victims of pollution. A number of other legal conventions have been developed since, most of which concern liability and compensation issues.

Also, in the 1970s a global search and rescue system was initiated, with the establishment of the International Mobile Satellite Organization (IMSO), which has greatly improved the provision of radio and other messages to ships.

The Global Maritime Distress and Safety System (GMDSS) was adopted in 1988 and began to be phased in from 1992. In February 1999, the GMDSS became fully operational, so that now a ship that is in distress anywhere in the world can be virtually guaranteed assistance, even if the ship's crew do not have time to radio for help, as the message will be transmitted automatically.

Two initiatives in the 1990s are especially important insofar as they relate to the human element in shipping. On 1 July 1998 the International Safety Management Code entered into force and became applicable to passenger ships, oil and chemical tankers, bulk carriers, gas carriers and cargo high speed craft of 500 gross tonnage and above. It became applicable to other cargo ships and mobile offshore drilling units of 500 gross tonnage and above from 1 July 2002.

On 1 February 1997, the 1995 amendments to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 entered into force. They greatly improve seafarer standards and, for the first time, give IMO itself powers to check Government actions with Parties required to submit information to IMO regarding their compliance with the Convention. A major revision of the STCW Convention and Code was completed in 2010 with the adoption of the "Manila amendments to the STCW Convention and Code".

New conventions relating to the marine environment were adopted in the 2000s, including one on anti-fouling systems (AFS 2001), another on ballast water management to prevent the invasion of alien species (BWM 2004) and another on ship recycling (Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009).

The 2000s also saw a focus on maritime security, with the entry into force in July 2004 of a new, comprehensive security regime for international shipping, including the International Ship and Port Facility Security (ISPS) Code, made mandatory under amendments to SOLAS adopted in 2002.

In 2005, IMO adopted amendments to the Convention for the Suppression of Unlawful Acts (SUA) Against the Safety of Maritime Navigation, 1988 and its related Protocol (the 2005 SUA Protocols), which amongst other things, introduce the right of a State Party desires to board a ship flying the flag of another State Party when the requesting Party has reasonable grounds to suspect that the ship or a person on board the ship is, has been, or is about to be involved in, the commission of an offence under the Convention.

As IMO instruments have entered into force and been implemented, developments in technology and/or lessons learned from accidents have led to changes and amendments being adopted.

The focus on implementation continues, with the technical co-operation programmed a key strand of IMO's work.

The IMO Member State Audit Scheme, which became mandatory under a number of key IMO instruments on 1 January 2016, will increasingly play a key role in supporting effective implementation by providing an audited Member State with a comprehensive and objective assessment of how effectively it administers and implements those mandatory IMO instruments which are covered by the Scheme.

IMO's **mission statement**,

"The mission of the International Maritime Organization (IMO) as a United Nations specialized agency is to promote safe, secure, environmentally sound, efficient and sustainable shipping through cooperation. This will be accomplished by adopting the highest practicable standards of maritime safety and security, efficiency of navigation and prevention and control of pollution from ships, as well as through consideration of the related legal matters and effective implementation of IMO's instruments with a view to their universal and uniform application."

CHAPTER 2

SOLAS ACCORDING TO THE IMO

The SOLAS Convention in its successive forms is generally regarded as the most important of all international treaties concerning the safety of merchant ships. The first version was adopted in 1914, in response to the Titanic disaster, the second in 1929, the third in 1948, and the fourth in 1960. The 1974 version includes the tacit acceptance procedure - which provides that an amendment shall enter into force on a specified date unless, before that date, objections to the amendment are received from an agreed number of Parties.

As a result, the 1974 Convention has been updated and amended on numerous occasions. The Convention in force today is sometimes referred to as SOLAS, 1974, as amended.

Technical provisions

The main objective of the SOLAS Convention is to specify minimum standards for the construction, equipment and operation of ships, compatible with their safety. Flag States are responsible for ensuring that ships under their flag comply with its requirements, and a number of certificates are prescribed in the Convention as proof that this has been done. Control provisions also allow Contracting Governments to inspect ships of other Contracting States if there are clear grounds for believing that the ship and its equipment do not substantially comply with the requirements of the Convention - this procedure is known as port State control. The current SOLAS Convention includes Articles setting out general obligations, amendment procedure and so on, followed by an Annex divided into 14 Chapters.

Chapter I - General Provisions

Includes regulations concerning the survey of the various types of ships and the issuing of documents signifying that the ship meets the requirements of the Convention. The Chapter also includes provisions for the control of ships in ports of other Contracting Governments.

Chapter II-1 - Construction - Subdivision and stability, machinery and electrical installations

The subdivision of passenger ships into watertight compartments must be such that after assumed damage to the ship's hull the vessel will remain afloat and stable. Requirements for watertight integrity and bilge pumping arrangements for passenger ships are also laid down as well as stability requirements for both passenger and cargo ships.

The degree of subdivision - measured by the maximum permissible distance between two adjacent bulkheads - varies with ship's length and the service in which it is engaged. The highest degree of subdivision applies to passenger ships.

Requirements covering machinery and electrical installations are designed to ensure that services which are essential for the safety of the ship, passengers and crew are maintained under various emergency conditions.

"Goal-based standards" for oil tankers and bulk carriers were adopted in 2010, requiring new ships to be designed and constructed for a specified design life and to be safe and environmentally friendly, in intact and specified damage conditions, throughout their life. Under the regulation, ships should have adequate strength, integrity and stability to minimize the risk of loss of the ship or pollution to the marine environment due to structural failure, including collapse, resulting in flooding or loss of watertight integrity.

Chapter II-2 - Fire protection, fire detection and fire extinction
Includes detailed fire safety provisions for all ships and specific measures for passenger ships, cargo ships and tankers.

They include the following principles: division of the ship into main and vertical zones by thermal and structural boundaries; separation of accommodation spaces from the remainder of the ship by thermal and structural boundaries; restricted use of combustible materials; detection of any fire in the zone of origin; containment and extinction of any fire in the space of origin; protection of the means of escape or of access for fire-fighting purposes; ready availability of fire-extinguishing appliances; minimization of the possibility of ignition of flammable cargo vapor.

Chapter III - Life-saving appliances and arrangements
The Chapter includes requirements for life-saving appliances and arrangements, including requirements for life boats, rescue boats and life jackets according to type of ship. The International Life-Saving Appliance (LSA) Code gives specific technical requirements for LSAs and is mandatory under Regulation 34, which states that all life-saving appliances and arrangements shall comply with the applicable requirements of the LSA Code.

Chapter IV - Radiocommunications
The Chapter incorporates the Global Maritime Distress and Safety System (GMDSS). All passenger ships and all cargo ships of 300 gross tonnage and upwards on international voyages are required to carry equipment designed to improve the chances of rescue following an accident, including satellite emergency position indicating radio beacons (EPIRBs) and search and rescue transponders (SARTs) for the location of the ship or survival craft.
Regulations in Chapter IV cover undertakings by contracting governments to provide radiocommunication services as well as ship requirements for carriage of radiocommunications equipment. The Chapter is closely linked to the Radio Regulations of the International Telecommunication Union.

Chapter V - Safety of navigation
Chapter V identifies certain navigation safety services which should be provided by Contracting Governments and sets forth provisions of an operational nature applicable in general to all ships on all voyages. This is in contrast to the Convention as a whole, which only applies to certain classes of ship engaged on international voyages.

The subjects covered include the maintenance of meteorological services for ships; the ice patrol service; routing of ships; and the maintenance of search and rescue services.

This Chapter also includes a general obligation for masters to proceed to the assistance of those in distress and for Contracting Governments to ensure that all ships shall be sufficiently and efficiently manned from a safety point of view.

The chapter makes mandatory the carriage of voyage data recorders (VDRs) and automatic ship identification systems (AIS).

Chapter VI - Carriage of Cargoes
The Chapter covers all types of cargo (except liquids and gases in bulk) "which, owing to their particular hazards to ships or persons on board, may require special precautions". The regulations include requirements for stowage and securing of cargo or cargo units (such as containers). The Chapter requires cargo ships carrying grain to comply with the International Grain Code.

Chapter VII - Carriage of dangerous goods
The regulations are contained in three parts:
Part A - Carriage of dangerous goods in packaged form - includes provisions for the classification, packing, marking, labelling and placarding, documentation and stowage of dangerous goods. Contracting Governments are required to issue instructions at the national level and the Chapter makes mandatory the International Maritime Dangerous Goods (IMDG) Code, developed by IMO, which is constantly updated to accommodate new dangerous goods and to supplement or revise existing provisions.

Part A-1 - Carriage of dangerous goods in solid form in bulk - covers the documentation, stowage and segregation requirements for these goods and requires reporting of incidents involving such goods.

Part B covers Construction and equipment of ships carrying dangerous liquid chemicals in bulk and requires chemical tankers to comply with the International Bulk Chemical Code (IBC Code).

Part C covers Construction and equipment of ships carrying liquefied gases in bulk and gas carriers to comply with the requirements of the International Gas Carrier Code (IGC Code).

Part D includes special requirements for the carriage of packaged irradiated nuclear fuel, plutonium and high-level radioactive wastes on board ships and requires ships carrying such products to comply with the International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships (INF Code).

The chapter requires carriage of dangerous goods to be in compliance with the relevant provisions of the International Maritime Dangerous Goods Code (IMDG Code).

Chapter VIII - Nuclear ships
Gives basic requirements for nuclear-powered ships and is particularly concerned with radiation hazards. It refers to detailed and comprehensive Code of Safety for Nuclear Merchant Ships which was adopted by the IMO Assembly in 1981.

Chapter IX - Management for the Safe Operation of Ships
The Chapter makes mandatory the International Safety Management (ISM) Code, which requires a safety management system to be established by the shipowner or any person who has assumed responsibility for the ship (the "Company").

Chapter X - Safety measures for high-speed craft
The Chapter makes mandatory the International Code of Safety for High-Speed Craft (HSC Code).

Chapter XI-1 - Special measures to enhance maritime safety
The Chapter clarifies requirements relating to authorization of recognized organizations (responsible for carrying out surveys and inspections on Administrations' behalves); enhanced surveys; ship identification number scheme; and port State control on operational requirements.

Chapter XI-2 - Special measures to enhance maritime security
Regulation XI-2/3 of the chapter enshrines the International Ship and Port Facilities Security Code (ISPS Code). Part A of the Code is mandatory and part B contains guidance as to how best to comply with the mandatory requirements. Regulation XI-2/8 confirms the role of the Master in exercising his professional judgement over decisions necessary to maintain the security of the ship. It says he shall not be constrained by the Company, the charterer or any other person in this respect.

Regulation XI-2/5 requires all ships to be provided with a ship security alert system.Regulation XI-2/6 covers requirements for port facilities, providing among other things for Contracting Governments to ensure that port facility security assessments are carried out and that port facility security plans are developed, implemented and reviewed in accordance with the ISPS Code. Other regulations in this chapter cover the provision of information to IMO, the control of ships in port, (including measures such as the delay, detention, restriction of operations including movement within the port, or expulsion of a ship from port), and the specific responsibility of Companies.

Chapter XII - Additional safety measures for bulk carriers
The Chapter includes structural requirements for bulk carriers over 150 meters in length.
Chapter XIII - Verification of compliance

Makes mandatory from 1 January 2016 the IMO Member State Audit Scheme.

Chapter XIV - Safety measures for ships operating in polar waters

The chapter makes mandatory, from 1 January 2017, the Introduction and part I-A of the International Code for Ships Operating in Polar Waters (the Polar Code).


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learn.marineinsight.com
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Amendments

The 1974 Convention has been amended many times to keep it up to date.

CHAPTER 3

LSA ACCORDING TO SOLAS CONVETION

LIFEBUOYS AND LIFE-JACKETS Every lifebuoy shall: 1) have an outer diameter of not more than 800 mm and an inner diameter of not less than 400 mm,2) be constructed of inherently buoyant material, it shall not depend upon rushes, cork shavings or granulated cork, any other loose granulated material or any air compartment which depends on inflation for buoyancy, 3) be capable of supporting not less than 14.5 kg of iron in fresh water for a period of 24 hours, 4) have a mass of not less than 2.5 kg, 5) not sustain burning or continue melting after being totally enveloped in a fire for a period of 2 seconds, 6) be constructed to withstand a drop into the water from the height at which it is stowed above the waterline in the lightest seagoing condition or 30 m, whichever is the greater, without impairing either its operating capability or that of its attached components, 7) if it is intended to operate the quick release arrangement provided for the self-activated smoke signals and self-igniting lights, have a mass sufficient to operate the quick release arrangement, 8) be fitted with a grab line not less than 9.5 mm in diameter and not less than 4 times the outside diameter of the body of the buoy in length. The grab line shall be secured at four equidistant points around the circumference of the buoy to form four equal loops.

SELF-IGNITING LIGHTSshall: 1) be such that they cannot be extinguished by water, 2) be of white color and capable of either burning continuously with a luminous intensity of not less than 2 cd in all directions of the upper hemisphere or flashing (discharge flashing) at a rate of not less than 50 flashes and not more than 70 flashes per min with at least the corresponding effective luminous intensity, 3) be provided with a source of energy capable of meeting the requirement of previous paragraph for a period of at least 2 hours, 4) be capable of withstanding the drop test into the water from the height at which it is stowed above the waterline in the lightest seagoing condition or 30 m, whichever is the greater, without impairing either its operating capability or that of its attached components.

SELF-ACTIVATING SMOKE SIGNAL shall: 1) emit smoke of a highly visible color at a uniform rate for a period of at least 15 min when floating in calm water, 2) not ignite explosively or emit any flame during the entire smoke emission time of the signal, 3) not be swamped in a seaway, 4) continue to emit smoke when fully submerged in water for a period of at least 10 s, 5) be capable of withstanding the drop test into the water from the height at which it is stowed above the waterline in the lightest seagoing condition or 30 m, whichever is the greater, without impairing either its operating capability or that of its attached components.

BUOYANT LIFELINES shall: 1) be non-kinking, 2) have a diameter of not less than 8 mm and 3) have a breaking strength of not less than 5 kN.

LIFE-JACKETS: An adult life-jacket shall be so constructed that: 1) shall not sustain burning or continue melting after being totally enveloped in a fire for a period of 2 seconds. ™ at least 75% of persons, who are completely unfamiliar with the lifejacket, can correctly don it within a period of one min without assistance, guidance or prior demonstration, 2) after demonstration, all persons can correctly don it within a period of one minute without assistance, 3) it is clearly capable of being worn in only one way or, as far as is practicable, cannot be donned incorrectly, 4) it is comfortable to wear, 5) it allows the wearer to jump from a height of at least 4.5 m into the water without injury and without dislodging or damaging the lifejacket, 6) shall have buoyancy which is not reduced by more than 5% after 24h submersion in fresh water, 7) shall be fitted with a whistle firmly secured by a cord

An adult lifejacket shall have sufficient buoyancy and stability in calm fresh water to: 1) lift the mouth of an exhausted or unconscious person not less than 120 mm clear of the water with the body inclined backwards at an angle of not less than 20° from the vertical position, 2) turn the body of an unconscious person in the water from any position to one where the mouth is clear of the water in not more than 5 s. 3) shall allow the person wearing it to swim a short distance and to board a survival craft.

A **child lifejacket** shall be constructed and perform the same as an adult lifejacket except as follows: 1) donning assistance is permitted for small children, 2) it shall only be required to lift the mouth of an exhausted or unconscious wearer clear of the water a distance appropriate to the size of the intended wearer, 3) assistance may be given to board a survival craft, but wearer mobility shall not be significantly reduced.

THE IMMERSION SUIT shall: be constructed with waterproof materials such that: 1) it can be unpacked and donned without assistance within 2 min, taking into account any associated clothing, and a lifejacket if the immersion suit is to be worn in conjunction with a lifejacket, 2) it will not sustain burning or continue melting after being totally enveloped in a fire for a period of 2 seconds, 3) it will cover the whole body with the exception of the face. Hands shall also be covered unless permanently attached gloves are provided, 4)it is provided with arrangements to minimize or reduce free air in the legs of the suit, 5) following a jump from a height of not less than 4.5 m into the water there is no undue ingress of water into the suit.

<u>The ANTI-EXPOSURE SUIT</u> shall be constructed with waterproof materials such that it: 1) provides inherent buoyancy of at least 70 N, 2) is made of material which reduces the risk of heat stress during rescue and evacuationoperations, 3) covers the whole body with the exception of the head and hands and, where the Administration so permits, feet, gloves and a hood shall be provided in such a manner as to remain available for use with the anti-exposure suits, 4) can be unpacked and donned without assistance within 2 min, 5) does not sustain burning or continue melting after being totally enveloped in a fire for a period of 2 seconds, 6) is equipped with a pocket for a portable VHF telephone, 7) has a lateral field of vision of at least 120°.

GENERAL REQUIREMENTS FOR LIFEBOATS

All lifeboats shall be properly constructed and shall be of such form and proportions that they have ample stability in a seaway and sufficient freeboard when loaded with their full complement of persons and equipment. All lifeboats shall have rigid hulls and shall be capable of maintaining positive stability when in an upright position in calm water and loaded with their full complement of persons and equipment and holed in any one location below the waterline, assuming no loss of buoyancy material and no other damage.

Each lifeboat shall be fitted with a certificate of approval, endorsed by the Administration, containing at least the following items: 1) manufacturer's name and address, 2) lifeboat model and serial number, 3) month and year of manufacture, 4) number of persons the lifeboat is approved to carry and with approval information including the Administration which approved it, and any operational restrictions. The certifying organization shall provide the lifeboat with a certificate of approval which, in addition to the above items, specifies: 1) number of the certificate of approval, 2) material of hull construction, in such detail as to ensure that compatibility problems in repair should not occur, 3) total mass fully equipped and fully manned, 4) statement of approval.

All lifeboats shall be of sufficient strength to: 1) enable them to be safely launched into the water when loaded with their full complement of persons and equipment, 2) be capable of being launched and towed when the ship is making headway at a speed of 5 knots in calm water.

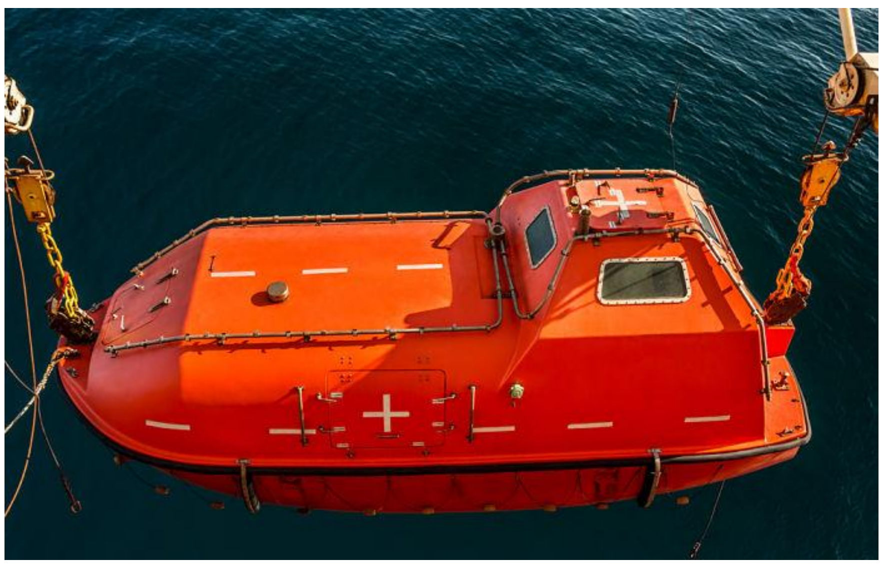
Hulls and rigid covers shall be fire-retardant or non-combustible.

Except for free-fall lifeboats, each lifeboat to be launched by falls shall be of sufficient strength to withstand a load, without residual deflection on removal of that load: 1) in the case of boats with metal hulls, 1.25 times the total mass of the lifeboat when loaded with its full complement of persons and equipment, or 2) in the case of other boats, twice the total mass of the lifeboat when loaded with its full complement of persons and equipment.

Except for free-fall lifeboats, each lifeboat to be launched by falls shall be of sufficient strength to withstand, when loaded with its full complement of persons and equipment and with, where applicable, skates or fenders in position, a lateral impact against the ship's side at an impact velocity of at least 3.5 m/s and also a drop into the water from a height of at least 3 m.

The number of persons which a lifeboat to be launched by falls shall be permitted to accommodate shall be equal to the lesser of: the number of persons having an average mass of 75 kg, all wearing lifejackets, that can be seated in a normal position without interfering with the means of propulsion or the operation of any of the lifeboat's equipment or the number of spaces that can be provided on the seating arrangements in accordance with figure 1. The shapes may be overlapped as shown, provided footrests are fitted and there is sufficient room for legs and the vertical separation between the upper and lower seat is not less than 350 mm.

Each seating position shall be clearly indicated in the lifeboat.



LIFEBOAT EQUIPMENT

1) except for free-fall lifeboats, sufficient buoyant oars to make headway in calm seas. 2) two boat-hooks; 3) a buoyant bailer and two buckets; 4) a survival manual 5) an operational compass which is luminous or provided with suitable means of illumination. In a totally enclosed lifeboat, the compass shall be permanently fitted at the steering position; in any other lifeboat, it shall be provided with a binnacle if necessary to protect it from the weather, and suitable mounting arrangements; 6) a sea-anchor of adequate size fitted with a shock-resistant hawser which provides a firm hand grip when wet. The strength of the sea-anchor, hawser and tripping line if fitted shall be adequate for all sea conditions; 7) two efficient painters of a length equal to not less than twice the distance from the stowage position of the lifeboat to the waterline in the lightest seagoing condition or 15 m, whichever is the greater. On lifeboats to be launched by free-fall launching, both painters shall be stowed near the bow ready for use. On other lifeboats, one painter

attached to the release device required to come together with release mechanism shall be placed at the forward end of the lifeboat and the other shall be firmly secured at or near the bow of the lifeboat ready for use; 8) two hatchets, one at each end of the lifeboat; 9) watertight receptacles containing a total of 3 liters of fresh water for each person the lifeboat is permitted to accommodate, of which either 1 liter per person may be replaced by a desalting apparatus capable of producing an equal amount of fresh water in 2 days, or 2 liters per person may be replaced by a manually powered reverse osmosis desalinator capable of producing an equal amount of fresh water in 2 days; 10) a rustproof dipper with lanyard; 11) a rustproof graduated drinking vessel; 12) a food ration totaling not less than 10,000 kJ for each person the lifeboat is permitted to accommodate; these rations shall be kept in airtight packaging and bestowed in a watertight container; 13) four rocket parachute flares; 14) six hand flares; 15) two buoyant smoke signals; 16) one waterproof electric torch suitable for Morse signaling together with one spare set of batteries and one spare bulb in a waterproof container; 17) one daylight signaling mirror with instructions for its use for signaling to ships and aircraft; 18) one copy of the life-saving signals prescribed by regulation V/16 on a waterproof card or in a waterproof container; 19) one whistle or equivalent sound signal; 20) a first-aid outfit in a waterproof case capable of being closed tightly after use; 21) anti-seasickness medicine sufficient for at least 48 h and one seasickness bag for each person; 22) a jack-knife to be kept attached to the boat by a lanyard; 23) three tin openers; 24) two buoyant rescue quoits, attached to not less than 30 m of buoyant line; 25) if the lifeboat is not automatically self-bailing, a manual pump suitable for effective bailing; 26) one set of fishing tackle; 27) sufficient tools for minor adjustments to the engine and its accessories; 28) portable fire-extinguishing equipment of an approved type suitable for extinguishing oil fires [A.602(15)]. 29) a searchlight with a horizontal and vertical sector of at least 6° and a measured luminous intensity of 2500 cd which can work continuously for not less than 3 h; 30) an efficient radar reflector, unless a survival craft radar transponder is stowed in the lifeboat; 31) thermal protective aids complying with the requirements of section 2.5 sufficient for 10% of the number of persons the lifeboat is permitted to accommodate or two, whichever is the greater; 32) in the case of ships engaged on voyages of such a nature and duration that, in the opinion of the Administration a food ration and fishing tackle are unnecessary, the Administration may allow these items to be dispensed with.

LIFEBOAT MARKINGS

1) The number of persons for which the lifeboat is approved shall be clearly marked on it in clear permanent characters. 2) The name and port of registry of the ship to which the lifeboat belongs shall be marked on each side of the lifeboat's bow in block capitals of the Roman alphabet. 3) Means of identifying the ship to which the lifeboat belongs, and the number of the lifeboat shall be marked in such a way that they are visible from above.

FREE-FALL LIFEBOATS

Free-fall lifeboats shall comply with the requirements of totally enclosed lifeboats described above. The carrying capacity of a free-fall lifeboat is the number of persons that can be provided with a seat without interfering with the means of propulsion or the operation of any of the lifeboat's equipment. The width of the seat shall be at least 430 mm. Free clearance in front of the backrest shall be at least 635 mm. The backrest shall extend at least 1,000 mm above the seat pan.

Each free-fall lifeboat shall make positive headway immediately after water entry and shall not come into contact with the ship after a free-fall launching against a trim of up to 10° and a list of up to 20° either way from the certification height when fully equipped and loaded with: 1) its full complement of persons,2) occupants so as to cause the center of gravity to be in the most forward position, 3) occupants so as to cause the center of gravity to be in the most aft position, 4) its operating crew only.

Each free-fall lifeboat shall be of sufficient strength to withstand, when loaded with its full complement of persons and equipment, a free-fall launch from a height of at least 1.3 times the free-fall certification height.

Each free-fall lifeboat shall be fitted with a release system which shall: 1) have two independent activation systems for the release mechanisms which may only be operated from inside the lifeboat and be marked in a color that contrasts with its surroundings, 2) be so arranged as to release the boat under any condition of loading from no load up to at least 200% of the normal load caused by the fully equipped lifeboat when loaded with the number of persons for which it is to be approved, 3) be adequately protected against accidental or premature use, 4) be designed to test the release system without launching the lifeboat, 5) be designed with a factor of safety of 6 based on the ultimate strength of the materials used.

In addition to the requirements for fully enclosed lifeboat certificate of approval for a free-fall lifeboat shall also state: 1) free-fall certification height, 2) required launching ramp lengthand 3) launching ramp angle for the free-fall certification height.

LIFE RAFTS

Every liferaft shall be so constructed as to be capable of withstanding exposure for 30 days afloat in all sea conditions.

The liferaft shall be so constructed that when it is dropped into the water from a height of 18 m, the liferaft and its equipment will operate satisfactorily. If the liferaft is to be stowed at a height of more than 18 m above the waterline in the lightest seagoing condition, it shall be of a type which has been satisfactorily drop-tested from at least that height.

The floating liferaft shall be capable of withstanding repeated jumps on to it from a height of at least 4.5 m above its floor both with and without the canopy erected.

The liferaft and its fittings shall be so constructed as to enable it to be towed at a speed of 3 knots in calm water when loaded with its full complement of persons and equipment and with one of its sea-anchors streamed.

The liferaft shall have a canopy to protect the occupants from exposure which is automatically set in place when the liferaft is launched and waterborne.

No liferaft shall be approved which has a carrying capacity of less than six persons

Unless the liferaft is to be launched by an approved launching appliance or is not required to be stowed in a position providing for easy side-to-side transfer, the total mass of the liferaft, its container and its equipment shall not be more than 185 kg.

The liferaft shall be fitted with an efficient painter of length equal to not less than 10 m plus the distance from the stowed position to the waterline in the lightest seagoing condition or 15 m whichever is the greater.

Davit-launched liferafts

In addition to the above requirements, a liferaft for use with an approved launching appliance shall: when the liferaft is loaded with its full complement of persons and equipment, be capable of withstanding a lateral impact against the ship's side at an impact velocity of not less than 3.5 m/s and also a drop into the water from a height of not less than 3 m without damage that will affect its function, be provided with means for bringing the liferaft alongside the embarkation deck and holding it securely during embarkation.

Every passenger ship davit-launched liferaft shall be so arranged that it can be rapidly boarded by its full complement of persons.

Every cargo ship davit-launched liferaft shall be so arranged that it can be boarded by its full complement of persons in not more than 3 min from the time the instruction to board is given.

The marking required on liferafts equipped in accordance with LSA code regulation 4.1.5.1 shall be "SOLAS A PACK" in block capitals of the Roman alphabet.

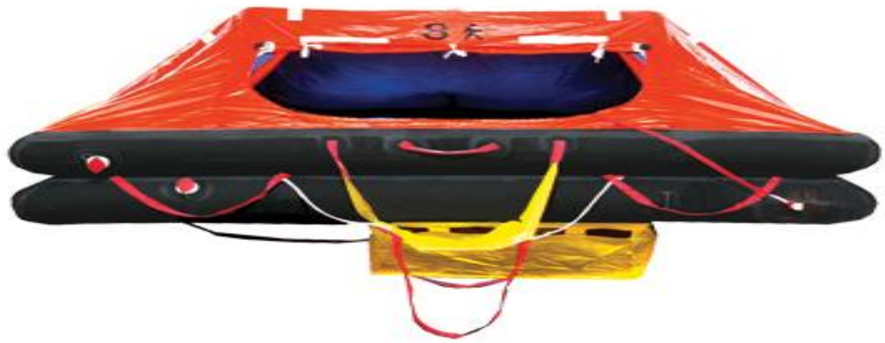
In the case of passenger ships engaged on short international voyages of such a nature and duration that, in the opinion of the Administration, not all the items specified in paragraph 4.1.5.1 are necessary, and "SOLAS B PACK" should be marked in block capitals of the Roman alphabet on liferaft.

The liferaft painter system shall provide a connection between the ship and the liferaft and shall be so arranged as to ensure that the liferaft when released and, in the case of an inflatable liferaft, inflated is not dragged under by the sinking ship.

If a weak link is used in the float-free arrangement, it shall: 1) not be broken by the force required to pull the painter from the liferaft container, 2) if applicable, be of sufficient strength to permit the inflation of the liferaft and 3) break under a strain of 2.2 ± 0.4 kN.

The liferaft shall be packed in a container that is: 1) so constructed as to withstand hard ware under conditions encountered at sea, 2) of sufficient inherent buoyancy, when packed with the liferaft and its equipment, to pull the painter from within and to operate the inflation mechanism should the ship sink, 3) as far as practicable watertight, except for drain holes in the container bottom.

The container shall be marked with: 1) maker's name or trade mark, 2) serial number, 3) name of approving authority and the number of persons it is permitted to carry,3) SOLAS, 4) type of emergency pack enclosed, 5) date when last serviced, 6) length of painter, 7) maximum permitted height of stowage above waterline (depending on drop-test height and length of painter), 8) launching instructions.



RESCUE BOATS

Rescue boats may be either of rigid or inflated construction or a combination of both and shall: be not less than 3.8 m and not more than 8.5 m in length and be capable of carrying at least five seated persons and a person lying on a stretcher.

Rescue boats shall be capable of maneuvering at a speed of at least 6 knots and maintaining that speed for a period of at least 4 hours.

Rescue boats shall have sufficient mobility and maneuverability in a seaway to enable persons to be retrieved from the water, marshal liferafts and tow the largest liferaft carried on the ship when loaded with its full complement of persons and equipment or its equivalent at a speed of at least 2 knots.

A rescue boat shall be fitted with an inboard engine or outboard motor. If it is fitted with an outboard motor, the rudder and tiller may form part of the engine.

Arrangements for towing shall be permanently fitted in rescue boats and shall be sufficiently strong to marshal or tow liferafts.

Inflated rescue boats shall be so constructed as to be capable of withstanding exposure: 1) when stowed on an open deck on a ship at sea, 2) for 30 days afloat in all sea conditions.

The buoyancy of an inflated rescue boat shall be provided by either a single tube subdivided into at least five separate compartments of approximately equal volume or two separate tubes neither exceeding 60% of the total volume.

In addition to complying with the requirements lifeboats, inflated rescue boats shall be marked with a serial number, the maker's name or trade mark and the date of manufacture.

The inflated rescue boat shall be maintained at all times in a fully inflated condition.

ROCKET PARACHUTE FLARES

The rocket parachute flare shall: 1) be contained in a water-resistant casing, 2) have brief instructions or diagrams clearly illustrating the use of the rocket parachute flare printed on its casing, 3) have integral means of ignition, 4) be so designed as not to cause discomfort to the person holding the casing when used in accordance with the manufacturer's operating instructions.

The rocket shall, when fired vertically, reach an altitude of not less than 300 m. At or near the top of its trajectory, the rocket shall eject a parachute flare, which shall: 1) burn with a bright red color,2) burn uniformly with an average luminous intensity of not less than 30,000 cd,3) have a burning period of not less than 40 s, 4) have a rate of descent of not more than 5 m/s and 5) not damage its parachute or attachments while burning.

HAND FLARES

The hand flare shall: 1) be contained in a water-resistant casing, 2) have brief instructions or diagrams clearly illustrating the use of the hand flare printed on its casing, 3) have a self-contained means of ignition and 4) be so designed as not to cause discomfort to the person holding the casing and not endanger the survival craft by burning or glowing residues when used in accordance with the manufacturer's operating instructions.

The hand flare shall: 1) burn with a bright red color,2) burn uniformly with an average luminous intensity of not less than 15,000 cd, 3) have a burning period of not less than 1 min, and 4 continue to burn after having been immersed for a period of 10s under 100 mm of water.

BUOYANT SMOKE SIGNALS

The buoyant smoke signal shall: 1) be contained in a water-resistant casing,2) not ignite explosively when used in accordance with the manufacturer's operating instructions 3) have brief instructions or diagrams clearly illustrating the use of the buoyant smoke signal printed on its casing.

The buoyant smoke signal shall: 1) emit smoke of a highly visible color at a uniform rate for a period of not less than 3 min when floating in calm water, not emit any flame during the entire smoke emission time, 2) not be swamped in a seaway, 3) continue to emit smoke when submerged in water for a period of 10 s

under 100 mm of water.

Embarkation ladders

Handholds shall be provided to ensure a safe passage from the deck to the head of the ladder and vice versa.

The steps of the ladder shall be: 1) made of hardwood, free from knots or other irregularities, smoothly machined and free from sharp edges and splinters, or of suitable material of equivalent properties, 2) provided with an efficient nonslip surface either by longitudinal grooving or by the application of an approved nonslip coating, 3) not less than 480 mm long, 115 mm wide and 25 mm in depth, excluding any nonslip surface or coating, 4) equally spaced not less than 300 mm or more than 380 mm apart and secured in such a manner that they will remain horizontal. The side ropes of the ladder shall consist of two uncovered manila ropes not less than 65 mm in circumference on each side. Each rope shall be continuous with no joints below the top step. Other materials may be used provided the dimensions, breaking strain, weathering, stretching and gripping properties are at least equivalent to those of manila rope. All rope ends shall be secured to prevent unraveling.

MARINE EVACUATION SYSTEMS

The Marine Evacuation Chute (MEC) System is the most efficient, easy-to-use, flexible, and cost-effective Marine Evacuation System available in the world today. As a gravity launch system, the Marine Evacuation System evacuates passengers and crew with the utmost safety in the shortest possible time.

Marine Evacuation System, dual-track slide platform, 50-person liferaft.

The passage of the marine evacuation system shall provide for safe descent of persons of various ages, sizes and physical capabilities wearing approved lifejackets from the embarkation station to the floating platform or survival craft. Strength and construction of the passage and platform shall be to the satisfaction of the Administration. If the passage gives direct access to the survival craft, it should be provided with a quick release arrangement.

A marine evacuation system shall be: 1) capable of deployment by one person, 2) such as to enable the total number of persons for which it is designed, to be transferred from the ship into the inflated liferafts within a period of 30 min in the case of a passenger ship and of 10 min in the case of a cargo ship from the time abandon ship signal is given, 3) arranged such that liferafts may be securely attached to the platform and released from the platform by a person either in the liferaft or on the platform, 4) capable of being deployed from the ship under unfavorable conditions of trim of up to 10° and list of up to 20° either way, 5) in the case of being fitted with an inclined slide, such that the angle of the slide to the horizontal is: 1) within a range of 30° to 35° when the ship is upright and in the lightest sea-going condition and 2) in the case of a passenger ship, a maximum of 55° in the final stage of flooding set by the requirements in regulation II-1/8, 3) evaluated for capacity by means of timed evacuation deployments conducted in harbor, 4) capable of providing a satisfactory means of evacuation in a sea state associated with a wind of force 6 on the Beaufort scale, 5) designed to, as far as practicable, remain effective under conditions of icing and 6) so constructed that only a minimum amount of routine maintenance is necessary.

Any part requiring maintenance by the ship's crews shall be readily accessible and easily maintained

The marine evacuation system shall be marked with: 1) maker's name or trade mark,2) serial number, 3) date of manufacture (month and year),4) name of approving authority, 5) name and place of servicing station where it was last serviced, along with the date of servicing and 6) the capacity of the system

Any inflatable liferaft used in conjunction with the marine evacuation system shall: 1) conform with the requirements of section 4.2, 2) be sited close to the system container but be capable of dropping clear of the deployed system and boarding platform, 3) be capable of release one at a time from its stowage rack with arrangements which will enable it to be moored alongside the platform, 4)bestowed in accordance with regulation III/13.4 and 5) be provided with pre-connected or easily connected retrieving lines to the platform.

LINE-THROWING APPLIANCES

Every line-throwing appliance shall: 1) be capable of throwing a line with reasonable accuracy, 2) include not less than four projectiles each capable of carrying the line at least 230 m in calm weather, 3) include not less than four lines each having a breaking strength of not less than 2 Kn, 4) have brief instructions or diagrams clearly illustrating the use of the line-throwing appliance.

The rocket, in the case of a pistol-fired rocket, or the assembly, in the case of an integral rocket and line, shall be contained in a water-resistant casing. In addition, in the case of a pistol-fired rocket, the line and rockets together with the means of ignition shall be stowed in a container which provides protection from the weather.

GENERAL EMERGENCY ALARM SYSTEM

The general emergency alarm system shall be capable of sounding the general emergency alarm signal consisting of seven or more short blasts followed by one long blast on the ship's whistle or siren and additionally on an electrically operated bell or klaxon or other equivalent warning system, which shall be powered from the ship's main supply and the emergency source of electrical power required by regulation II-1/42 or II1/43, as appropriate.

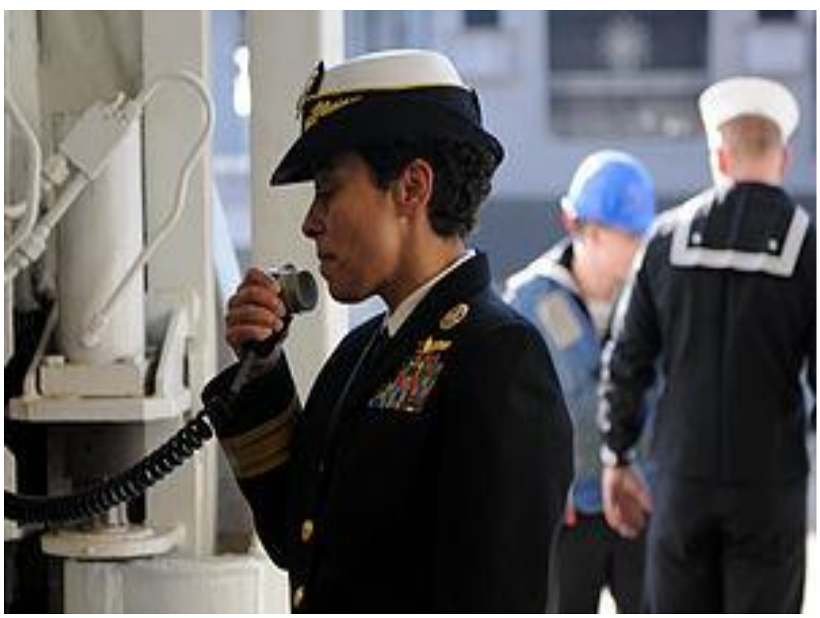
The system shall be capable of operation from the navigation bridge and, except for the ship's whistle, also from other strategic points. The system shall be audible throughout all the accommodation and normal crew working spaces. The alarm shall continue to function after it has been triggered until it is manually turned off or is temporarily interrupted by a message on the public address system. The minimum sound pressure levels for the emergency alarm tone in interior and exterior spaces shall be 80 dB (A) and at least 10 dB (A) above ambient noise levels existing during normal equipment operation with the ship underway in moderate weather. In cabins without a loudspeaker installation, an electronic alarm transducer shall be installed, e.g.

a buzzer or similar. The sound pressure levels at the sleeping position in cabins and in cabin bathrooms shall be at least 75 dB (A) and at least 10 dB (A) above ambient noise levels as regulated in A.830(19).

PUBLIC ADDRESS SYSTEM

The public address system shall be a loudspeaker installation enabling the broadcast of messages into all spaces where crew members or passengers, or both, are normally present, and to muster stations. It shall allow for the broadcast of messages from the navigation bridge and such other places on board the ship as the Administration deems necessary. It shall be installed with regard to acoustically marginal conditions and not require any action from the addressee. It shall be protected against unauthorized use.

With the ship underway in normal conditions, the minimum sound pressure levels for broadcasting emergency announcements shall be: in interior spaces 75 dB (A) and at least 20 dB (A) above the speech interference level, in exterior spaces 80 dB (A) and at least 15 dB (A) above the speech interference level.



IMO SYMBOLS AND SAFETY SIGNS

CHAPTER 4

ISM ON BOARD VESSELS AND ITS PURPOSE

THE PURPOSE OF THE ISM CODE

- To ensure safety at sea and prevent damage to property, personnel and environment.

In order to comply with the ISM Code, Company operating the vessel has to be Audited first (after they submit their Safety Management System Manual and is approved by Flag Administration or Recognized Organization (RO)). Once Company is Audited, Document of Compliance (DOC) will be issued (validity 5 years). Company is subject to auditing every year (three months before and after anniversary date and before DOC expiration date). Upon issuing DOC to Company (or Managing Company) each vessel can be audited to verify vessel compliance with ISM Code. Each vessel will be issued SMS (Safety Management Certificate) valid for 5 years and subject to verification of Compliance with ISM Code between second and third years of certificate validity.

Safety Management System Manual consists of the following elements:

- Commitment from top management
- A top tier policy manual
- A procedures manual that documents what is done on board the ship, during normal operations and in emergency situations
- Procedures for conducting both internal and external audits to ensure the ship is doing what is documented in the procedure’s manual
- A designated person ashore to serve as the link between the ships and shore staff and to verify the SMS implementation
- A system for identifying where actual practices do not meet those that are documented and for implementing associated corrective action
- Regular management reviews

Also, the ship must be maintained in conformity with the provisions of relevant rules and regulations and with any additional requirements which may be established by the company. Comments from the auditor and/or audit body and from the ship are incorporated into the SMS by headquarters.

The requirements of the ISM Code may be applied to all commercial ships over 500 GT. The ISM Code is a chapter in SOLAS. If SOLAS does not apply, then ISM is not mandatory. Compliance with ISM Code is sometimes required by vessel client regardless of Gross Tonnage (GT).

The ISM Code was created by the IMO and Ferriby Marine's Capt. Graham Botterill, Specialist Advisor to the House of Lords in the UK on ship safety, among others.

HISTORY,

On the evening of March 6, 1987, the cross-channel Ro-Ro ferry *Herald of Free Enterprise*, carrying more than 450 passengers, around 80 crew, more than 80 cars, and close to 50 freight vehicles, left the Belgian port of Zeebrugge for the English port of Dover. Soon after the *Herald of Free Enterprise* passed Zeebrugge's breakwater, water flooded into the ferry's lower car deck and destabilized it, causing it to sink in a matter of minutes. 193 lives were lost.

The immediate cause of the accident was that the bow door remained wide open, allowing a great inrush of water as the vessel increased speed, while the fatigued assistant boatswain directly responsible for closing it lay asleep in his cabin. The public inquiry led by Justice Sheen revealed that the assistant boatswain's negligence was simply the last in a long string of actions that laid the groundwork for a major accident. The Sheen Report did not stop at identifying the shortcomings of the ship's master and his crew. The inquiry revealed that the shore management, Townsend Car Ferries Ltd., was just as blameworthy. Numerous memos written by Townsend ship's masters pointing out the need to implement safety-enhancing measures or address serious deficiencies on board their vessels went unheeded (Rasmussen and Svedung, 2000). The report summed up the management's cavalier attitude towards safety in the following statement: 'From top to bottom the body corporate was infected with the disease of sloppiness' (Sheen, 1987).

The *Herald of Free Enterprise* was a modern ferry equipped with advanced technology and manned by a highly qualified crew. Only seven years prior to the accident, it was built in a German shipyard according to international maritime safety regulations. Why did it capsize? The general frustration in the shipping industry following the capsizing of the *Herald of Free Enterprise* is typical of the kind of accident that precipitated in a paradigm shift in maritime safety administration and the development of the ISM Code.

ONE EXAMPLE OF THE CONTENTS INCLUDED ON THE ISM FOR THE SAFETY OF CREW AND VESSEL

MOORING OPERATION ON BOARD

Mooring operation is one of the important tasks that seafarers have to perform on ship's deck. Technically, the operation may seem simple but there are several dangerous associated with it. As a seafarer, you must have heard about "Death Traps" on ships and how crew members have lost lives during mooring operation.

Working on the ship's deck is not an easy task. Deck crew has to consider various safety precautions and understand working of deck machinery and systems, along with cargo operation equipment. When it comes to mooring operations, additional precautions need to be taken to ensure personal and crew members' safety.

Mentioned below are ten points that must be considered while handing mooring operation on ships:

1. Don't Allow Any Extra Crew Member on the Deck: Ensure that no extra personnel are present at the mooring station except those who are involved in the operation. Anyone who is not assisting in the mooring operation must be asked to leave the mooring station for his/her and other's safety.

2. Consider Weather Condition: Before planning the mooring operation, consider the weather condition by taking factors such as wind and current. The ship's master and responsible officer must have the details of current and future weather data before commencing the mooring operation.

3. Have knowledge of Snap Back Zone and Rope Bight: All personnel involved with the mooring operation should be aware of the snap back zones and rope bight.

4. Check All the Mooring Equipment: Check all the equipment (mooring winch, drums, windlass etc.) involved in the mooring operation for any kind of problem. Proper routine maintenance is the key to ensure smooth running of mooring equipment and systems.

5. Check the Tail of Mooring Line: If the mooring wire line is provided with tail (short lengths of synthetic fiber rope which are placed in series with the vessel's winch-mounted wires to decrease mooring line stiffness and thus to reduce peak line loads and fatigue due to vessel motions) ensure same size and material of tails are used for all lines in the same service (breast, spring and headlines). Different tail size and material would lead to uneven load in the mooring line.

ENVIROMENTAL ISSUES AT SEA

INTRODUCTION

Marine pollution occurs when harmful effects result from the entry into the ocean of chemicals, particles, industrial, agricultural, and residential waste, noise, or the spread of invasive organisms. Eighty percent of marine pollution comes from land. Air pollution is also a contributing factor by carrying off pesticides or dirt into the ocean. Land and air pollution have proven to be harmful to marine life and its habitats.

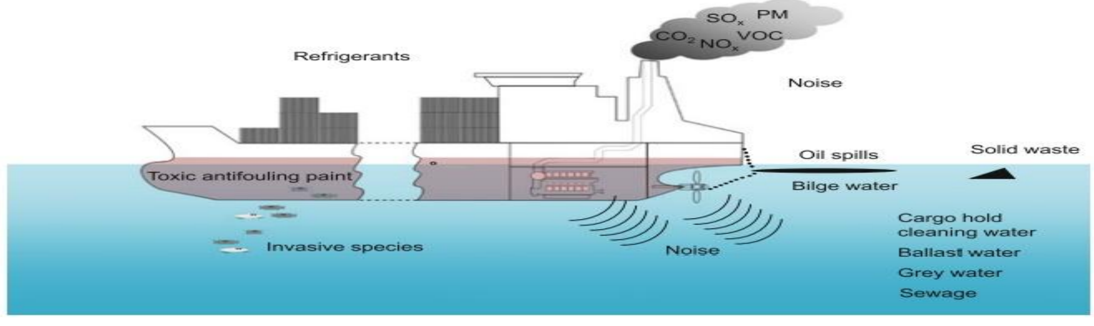
The pollution often comes from nonpoint sources such as agricultural runoff, wind-blown debris, and dust. Nutrient pollution, a form of water pollution, refers to contamination by excessive inputs of nutrients. It is a primary cause of eutrophication of surface waters, in which excess nutrients, usually nitrates or phosphates, stimulate algae growth. Many potentially toxic chemicals adhere to tiny particles which are then taken up by plankton and benthic animals, most of which are either deposit feeders or filter feeders. In this way, the toxins are concentrated upward within ocean food chains. Many particles combine chemically in a manner highly depletive of oxygen, causing estuaries to become anoxic.

When pesticides are incorporated into the marine ecosystem, they quickly become absorbed into marine food webs. Once in the food webs, these pesticides can cause mutations, as well as diseases, which can be harmful to humans as well as the entire food web. Toxic metals can also be introduced into marine food webs. These can cause a change to tissue matter, biochemistry, behavior, reproduction, and suppress growth in marine life. Also, many animal feeds have a high fish meal or fish hydrolysate content. In this way, marine toxins can be transferred to land animals, and appear later in meat and dairy products.

In order to protect the ocean from marine pollution, policies have been developed internationally. There are different ways for the ocean to get polluted, therefore there have been multiple laws, policies, and treaties put into place throughout history.

The environmental impact of shipping includes air pollution, water pollution, acoustic, and oil pollution. Ships are responsible for more than 18 percent of some air pollutants.

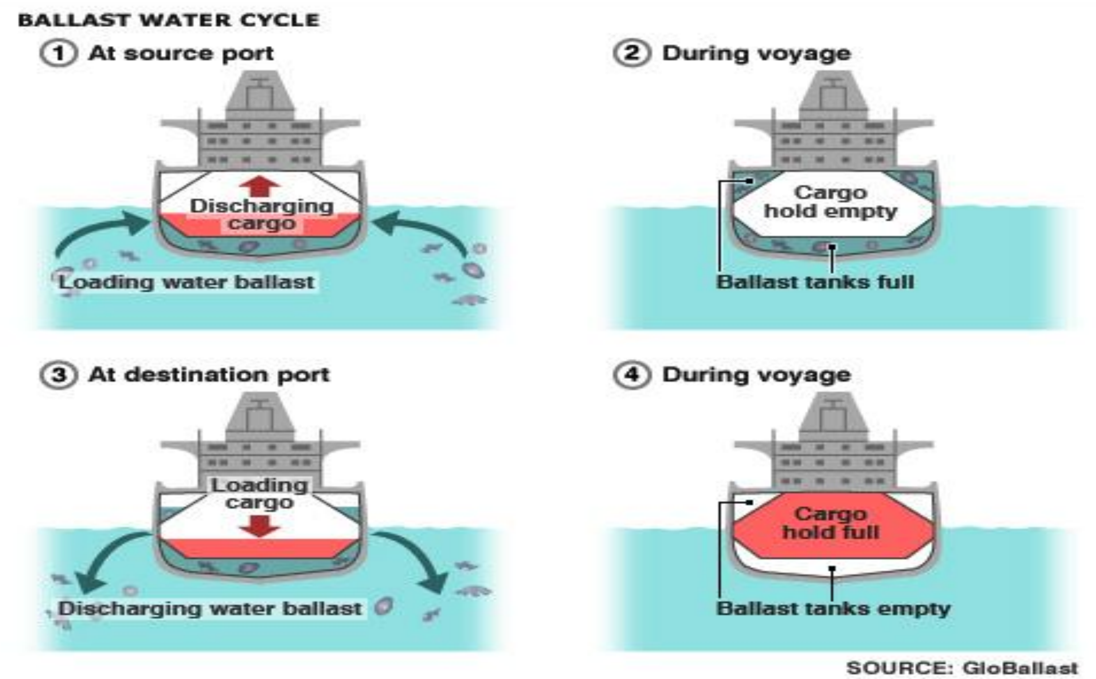
It also includes greenhouse gas emissions. The International Maritime Organization (IMO) estimates that carbon dioxide emissions from shipping were equal to 2.2% of the global human-made emissions in 2012 and expects them to rise 50 to 250 percent by 2050 if no action is taken. The First Intersessional Meeting of the IMO Working Group on Greenhouse Gas Emissions from Ships took place in Oslo, Norway on 23–27 June 2008. It was tasked with developing the technical basis for the reduction mechanisms that may form part of a future IMO regime to control greenhouse gas emissions from international shipping, and a draft of the actual reduction mechanisms themselves, for further consideration by IMO's Marine Environment Protection Committee (MEPC).



Environmental impacts of marine transportation during the use of a vessel

CHAPTER 1

The Pollution of Ships' Ballast Water to the Marine Environment and Countermeasures.



Key words: ballast water; marine environment; ballast water exchange; heating-electrolysis

Abstract: as the integration of the world economy, the amount of global trade has increased. 80% of the trade commodities are transported by sea. A large number of ships whose ballast water cause great damage to the marine environment are sailing in the ocean every year. Ship’s ballast water has become an important way for microorganisms transmitting all over the world. The pollution to the marine environment which is caused by ship’s ballast water and the methods how to deal with ship’ ballast water will be discussed in this paper.

Introduction

When the Ship navigates without any cargo, it is necessary for the ship to pump in some sea water to increase its stability so as to fight against the wind and the wave. When the ship arrives at the destination port, the sea water which has been pumped in at the other port will be discharged into the destination port, so the amount of seawater is called ballast water. Ship’s ballast water plays an important role in adjusting the draft and trimming of the ship, reducing hull deformation, reducing hull resistance, lowering hull vibration, improving the seaworthiness of the ship and so on. If the ballast water contains harmful aquatic organisms or pathogens, and these ballast waters is discharged into the waters of other ports, in this case, the marine ecological condition and local economy and human health will be affected. The damage to the marine environment which is caused by marine species in ship's ballast water has been recognized as one of the four major threats to the oceans by Global Environment Facility. Ship's ballast water pollution has been put a high premium by IMO(International Maritime Organization) and the governments of many countries, and they are studying how to deal with this issue of ballast water.

The Marine Environment Pollution Caused by Ship's Ballast Water Ship's ballast water can be divided into two categories: one is the oil tank ballast water, and the other is the ballast from the ordinary holds of the ship. Some crude oil tankers don't have dedicated clean ballast tanks, so they use the oil tanks which have been carried out COW (crude oil washing) to carry ballast water, thus the oil residue which has been left in the oil tank will be discharged into the other port together with the ballast water when necessary. So, this will cause oil pollution to the sea environment. The other category of ballast water pollution is the ordinary cargo holds are used as ballast tanks, in this case, there are noxious liquid substances, harmful substances and viruses, bacteria which are pumped in the port of infected areas and the like. As a preliminary appreciation, there is about 11 billion tons of ballast water transferring from one place to another globally every year. These ballast waters are mainly from the ship's discharging port or some areas nearby. The ballast water will transfer about 3000 ~ 4000 species of organisms every day globally, although Most aquatic organisms in ballast tanks can't tolerate the environment of no light, no oxygen, high iron concentration, and will die on the voyage, but few strong vitalities of aquatic organisms are able to successfully reach the discharging port and can reproduce themselves in local waters. So, they become invaders. Invasion of alien species can cause damage to the ecological balance of the waters of the port State, lead losses to the local economy. Ships carry ballast water full of pathogens may also have serious regional epidemic characteristics, leading to the spread of epidemics, which will cause threat of port State public health. In 2006,The State Environmental Protection Administration

4th International Conference on Machinery, Materials and Computing Technology (ICMMCT 2016)reported that: biological invasion which plays a major role caused direct economic losses to the country up to 57.4 billion RMB.

The Methods of Dealing with Ship's Ballast Water In order to prevent the ship's ballast water causing pollution to the marine environment, there are many methods used to deal with ship's ballast water throughout the whole world at present. Mechanical method, physical method, and chemical method are used to deal with ballast water. More research has been done to chemical methods to deal with ballast water such as chlorination, electrolysis, strong ionization discharge treatment method. The following are some methods to deal with ship's ballast water:

Mechanical Method –deep Sea Ballast Water Exchange. Deep sea ballast water exchange is based on a theory that: freshwater, estuarine and coastal water organisms generally can't survive in the deep-sea environment, on the other hand, the deep sea marine organisms can't survive in the coastal environment too, furthermore, deep-sea waters almost do no harm to human lives. To carry out this method, ships have to replace its ballast when she is sailing in deep sea whose depth is more than 200 meters and 200 nautical miles offshore. Ballast water exchange methods can be divided into emptying, overflowing and dilution method according to their different operation.

Emptying Method. The ship has to discharge all the ballast water which is pumped in at the coastal port, and clean the residue at the tank bilge, and then inject deep sea water into the ballast tank. Using this method, the coastal ballast water can be 100% replaced by deep sea water, so it is recognized as the most effective and most practical method to prevent the spread of harmful aquatic organisms and pathogens. During the process of replacing the ballast water, the loading condition and stability of the ship will change significantly, so the ship officers must calculate the stability, trim, strength of the ship at each step of replacing process in advance so as to ensure the safe navigation. Emptying method is not suitable when the ship encounters bad weather, because it can't ensure the strength and stability of the ship.

Overflowing Method. This method is to pump the deep-sea water into the full ballast tank from the tank bottom, so that the original coastal ballast water will overflow from the holes on top the deck. The ship has to pump in three times the amount of ballast water in order to replace 90% of the coastal ballast water. This method does not change the stability, strength and the trim of the ship, so it can be performed during adverse weather conditions. But the ballast water can't be replaced completely, the validity of this method is challenged. In addition, the ballast tanks will withstand overstress, sea water will form ice on deck in winter. These points will also make this method less safe, especially with respect to some old ships.

Dilution Method. This is a new method proposed by Brazil recently, which uses three times of deep-sea water to replace the amount of the coastal ballast water from the top edge of the ballast tank, at the same time discharge the original ballast from the bottom of ballast tanks. Dilution method is safer than the overflowing method, but the effectiveness is not enough.

Physical Method. Heating Method. Focus on the study result so far, most organisms will be killed when they are put in the water whose temperature is between 38°Cand50°C for 2 ~ 4h duration. There are three kinds of ways to heat ballast water: press water vapor into the ballast water, heat the ballast water using the ship's main engine heat, or microwave method. Although this method is considered to be a potentially attractive approach, but it needs a long processing time, high energy consumption, and also the safe navigation will be affected by the thermal stress at the same time.

Filtration. A certain size of organisms can be separated out from the ballast water by using onboard filtration system, which serve to prevent and reduce the harmful organisms from entering the ballast tank. Through this method, it is not necessary to exchange ballast water and some further operation steps. But in order to achieve more security filtering, some more detailed work has to be done. Because of the high flow speed and high flow during pumping in and pump out ballast water, it demands the filtration equipment has a good quality. And when biological and particle size becomes smaller, the complexity and cost of the filtration system will increase accordingly. The material filtered out from the ballast water can be stored on board and then receipted by shore facilities for further processing, it can't be discharged back to sea except the rules allow. Filtering system can choose the net filter or thick material filter.

Ultraviolet Irradiation. Studies have shown that if ultraviolet irradiation can kill the organisms is largely depending on the size and shape of the microorganism. When the wavelength is between 240 ~ 260nm, especially at 253.7nm, the organisms and pathogens in the ballast water will be easily killed. The main problem with this method is that there are large amounts of suspended material in the coastal water which will block ultraviolet radiate on biological pathogens. So, combining ultraviolet irradiation method and filtration method will receive a better result. Furthermore, it will cost more when we use ultraviolet irradiation method to deal with ballast water.

Chemical Act method. Heating-electrolysis. To remove microorganism in the ballast water by using chlorination is feasible. But for different organisms, we have to use different chlorine to kill them. For details see table 3.1. Generally speaking, a small amount of chlorine can kill bacteria in ballast water; for plank tonic algae, because its tolerance to chlorine is strong, so it requires a higher chlorine content to kill plank tonic algae. When the seawater is heated to 38℃~45℃, most algae and protozoa can't survive. We can produce chlorine using electrolysis of seawater. And the chlorine can kill all sea creatures and bacteria. Almost all bacteria in seawater will be killed when the concentration of chlorine reaches 20mg/L. There is an electrolysis system of seawater in the ballast water handling system which can produce chlorine to kill organisms in the ballast water. One way is to pump out some sea water from the main sea water pipe, and then send the sea water in to electrolysis apparatus to produce chlorine, and finally push the sea water full of chlorine in to the ballast tank. We have to control the concentration of chlorine less than 0.1mg / L after all organisms has been killed. In this situation, it will do no harm to corrode the sea water pipes and will cause no secondary pollution. Another method is to install the electrical bait directly in the ballast handling system, all the sea water will pass through the electrolysis apparatus. It is difficult to control the concentration of chlorine and cause large power consumption. During the process of electrolyzing sea water and killing the organisms, a carcinogen chloroform (THM) will be produced. But the chloroform will decompose soon and almost cause no damage to the environment.

Strong Ionization Method. Institute of Environmental Engineering of Dalian Maritime University has developed a "strong ionization method to deal with ballast water so as to prevent invasion of harmful microorganisms" which can prevent the spread of harmful ballast water organisms effectively. This is a new method to deal with ship's ballast water. According to reports, the hydroxyl radical is a strong oxidant, it has the same oxidation reduction potential as fluorine, and it can easily kill microorganisms. Hydroxyl will cause the protein of invasive microorganisms to lose activity and died finally. In addition, the reaction between invasive microorganisms and hydroxyl is a free radical reaction whose reaction speed is very high. This reaction can kill the microorganisms during the process of pumping in the ballast water. But the technology is still in the laboratory stage, once recognized by IMO (International Maritime Organization),it will become an effective way to deal with ballast water pollution.

Conclusion

With the introduction of MARPOL (International Convention for the Prevention of Pollution from Ships) Convention, marine environmental protection has been focused by the international community. One of the important problems is how to prevent pollution caused by ships' ballast water. Dealing with ballast water is a complex issue demanding safety, reliability, effectiveness and economy. Exchange ballast water in deep sea during voyage is the most effective and practical method to deal with ship's ballast water so far. But there are security risks to the operation of the ship. Other methods described in this paper, although they are possible in theory, but there will be some shortcomings in the implementation process. Therefore, to develop more practical, more economical ballast water pollution prevention method is imperative. On the other hand, some vessels are equipped with ballast water system, but they do not use it because of the economy reason. Ballast water system is used only in the PSC inspection. In this case, it is important to establish supervising equipment for every ship in order to force them to use their ballast water system all the time.

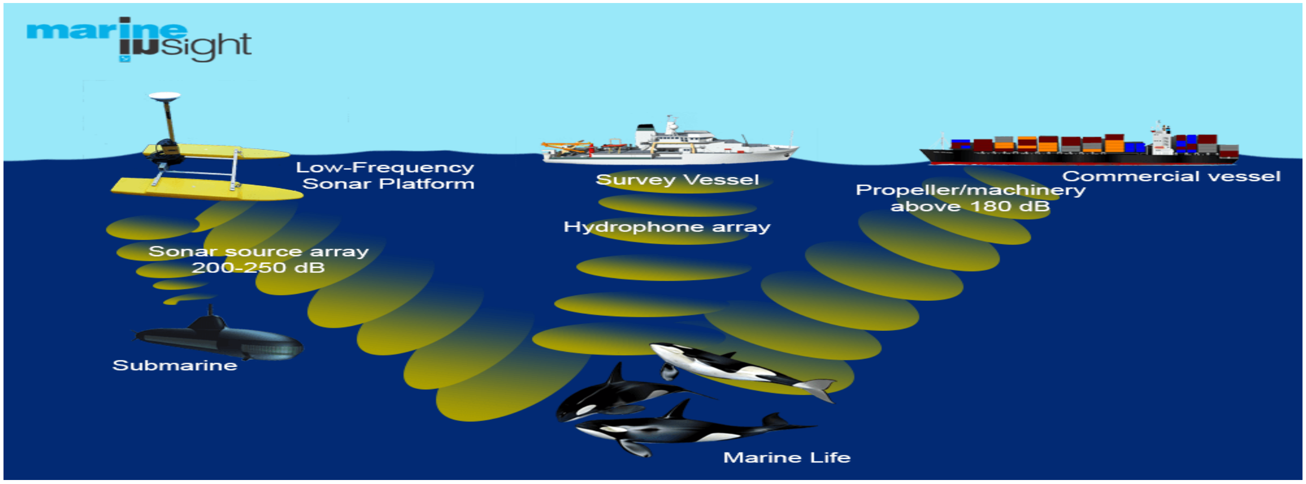
CHAPTER 2

Effects of Noise Pollution from Ships on Marine Life

Just as much salvation has been brought to the world due to developments in marine industry in terms of better technology, there is no denying the fact that simultaneously the natural balance of things has had to pay a price. With ship transportation picking up pace, the environmental effects of it is now surfacing. Among them, effects of noise pollution especially on marine life are highly prominent.

Two main reasons that make environmental impact of noise in marine life especially grave are- firstly noise travels much more in water, covering greater distances than it would do on land while travelling though air, and secondly because the marine life is extremely sensitive to noise pollution. Due to their extreme reliance on underwater sounds for basic life functions like searching for food and mate and an absence of any mechanism to safeguard them against it, underwater noise pollution disrupts marine life in more serious ways.

Source of ocean noise pollution include everything from the ship noise to the low frequency sonar 'sounds' used extensively in submarine detection or even the seismic air gun noise from oil and gas exploration or even commercial shipping traffic and coastal jet ski traffic. Studies have showed that while these 'sounds' may have no impact on human, in marine life, they can be detrimental. Population of cetacean (whales and dolphins) has declined in areas prone to such noise pollution from ships.



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The death of animals can occur merely hours after exposure to extreme underwater noise for example whales can die soon enough due to standings. Beaching themselves shortly after a tactical sonar exercise is a rather common environmental impact of noise pollution. Such beaching has been reported in regions like Greece, Madeira, Hawaii, Spain and the coastal US- areas where sonar exercises are common.

Mass stranding of giant squids in coastal areas of Spain between 2001 and 2003 showed how grave the implications of noise pollution in marine life can be. These beaching can occur merely hours after such an exercise. Dislocation or movement of marine animals to newer location is also one of the many ocean noise pollution effects. While this may seem like a survival mechanism, studies conducted for a follow up on these animals isn't that promising as most animals fail to acclimatize in the new environment, not to mention loss of diversity in many regions.

The effect of underwater noise pollution is more painful than anything else for the animals. Most animals are alarmed by the alien sounds. The deaths can occur due to hemorrhages, changed diving pattern, migration to newer places,and damage to internal organs and an overall panic response to the foreign sounds. There is also a disruption in normal communication between marine animals as a result of underwater noise pollution. This means animals prone to noise pollution are unable to call their mates, look for food or even make a cry for help under such circumstances.

Many marine animals like the fish (rockfish, herring, san eel, cod, blue whiting etc) show signs of extensive damage to their ears upon exposure to seismic air guns even up to several kilometers. Exposure to noise during embryonic stage increases sensitivity of fish to noise impact, increasing the mortality rates at time of birth and development of genetic anomalies. The migration to new areas not only affects the marine diversity balance but indirectly affects humans too. A decreased catch in many fish species like herring, cod and blue whiting especially in areas susceptible to noise pollution from ships has been noticed.

Sensitivity of various marine animals to ocean noise pollution is varying. While cetaceans like whales and dolphins may show a greater resistance, soft shelled species like mollusks, prawns, fish etc are much more sensitive. However, it is important to note that as many as 24 cetacean species have shown negative effects of noise pollution in ocean. In all about 55 marine species have been noted to have suffered due to exposure to sound of varying frequencies. These include sperm whale, grey whale, mink whale, pygmy sperm whale, killer whale, sea bass, pink snapper, goldfish, cod, haddock, bluefin tuna, squid, lobster, brown shrimp etc.

There is a reason why ocean is called as the 'silent world'. In this world, where sounds of their own exist, there is no room or rather any need for foreign sounds to breach the harmony of their world. Studies are being conducted to understand effects of noise pollution on marine life in a much better way. But until a safe mechanism can be thought of which will ensure that marine animals do not continue to commit as much as mass suicide due to human errors, safety through prevention is out best shot at keeping the sanctity of this 'silent world' intact.

CHAPTER 3

Collisions between vessels and marine animals

The movement of ships and boats to and from ports may potentially have some effect on marine life simply by virtue of their presence. This is particularly the case with high-speed leisure craft and in marine SACs designated for their marine mammals. There have been a number of studies on the effects of vessel movement on marine mammals. These include the Institute of Zoology's Marine Mammal Stranding's Project (Jepson personal communication 1998), the Natural History Museum's stranded whale recording scheme (Muir personal communication 1998), the work of the Sea Mammal Research Unit and Durlston Country Park in Dorset (Browning personal communication 1998) and studies undertaken in Cardigan Bay (Evans personal communication 1998) and the Firth of Forth (Reid personal communication 1998). Research has shown that although a rare occurrence in UK waters, collisions do occur between marine mammals and ships/boats operating at speed, which may result in fatal injuries or wounding. However, quantified information on the occurrence of these incidents is very limited.

Over the past few years, there have been a limited number of incidents where dead and stranded marine mammals, often harbor porpoises, have shown evidence of propeller damage or massive trauma, indicative of ship collisions. In Scottish waters there have been recent reports of fatal collisions between vessels and basking sharks, which are a protected species under the Wildlife and Countryside Act. Further collision incidents are known to taken place with seals, however, there is very little information available on the occurrence of these events (National Seal Sanctuary personal communication 1998). Generally, the risk of collisions with marine mammals is greater for recreational craft and dolphin-watching boats and guidelines have been developed for minimizing the disturbance to dolphins and porpoises from these activities.

As one would expect, wherever possible, animals will avoid contact with moving vessels. However, this is not always the case, for example dolphins and porpoises often actively seek out moving vessels and swim close alongside in the bow wave which may make them vulnerable to injury from collision (A. Muir Natural History Museum personal communication 1998). Many mariners, including yachtsmen, regularly report the enthusiasm with which dolphins accompany their vessels, often for relatively long periods of time before diving away. For example, bottlenose dolphins in the Moray Firth readily approach vessels, to bow ride or to accompany them through the narrows (UK CEED 1993).

Research has been undertaken by the Sea Mammal Research Unit to establish the distribution of seals around UK waters. Observations show that seals co-exist with shipping in many areas around the coast. The presence of fishing vessels may even provide an additional food source as a result of the practice of discarding unwanted fish overboard. It is unlikely that other marine animals will be affected greatly by vessel movements in the UK.

Noise from ships and boats

Noise associated with shipping has the potential to cause disturbance to marine animals, including the marine mammals, fish and birds designated under the Habitats Directive. The main source of noise from vessels is generated by the engine, which may travel via the atmosphere or be transmitted through the structure of the craft. The volume of sound generated and transmitted into the air or water will depend on the size, design and location of the engine, and the craft's size and construction. There have been very few studies carried out to investigate the effects of noise pollution in UK coastal waters, particularly with regard to ship-generated noise on marine animals. The level of information that is available on underwater noise is generally inconclusive with regard to the effects on marine life.

Marine mammals are known to continue to use areas with very high levels of boat traffic and noise, such as Galveston Harbor in Texas (ICES 1991). However, there is concern over noise pollution in general which tends to center on the possible behavioral effects and that in the worse cases marine mammals, fish or birds may be driven away from their home territories. In recognition that noise and erratic boat movements can distract feeding dolphin or drive them away, codes of conduct have been prepared for vessels operating in Cardigan Bay and the Firth of Forth (Section 3.4.3).

Dolphins have a sensitive echo location system. Concerns have been expressed that underwater noise may disturb dolphins, however, there is little research available to support or disprove these concerns in relation to noise from commercial shipping and recreational craft in UK waters. The preliminary findings of a study undertaken as part of the Durlston Dolphin Research Programme indicates that it is unlikely that bottlenose dolphin is disturbed by the noise generated by high speed ferries operating out of Poole Harbor (case study - Browning, Williams &Haarland 1997).

Observations of seals made as part of the work of the Sea Mammal Research Unit show, not surprisingly, that seals are usually less tolerant to disturbance during the breeding season and when feeding their offspring. Further research is required to establish whether seals exhibit behavioral changes as a result of noise from shipping and port operations. Seals generally choose relatively undisturbed areas to come ashore and breed. Ironically, RAF bombing ranges, which despite being the source of a certain level of noise pollution have been observed to provide suitable areas for colonies of seals. This observation is likely to be a result of the restrictions to public access along these stretches of coast (Sea Mammal Research Unit personal communication 1998).

The effect of underwater noise has been more extensively studied with regard to the impact of seismic surveys on marine animals, and the resultant disturbance to fish feeding behavior, repulsion from fishing grounds, avoidance behavior in sea mammals and disturbance of breeding colonies of birds. Effects of the high level, low frequency sounds from seismic surveys are thought to be temporary, with lasting harm to fish, sea birds and mammals unlikely (Turnpenny&Nedwell 1994).

Marine accidents

There is an inherent risk of marine accidents occurring where goods are transported by sea, just as there are risks associated with other forms of transport, although these risks are far less per ton mile than occur with other forms. Such accidents may occur if a ship is unsuccessful in its attempt to avoid another vessel or obstruction. Harbor authorities make an important contribution to reducing the risk of such events by undertaking their responsibilities as conservancy authorities over various measures to provide for navigation safety. Furthermore, where response plans have been drawn up, an appropriate, coordinated approach to any incident will ensure that any potential damage to the environment is limited, particularly where hull ruptures and loss of cargo or fuel spillage occur. The potential impacts of such oil spills and discharges are discussed in the Waste Management Section.

When a vessel runs aground it is inevitable that this event will disturb the seabed. The length of time a vessel stays aground may influence the extent of damage caused, however, waiting for the tide to re-float the vessel may be less harmful than vigorous action by tugs. Grounding of a vessel may cause resuspension of sediment resulting in turbidity and mobilization of any contaminants in the sediment. The disturbance to the benthic community will be short lived and dependent upon the type of benthic animals in situ. Hard bottom communities are generally less resistant to increases in turbidity than those adapted to a silty estuarine environment. Some loss may occur as a result of burial. In general, the impact of a grounding incident and the length of time required for habitat recovery is likely to be greatest for sensitive, slow growing species and communities in the intertidal and shallow subtidal that are unable to move away, such as marl or seagrass beds. In hard bottom areas, physical damage to rocky communities, such as those of reef habitats, may be an issue, although the greater risk of hull damage will normally mean that navigators will allow greater safety margins to minimize risk.

Anchoring and mooring

Ports and harbors around the UK coast, and the estuary and bay habitats in which they lie provide shelter and safe anchorage for ships and boats. However, the anchoring of vessels may disturb or damage animals and plants on the seabed, either temporarily by increasing suspended sediments from the disturbance of the bottom or through direct contact with dragging anchors. The effects are of most concern in areas with sensitive or slow growing species, such as shellfish beds, soft corals, sea grasses and marl. Disturbance from anchoring depends upon the frequency, magnitude and location of activity, type of sediments, and the sensitivity of benthic communities. Where the seabed sediments are soft and there are no sensitive communities or other underwater obstructions, damage caused by anchoring is likely to be minimal and any disturbance is generally temporary, although disturbance in low energy environments can be more than temporary. However, when anchoring over sensitive rocky communities the effects may be more damaging, for example on subtidal reef habitats. However, anchoring is often already restricted or discouraged in areas containing debris, wrecks and other obstructions, typical of uneven rocky bottom areas, which are referred to as foul ground on navigational charts. The impacts from mooring vessels depend on the type of mooring involved.

There have been concerns expressed that the location of moored craft close to the shore may cause disturbance through noise and vessel movements, particularly where it is adjacent to intertidal feeding areas used by birds. However, there appears to be very little literature and evidence that supports this view. The existence of tall yacht masts does not seem to constitute a line of sight obstruction for those birds that are sensitive to such a constraint. In most leisure mooring areas, the number of times a vessel is moved per year is very low and such movements are concentrated into a few hours on Saturday mornings and Sunday evenings. Disturbance levels are therefore minimal. Where drying moorings exist, the moorings can only be used when the intertidal areas are covered, thus eliminating any disturbance to feeding birds.

The existence of a permanent mooring area close to a wildlife site has the effect of keeping vessels that are likely to cause a disturbance through noise or wash, such as high-speed recreational craft, water skiers and personal water craft, further away from intertidal habitats. In such circumstances mooring areas can provide a positive protection to designated features. Mooring areas also represent an area where restrictions are in place for human safety reasons, including speed limits and fishing bans. Mooring areas therefore represent a haven where impacts that may normally exist in an area are at a reduced level. In one example, civil law (an injunction) was used to prevent clam fishermen from dredging in a mooring area and damaging the mooring gear after they had extensively fished the rest of the harbor. In this case the mooring area was effectively a nursery.

Means of avoiding, minimizing and addressing the potential impacts of port and harbor operations

It is evident from the literature review that a wide range of port and harbor operations may cause adverse environmental impacts. Where uncertainty exists, it is equally possible that they do not, or that the impact is insignificant in relation to the reasons for which the site was designated. Suitable actions that should be considered in ports and harbors to address the impacts identified above, some of which are already in operation, are as follows:

Environmental policy, reviews and management systems,

Information and codes of conduct,

Ensuring safety,

Emergency response procedures,

Provision of information on SACs,

Zoning of activities,

Re-routing via alternative navigation channels,

Protection of intertidal features using breakwaters and other structures,

Compliance with regulations covering cargo operations and promotion of good practice, and

Managing anchoring.

CHAPTER 4

Air pollution from ships

This page provides background information on the health and environmental impacts of air pollution from ships. It also highlights the measures that can be taken to significantly reduce Sox, NOx and fine-particle emissions from ships with recommendations for EU action.

How much air pollution does shipping cause in Europe?

In 2005, in the seas surrounding Europe (the Baltic Sea, the North Sea, the North-Eastern part of the Atlantic, the Mediterranean and the Black Sea), Sulphur dioxide (SO2) emissions from international shipping were estimated at 1.7 million tons a year, nitrogen dioxide (NOx) emissions at 2.8 million tons, and particulate matter (PM 2.5) at 195,000 tons. Due to the application from the start of 2015 of the 0.1% MARPOL limit in Sulphur Emissions Control Areas (SECAs) in the North and Baltic Sea and English Channel, ship-sourced Sulphur emissions have reduced considerably in these areas. Emissions will be further reduced in the remaining EU seas with the implementation in 2020 of the 0.5% regional limits. However, in the long-term emissions will rise due to increases in transport volume.

How much and how fast can pollution from ships be cut?

Technical measures to cut air pollution from ships significantly are implementable and outweigh the costs involved. These measures include the adoption of cleaner fuels, adding closed-loop 'scrubbers' or other exhaust gas cleaning devices to ships (for Sox), SCR systems (for NOx), slow steaming, and wider use of alternative sources of energy including wind power and port-side electricity.

Why is it important to pay more attention to ship emissions?

Air pollution from ships continues to increase as the sector grows. Land-based emissions – Sox and NOx – on the other hand, particularly from fixed installations, have been reduced dramatically at great cost. NOx from shipping is set to exceed NOx from all EU land-based sources in the coming decade.

How do SO2, NOx and particle emissions pose a threat to human health?

Air pollution from international shipping accounts approximately for 50,000 premature deaths per year in Europe, at an annual cost to society of more than €58 billion according to recent scientific studies. Through chemical reactions in the air, SO2 and NOx is converted into fine particles, sulphate and nitrate aerosols. In addition to the particles directly emitted by ships such as black carbon, these secondary particles increase the health impacts of shipping pollution. Tiny airborne particles are linked to premature deaths. The particles get into the lungs and are small enough to pass through tissues and enter the blood. They can then trigger inflammations which eventually cause heart and lung failures. Ship emissions may also contain carcinogenic particles.

Implementing the Sulphur standards for shipping fuels that the International Maritime Organization (IMO) adopted in 2008 is expected to save 26,000 lives a year in the EU as from 2020.

How much would be reducing air pollution from ships cost?

Air pollution from international shipping accounts for approximately 50,000 premature deaths per year in Europe, at an annual cost to society of more than €58 billion, according to recent scientific studies. Through chemical reactions in the air, SO2 and NOx is converted into fine particles, sulphate and nitrate aerosols. In addition to the particles directly emitted by ships such as black carbon, these secondary particles increase the health impacts of shipping pollution. Tiny airborne particles are linked to premature deaths. The particles enter the lungs and are small enough to pass through tissue into the bloodstream triggering inflammation and potentially heart and lung failure. Ship emissions may also contain carcinogenic particles.

Implementing the global 0.5% Sulphur standard for marine fuels from 2020, as adopted by the IMO in 2008 and reconfirmed in 2016, is expected to save 40,000 lives a year globally from lung cancer and cardio vascular deceases (lives saved exclude child asthma and morbidity).

What are the new Sulphur standards agreed at the IMO level and in the EU?

In 2008, the IMO revised its standards on the Sulphur content of marine fuels (contained in MARPOL Annex VI). In October 2012, the standards were officially transposed in Europe. Under the current EU regulations:

1. Since 2015, ships sailing in a Sulphur Emission Control Area (SECA) cannot use fuels with more than 0.1% of Sulphur. The European SECAs currently include the Baltic Sea, the North Sea and the English Channel;
2. Globally, ships are allowed to use fuels with Sulphur content up to 3.5%. In 2016, the IMO confirmed 2020 implementation date of the new global of 0.5% Sulphur standard outside SECAs.
3. In Europe only, passenger ships are required to use fuels with Sulphur content of maximum 1.5%, which was set in 2005 and updated in 2012 by the EU Sulphur Directive. From 2020, all ships sailing outside SECAs will have to comply with the 0.5% Sulphur standard as required both by the EU Sulphur Directive and IMO's MARPOL Annex VI.
4. Different compliance methods are offered to ship-owners. Instead of using low-Sulphur marine diesel, marine gasoil or low and ultra-low Sulphur heavy fuel oil (LSFO/ULSFO), ship operators can choose to switch to LNG, methanol or to cut their Sulphur emissions by fitting exhaust systems with scrubbers or other exhaust gas cleaning technologies.

What standards are in place to reduce NOx emissions from ships?

The IMO MARPOL Annex VI has also strengthened the standards relating to ship NOx emissions, with NOx emissions from new ships to be cut by 16-22% as from 2011 and by 80% (only in NECAs) from 2016/2021 compared to 2000 levels.

While, ship fuel Sulphur standards apply to the entire fleet, the NOx limits only apply to new ships. In addition, the strictest limit, called Tier III, currently only applies to new ships sailing in designated areas around North America from 2016, the NOx Emission Control Areas (NECAs).

In Europe, shipping in the Baltic Sea, the North Sea and the English Channel causes more than 800,000 tons of airborne nitrogen to be deposited each year, worsening the existing problem of eutrophication. Moves to have NOx included in the Baltic Sea, North Sea and English Channel ECAs were first discussed in 2007, but a series of environmental and economic studies to justify the NOx limits have taken several years to complete. In 2014, Russia failed to join its Helsinki Commission partners in agreeing to go forward with an application to the IMO. This coincided with Russian moves to delay the Tier III implementation dates for all NECAs which resulted in the fixed date (2016) in MARPOL for new ECAs to apply to North America only. Under the compromise reached, the start date of each new NECA will in the future be decided on an individual basis.

After many rounds of negotiations, the Helsinki Commission – grouping the nine countries with Baltic coastlines – agreed to apply to the IMO for stricter NOx emissions limits for new ships to apply in the Baltic. Simultaneously a similar application was lodged for the North Sea and English Channel. Both applications were approved by the IMO's marine environment protection committee in October 2016 and adopted in July 2017. The stricter Tier III NOx standard will apply to new ships built after 2021 only while sailing in the North Sea, Baltic Sea and English Channel. NECA Tier III standard requires *new* ships built after 2021 to emit a maximum of 2-3.4 g of NOx/kWh compared to the current global Tier II standard of 7.7-14.4 g of NOx/kWh.

Since the IMO Tier III NOx regulation only applies to new ships and only when sailing in NECAs, additional measures are needed in Europe to address NOx emissions from the existing fleet. A levy on nitrogen oxides (NOx) emissions with revenues earmarked to fund the uptake of NOx abatement technologies would appear to be the most promising tool with achievable emissions reductions of up to 70%. In addition to a NOx levy with a fund, mandatory slow steaming of ships (with a levy and fund as an alternative compliance option) and a stand-alone levy on emitted NOx could also deliver emission reductions.

What technological improvements will the industry have to put in place to cut air pollution from international shipping?

The industry has at its disposal a wide range of options and techniques to cut pollution, most of which are already available on a large scale and easily implementable. These include:

- Using low-Sulphur fuels: this is the easiest way of reducing air pollutants from ships. Shipping fuels in use outside Sulphur emission control areas contain up to 3,500 times the Sulphur content of fuels used by road transport in Europe. Low-Sulphur fuels can make the ship's engine run smoother and more efficiently with less operating problems and maintenance costs. Last but not least, using low-Sulphur (non-residual) fuels reduces other pollutant emissions, such as black carbon which is a potent global-warming agent.
- Scrubbers: an alternative compliance option to burning low-Sulphur fuels approved by the IMO and the EU is for ships to install scrubbers. These could cut emissions of SO_2 by 99% and considerably

reduce emissions of other polluting particles. There are, however, concerns regarding wash-water discharges from open-loop scrubbers which deposit them in open seas and closed-water areas. This leads to higher pH levels in surrounding waters causing additional environmental concerns. Hence, open-loop scrubbers are not a sustainable alternative compliance method for marine Sulphur standards.

- Internal engine modifications, such as water injection and exhaust gas recirculation (EGR – for 4-stroke engines): these are techniques to prevent NOx production during the combustion process. However, Tier III standard cannot be met by these methods alone.
- Humid air motor: adding water vapor to the combustion air can also reduce NOx emissions, however, not down to Tier III levels.
- Selective catalytic reduction (SCR): a system to treat exhaust gases after their production but before they are actually emitted. SCR is very effective in reducing NOx emissions far beyond Tier III. It's already used by many ships worldwide and works better with low-Sulphur fuels.
- Gas or duel-fuel engines: ship engines can work with liquefied natural gas (LNG) which doesn't contain Sulphur and therefore has SO2 emissions close to zero. Gas engines also dramatically reduce other PM and BC emissions. Although it's easier to fit new ships with such engines, a few conversions have already taken place. LNG can also reduce NOx emissions; it has been shown to reach Tier III levels, hence providing a good solution for ship air pollution.
- Shore-side electricity: can be used while ships are at the port, virtually eliminating ship-sourced SOx, NOx, PM, but also CO2.
- Alternative energy sources: experiments with wind and solar power, biofuels and fuel cells are ongoing and could be useful in the future.

What should the EU and member states do to reduce air pollution from ships?

T&E has formulated a series of recommendations for the EU and its member states. These include:

- Transpose the international IMO standards for NOx emissions into EU law and adopt additional EU legislation to address NOx emissions from the existing fleet.
- Extend SECA and NECA standards to the rest of the EU seas: Mediterranean, Adriatic, Black and Irish Seas and the North East Atlantic.
- Monitor whether proper enforcement procedures are adopted in Europe in order to ensure compliance with the standards. For Sulphur, a global ban on bunkering of non-compliant fuels (unless ships are fitted with EGCS) and a global mandate for continuous emissions monitoring systems (CEMSs) are the most promising methods of enforcement. The latter would serve for NOx enforcement, too.
- Adopt market-based measures to make polluters pay a fair price for the emissions the shipping sector is responsible for.

CHAPTER 5

Oil Spills: Impact on the Ocean

Oil wastes that enter the ocean come from many sources, some being accidental spills or leaks, and some being the results of chronic and careless habits in the use of oil and oil products. Most waste oil in the ocean consists of oily stormwater drainage from cities and farms, untreated waste disposal from factories and industrial facilities, and unregulated recreational boating.

It is estimated that approximately 706 million gallons of waste oil enter the ocean every year, with over half coming from land drainage and waste disposal; for example, from the improper disposal of used motor oil. Offshore drilling and production operations and spills or leaks from ships or tankers typically contribute less than 8 percent of the total. The remainder comes from routine maintenance of ships (nearly 20 percent), **hydrocarbon** particles from onshore air pollution (about 13 percent), and natural seepage from the seafloor (over 8 percent).

Prevalence during Drilling versus Transportation

Offshore oil spills or leaks may occur during various stages of well drilling or workover and repair operations. These stages can occur while oil is being produced from offshore wells, handled, and temporarily stored; or when oil is being transported offshore, either by flowline, underwater pipeline, or tanker. Of the approximately 706 million gallons of waste oil in the ocean each year, offshore drilling operations contribute about 2.1 percent, and transportation accidents (both ships and tankers) account for another 5.2 percent. The amount of oil spilled or leaked during offshore production operations is relatively insignificant.

Oil waste from offshore drilling operations may come from disposal of oil-based drilling fluid wastes, deck runoff water, flowline and pipeline leaks, or well failures or blowouts. Disposal of offshore production waste can also pollute the ocean, as can deck runoff water, leaking storage tanks, flowline and pipeline leaks, and the wells themselves. Oil spilled from ships and tankers includes the transportation fuel used by the vessels themselves or their cargos, such as crude oil, fuel oil, or heating oil.

Over half the ocean's waste oil comes from land-based sources and from unregulated recreational boating. The heavy development in this busy California port illustrates one potential source of petroleum contamination in coastal waters. (Note dark plume in left foreground.)

Oil Spill Behavior

When oil is spilled in the ocean, it initially spreads in the water (primarily on the surface), depending on its relative density and composition. The oil slick formed may remain cohesive or may break up in the case of rough seas. Waves, water currents, and wind force the oil slick to drift over large areas, impacting the open ocean, coastal areas, and marine and terrestrial habitats in the path of the drift.

Oil that contains **volatile organic compounds** partially evaporates, losing between 20 and 40 percent of its mass and becoming denser and more viscous (i.e., more resistant to flow). A small percentage of oil may dissolve in the water. The oil residue also can disperse almost invisibly in the water or form a thick **mousse** with the water. Part of the oil waste may sink with suspended particulate matter, and the remainder eventually congeals into sticky tar balls. Over time, oil waste weathers (deteriorates) and disintegrates by means of photolysis (decomposition by sunlight) andbiodegradation (decomposition due to microorganisms). The rate of biodegradation depends on the availability of nutrients, oxygen, and microorganisms, as well as temperature.

Oil Spill Interaction with Shoreline.

If oil waste reaches the shoreline or coast, it interacts with sediments such as beach sand and gravel, rocks and boulders, vegetation, and terrestrial habitats of both wildlife and humans, causing erosion as well as **contamination** . Waves, water currents, and wind move the oil onto shore with the surf and tide.

Crude oil from the *Sea Empress* tanker spill coats a beach at Pembrokeshire, Wales in 1996. Although marine transportation accidents can result in such oil spills, they account for only about 5 percent of the waste oil that enters the ocean annually.

Beach sand and gravel saturated with oil may be unable to protect and nurture normal vegetation and populations of the substrate **biomass.** Rocks and boulders coated with sticky residue interfere with recreational uses of the shoreline and can be toxic to coastal wildlife.

Examples of Large Spills.

The largest accidental oil spill on record (Persian Gulf, 1991) put 240 million gallons of oil into the ocean near Kuwait and Saudi Arabia when several tankers, port facilities, and storage tanks were destroyed during war operations. The blowout of the *Ixtoc I* exploratory well offshore Mexico in 1979, the second largest accidental oil spill, gushed 140 million gallons of oil into the Gulf of Mexico. By comparison, the wreck of the *Exxon Valdez* tanker in 1989 spilled 11 million gallons of oil into Prince William Sound offshore Alaska and ranks fifty-third on the list of oil spills involving more than 10 million gallons.

The number of large spills (over 206,500 gallons) averaged 24.1 per year from 1970 to 1979 but decreased to 6.9 per year from 1990 through 2000.

Damage to Fisheries, Wildlife, and Recreation

Oil spills present the potential for enormous harm to deep ocean and coastal fishing and fisheries. The immediate effects of toxic and smothering oil waste may be mass **mortality** and contamination of fish and other food species, but long-term ecological effects may be worse. Oil waste poisons the sensitive marine and coastal organic substrate, interrupting the food chain on which fish and sea creatures depend, and on which their reproductive success is based. Commercial fishing enterprises may be affected permanently.

Wildlife other than fish and sea creatures, including mammals, reptiles, amphibians, and birds that live in or near the ocean, are also poisoned by oil waste. The hazards for wildlife include toxic effects of exposure or ingestion, injuries such as smothering and deterioration of thermal insulation, and damage to their reproductive systems and behaviors. Long-term ecological effects that contaminate or destroy the marine organic substrate and thereby interrupt the food chain are also harmful to the wildlife, so species populations may change or disappear.

Coastal areas are usually thickly populated and attract many recreational activities and related facilities that have been developed for fishing, boating, snorkeling and scuba diving, swimming, nature parks and preserves, beaches, and other resident and tourist attractions. Oil waste that invades and pollutes these areas and negatively affects human activities can have devastating and long-term effects on the local economy and society. Property values for housing tend to decrease, regional business activity declines, and future investment is risky.

Long-term Fate of Oil on Shore

The fate of oil residues on shore depends on the spilled oil's composition and properties, the volume of oil that reaches the shore, the types of beach and coastal sediments and rocks contacted by the oil, the impact of the oil on sensitive habitats and wildlife, weather events, and seasonal and climatic conditions. Some oils evaporate, disperse, emulsify, weather, and decompose more easily than others. The weather and seasonal and climatic conditions may accelerate or delay these processes.

In 2000, several thousand penguins were affected by a fuel oil spill after the iron-ore carrier *Treasure* sank off South Africa. Many oil-soaked birds were cleaned and released.

Oil waste that coalesces into a tar-like substance or that saturates sediments above the surf and tide level is especially persistent. Efforts to remove the oil and clean, decontaminate, and remediate an oil-impacted shoreline may make the area more visibly attractive, but may be more harmful than helpful in terms of actual recovery.

Cleanup and Recovery

The techniques used to clean up an oil spill depend on oil characteristics and the type of environment involved; for example, open ocean, coastal, or wetland**.** Pollution-control measures include containment and removal of the oil (either by skimming, filtering, or *in situ* combustion), dispersing it into smaller droplets to limit immediate surficial and wildlife damage, biodegradation (either natural or assisted), and normal weathering processes. Individuals of large-sized wildlife species are sometimes rescued and cleaned, but micro-sized species are usually ignored.

Oil spill countermeasures to clean up and remove the oil are selected and applied on the basis of many interrelated factors, including ecological protection, socioeconomic effects, and health risk. It is important to have contingency plans in place in order to deploy pollution control personnel and equipment efficiently.

Environmental Recovery Rates.

The rate of recovery of the environment when an oil spill occurs depends on factors such as oil composition and

Workers clean up an oil refinery spill that polluted Anacortes Bay, Washington. The floating ring of absorbent pads trailing behind the boat is being used to contain some of the oil that has spilled.

properties and the characteristics of the area impacted, as well as the results of intervention and remediation. Physical removal of oil waste and the cleaning and decontaminating of the area assist large-scale recovery of the environment but may be harmful to the substrate biomass. Bioremediation efforts—adding microorganisms, nutrients, and oxygen to the environment—can usually boost the rate of biodegradation.

Because of the type of oil spilled and the Arctic environment in which it spilled, it is estimated that the residue of the *Exxon Valdez* oil spill will be visible on the Alaskan coast for 30 years.

Costs and Prevention

The costs of an oil spill are both quantitative and qualitative. Quantitative costs include loss of the oil, repair of physical facilities, payment for cleaning up the spill and remediating the environment, penalties assessed by regulatory agencies, and money paid in insurance and legal claims. Qualitative costs of an oil spill include the loss of pristine habitat and communities, as well as unknown wildlife and human health effects from exposure to water and soil pollution.

Prevention of oil spills has become a major priority; and of equal importance, efforts to contain and remove oil that has spilled are considered to be prevention of secondary spills. The costs associated with oil spills and regulations governing offshore facilities and operations have encouraged the development of improved technology for spill prevention.

Responsibility for the prevention of oil spills falls upon individuals as well as on governments and industries. Because the sources of oil waste in the ocean are generally careless, rather than accidental, truly effective prevention of oil spills involves everyone.

CHAPTER 6

IMO MARPOL CONVENTION

The legislation on on-board processing of SGW is described in the IMO MARPOL Convention. MARPOL has six Annexes of which five relate to waste in the scope of this study:

– Oily waste (sludge, bilge water, engine oil, Annex I);

– Cargo residues (Annex II and V);

– Sewage (Annex IV);

– Garbage (food waste, plastic, Annex V);

– Ozone depleting substances (Annex VI)

MARPOL ANNEX I

Regulation on the prevention of pollution by oil can be found in Annex I of MARPOL. Regulation 15 and 17 provide requirements for machinery spaces of all ships (IMO, 2016); (IMO, 2006a):

– Regulation 15: Discharge of oil or oily mixtures from ships of 400 gross tonnage and above into the sea is generally prohibited. The oil residues which cannot be discharged into the sea in compliance with this regulation should be retained on-board for subsequent discharge to reception facilities. In the case of a ship of less than 400 gross tonnage, oil and all oily mixtures should either be retained on-board for subsequent delivery to reception facilities or discharged into the sea given certain provisions. Only when a number of criteria are met, including that the oil content may not exceed 15 ppm, may water contaminated with oil be discharged in the sea by way of exception to this general rule.

– Regulation 17: Oil tankers of 150 gross tonnage and above and other ships of 400 gross tonnage and above should have an Oil Record Part I book which has to be completed if a machinery space operation takes place. In case of oil discharge a statement has to be made in the Oil Record Book Part I.

Regulation 34 and 36 provide requirements on the handling of waste from oil cargo:

– Regulation 34: Any discharge into the sea of oil or oily mixture from the cargo area of an oil tanker is prohibited while in a special area. In the case of discharges outside a special area, discharge into the sea of oil or oily mixtures from the cargo area of an oil tanker is prohibited except when several conditions are satisfied. The oil residues which cannot be discharged into the sea should be retained on-board for subsequent discharge to reception facilities.

– Regulation 36: Oil tankers of 150 gross tonnage and above should have an Oil Record book Part II which has to be completed if a cargo/ballast operation takes place. In case of oil or oily mixture discharge a statement has to be made in the Oil Record Book Part II.

An exception on Regulation 15 and 34 is the discharge at sea in case of securing the safety of a ship and those on-board and to save a life at sea. It is also allowed to discharge in case of discharge as a result of damage to a ship provided all precautions have been taken.

MARPOL ANNEX II

Although Annex II waste is beyond the scope of the empirical part of this study, a brief discussion on cargo residues is included here in order to present a complete overview of the IMO legislation

Regulation for the control of pollution of noxious liquid substances in bulk can be found in Annex II. Annex II contains a set of regulations including Regulation 13 on the control of discharge of residues of noxious liquid substances. The following regulations are relevant for cargo residues (IMO, 2016):

– Ventilation of cargo residues may be used to remove cargo residues from a tank. Water that is introduced in the tank after the ventilation will be regarded as clean. – An exemption of a prewash can be granted in the case that the cargo residues will be removed by a ventilation procedure.

– The procedures for ventilation of cargo residues are described in Appendix 7 of Annex 7. Cargo residues that are allowed to be removed from a cargo tank by ventilation are substances with a vapour pressure greater than 5kPa at 20°C.

– It is allowed to discharge at sea in case of securing the safety of a ship and those on-board and to save a life at sea. It is also allowed to discharge in case of discharge as a result of damage to a ship provided all precautions have been taken.

Regulation 6 describes the categorization of noxious liquid substances:

– Category X: Noxious liquid substances which, if discharged into sea are considered to present a major hazard to the marine resources or human health and are prohibited to be discharged into the marine environment;

– Category Y: Noxious liquid substances which, if discharged into sea are considered to present a hazard to the marine resources or human health or cause harm to amenities or other legitimate uses of the sea and are limited on the quality and quantity of discharge into the marine environment;

– Category Z: Noxious liquid substances which, if discharged into sea are considered to present a minor hazard to the marine resources or human health and have less stringent restrictions on the quality and quantity of discharge into the marine environment;

– Other substances: Other substances that are considered not to present harm to marine resources, human health, amenities or other legitimate uses of the sea when discharged and which are not subject to any requirements.

MARPOL ANNEX III

Annex III of the MARPOL convention for regulating sea transports of harmful substances in packaged form

"Regulations for the Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form", that is the elaborate title of MARPOL annex III. It regulates the safe sea transportation of harmful substances in packaged form.

Different from annex II (bulk chemicals) there are no pollution categories in annex III. Such categorization is made in the International Maritime Dangerous Goods (IMDG) code, which must therefore also be considered when consulting MARPOL annex III. Marine pollutants according to the IMDG code are dangerous goods with properties adverse to the marine environment, e. g.:

- Hazardous to aquatic life (marine fauna and flora),
- impairing the taste of seafood, or
- accumulating pollutants in aquatic organisms.

Special labelling and packing of marine pollutants

Marine pollutants must be specially packaged, labelled and stowed on board to prevent their release into the marine environment. By means of the special labelling such pollutants may also be identified and separated from other cargoes during salvage operations after an accident.

MARPOL ANNEX IV

Regulation for the prevention of pollution by sewage can be found in Annex IV of MARPOL (IMO, 2016). Annex IV contains a set of regulations regarding the discharge of sewage into the sea from ships, including:

– Regulations regarding the ships' equipment and systems for the control of sewage discharge;

– The provision of port reception facilities for sewage; and – requirements for survey and certification. It is generally considered that on the high seas, the oceans are capable of assimilating and dealing with raw sewage through natural bacterial action. Therefore, the regulations in Annex IV of MARPOL prohibit the discharge of sewage into the sea within a specified distance from the nearest land, unless otherwise provided.

The revised Annex applies to new ships engaged in international voyages of 400 gross tonnage and above or which are certified to carry more than 15 persons and includes the following requirements:

– The Annex requires ships to be equipped with either an approved sewage treatment plant or an approved sewage comminuting and disinfecting system or a sewage holding tank. – The discharge of sewage into the sea is prohibited, except when the ship has in operation an approved sewage treatment plant or when the ship is discharging comminuted and disinfected sewage using an approved system at a distance of more than 3 nautical miles from the nearest land.

– Sewage which is not comminuted or disinfected may be discharged at a distance of more than 12 nautical miles from the nearest land, and the rate of discharge of untreated sewage shall be approved by the Administration (see resolution MEPC.157(55) (MEPC, 2006)).

– It is allowed to discharge at sea in case of securing the safety of a ship and those on-board and to save a life at sea. It is also allowed to discharge in case of discharge as a result of damage to a ship provided all precautions have been taken.

A special area established under Annex IV is the Baltic Sea area. The discharge of sewage from passenger ships within the special area will generally be prohibited under the new regulations, except when the ship has in operation an approved sewage treatment plant which has been certified by the Administration. The sewage treatment plant installed on a passenger ship intending to discharge sewage effluent in special areas should meet more stringent nitrogen and phosphorus removal standards (tertiary treatment2). The discharge of sewage from passenger ships within special areas are prohibited after 1 January 2019 for new passenger ships and after 1 January 2021 for existing passenger ships (MEPC, 2016)

MARPOL ANNEX V

Regulation for the prevention of pollution by garbage from ships can be found in Annex V which applies for all types of ships. In July 2011, MEPC 62 adopted the revised MARPOL Annex V which entered into force on the first of January 2013 (MEPC, 2011). Garbage is defined as all kinds of food, domestic and operational waste, all plastics, cargo residues, incinerator ashes, cooking oil, fishing gear, and animal carcasses. Garbage does not include fresh fish (parts) as a result of fishing activities or as a result of aquaculture activities.

Annex V prohibits the discharge of garbage except as provided otherwise in the regulations 4, 5, 6 and 7 of the Annex:

– Regulation 4: Cleaning agents or additives may be discharged into sea, if they are not harmful to the marine environment. The discharge of the following garbage outside special areas shall only be permitted while the ship is en route and as far as practicable from the nearest land, but not less than:

• 3 nm from the nearest land for food wastes which have been passed through a comminuter or grinder with a screen less than 25mm.

• 12 nm from the nearest land for food wastes that have not been treated in accordance with previous paragraph.

• 12 nm from the nearest land for cargo residues that cannot be recovered using commonly available methods for unloading. These cargo residues shall not contain any substances classified as harmful to the marine environment, taking into account guidelines developed by the Organization.

• For animal carcasses, discharge shall occur as far from the nearest land as possible, taking into account the guidelines developed by the Organization

– Regulation 5: The discharge into the sea of any garbage is prohibited from fixed or floating platforms and from all other ships when alongside or within 500 m of such platforms. Food wastes may be discharged into the sea from fixed or floating platforms located more than 12 nautical miles from the nearest land and from all other ships when alongside or within 500 m of such platforms, but only when the wastes have been passed through a comminutor or grinder. Such comminuted or ground food wastes shall be capable of passing through a screen with openings no greater than 25 mm.

– Regulation 6: Discharge of the following garbage into the sea within special areas shall only be permitted while the ship is en route and as follows:

• Discharge into the sea of food wastes as far as practicable from the nearest land, but not less than 12 nautical miles from the nearest land or the nearest ice shelf. Food wastes shall be comminuted or ground and shall be capable of passing through a screen with openings no greater than 25 mm. Food wastes shall not be contaminated by any other garbage type. Discharge of introduced avian products, including poultry and poultry parts, is not permitted in the Antarctic area unless it has been treated to be made sterile.

• Discharge of cargo residues that cannot be recovered using commonly available methods for unloading, where all the following conditions are satisfied: – Cargo residues, cleaning agents or additives, contained in hold washing water do not include any substances classified as harmful to the marine environment, taking into account guidelines developed by the Organization; – Both the port of departure and the next port of destination are within the special area and the ship will not transit outside the special area between those ports; – No adequate reception facilities are available at those ports taking into account guidelines developed by the Organization; and – Where the conditions of subparagraphs 2.1, 2.2 and 2.3 of this paragraph have been fulfilled, discharge of cargo hold washing water containing residues shall be made as far as practicable from the nearest land or the nearest ice shelf and not less than 12 nautical miles from the nearest land or the nearest ice shelf. – Cleaning agents or additives contained in deck and external surfaces wash water may be discharged into the sea, but only if these substances are not harmful to the marine environment, taking into account guidelines developed by the Organization.

– The following rules (in addition to the rules in paragraph 1 of this regulation) apply with respect to the Antarctic area:

• Each Party at whose port’s ships depart en route to or arrive from the Antarctic area undertakes to ensure that as soon as practicable adequate facilities are provided for the reception of all garbage from all ships, without causing undue delay, and according to the needs of the ships using them.

• Each Party shall ensure that all ships entitled to fly its flag, before entering the Antarctic area, have sufficient capacity on board for the retention of all garbage, while operating in the area and have concluded arrangements to discharge such garbage at a reception facility after leaving the area.

• When garbage is mixed with or contaminated by other substances prohibited from discharge or having different discharge requirements, the more stringent requirements shall apply.

– Regulation 7: Exceptions of regulation 3,4,5 and 6 are:

• The discharge of garbage from a ship necessary for the purpose of securing the safety of a ship and those on board or saving life at sea; or

• The accidental loss of garbage resulting from damage to a ship or its equipment, provided that all reasonable precautions have been taken before and after the occurrence of the damage, to prevent or minimize the accidental loss; or

• The accidental loss of fishing gear from a ship provided that all reasonable precautions have been taken to prevent such loss; or

• The discharge of fishing gear from a ship for the protection of the marine environment or for the safety of that ship or its crew.

• The en route requirements of regulations 4 and 6 shall not apply to the discharge of food wastes where it is clear the retention on board of these food wastes presents an imminent health risk to the people on board

– ANNEX V provides several regulations on control and enforcement of the disposal prohibition of garbage:

Regulation 8: Each Party undertakes to ensure the provision of adequate facilities at ports and terminals for the reception of garbage without causing undue delay to ships, and according to the needs of the ships using them.

– Regulation 9 : A ship when in a port or an offshore terminal of another Party is subject to inspection by officers duly authorized by such Party concerning operational requirements under this Annex, where there are clear grounds for believing that the master or crew are not familiar with essential shipboard procedures relating to the prevention of pollution by garbage. Procedures relating to the port State control as prescribed in article 5 also apply to this regulation

– Regulation 10: Regulation on placards, garbage management plans and garbage record-keeping:

• Every ship of 12 m or more in length overall and fixed or floating platforms shall display placards which notify the crew and passengers of the discharge requirements of regulations 3, 4, 5 and 6 of this Annex, as applicable. The placards shall be written in the working language of the ship's crew and, for ships engaged in voyages to ports or offshore terminals under the jurisdiction of other Parties to the Convention, shall also be in English, French or Spanish.

• Every ship of 100 gross tonnage and above, and every ship which is certified to carry 15 or more persons, and fixed or floating platforms shall carry a garbage management plan which the crew shall follow

This plan shall provide written procedures for minimizing, collecting, storing, processing and disposing of garbage, including the use of the equipment on board. It shall also designate the person or persons in charge of carrying out the plan. Such a plan shall be based on the guidelines developed by the Organization2 and written in the working language of the crew.

– Every ship of 400 gross tonnage and above and every ship which is certified to carry 15 or more persons engaged in voyages to ports or offshore terminals under the jurisdiction of another Party to the Convention and every fixed or floating platform shall be provided with a Garbage Record Book

– The competent authority of the Government of a Party to the Convention may inspect the Garbage Record Books or ship's official log–book on board any ship to which this regulation applies while the ship is in its ports or offshore terminals and may make a copy of any entry in those books, and may require the master of the ship to certify that the copy is a true copy of such an entry. Any copy so made, which has been certified by the master of the ship as a true copy of an entry in the ship's Garbage Record Book or ship's official log-book, shall be admissible in any judicial proceedings as evidence of the facts stated in the entry. The inspection of a Garbage Record Book or ship's official log-book and the taking of a – certified copy by the competent authority under this paragraph shall be performed as expeditiously as possible without causing the ship to be unduly delayed.

– The accidental loss or discharge of fishing gear as provided for in regulations 7.1.3 and 7.1.3bis which poses a significant threat to the marine environment or navigation shall be reported to the State whose flag the ship is entitled to fly, and, where the loss or discharge occurs within waters subject to the jurisdiction of a coastal State, also to that coastal State. An overview of the types of garbage and whether ships are allowed to discharge waste into the sea is provided in Figure 2 (IMO, 2016).

MARPOL ANNEX VI

Regulation 12 in Annex VI describes the ozone-depleting substances. Deliberate emissions of ozone-depleting substances are prohibited. They include emissions occurring during maintenance, service, repair or disposal of systems or equipment. This excludes minimal releases associated with the recapture or recycling of an ozone-depleting substance. New installations which contain ozone-depleting substances are prohibited on all ships. New installations containing hydro chlorofluorocarbons (HCFCs) are permitted until 1 January 2020.

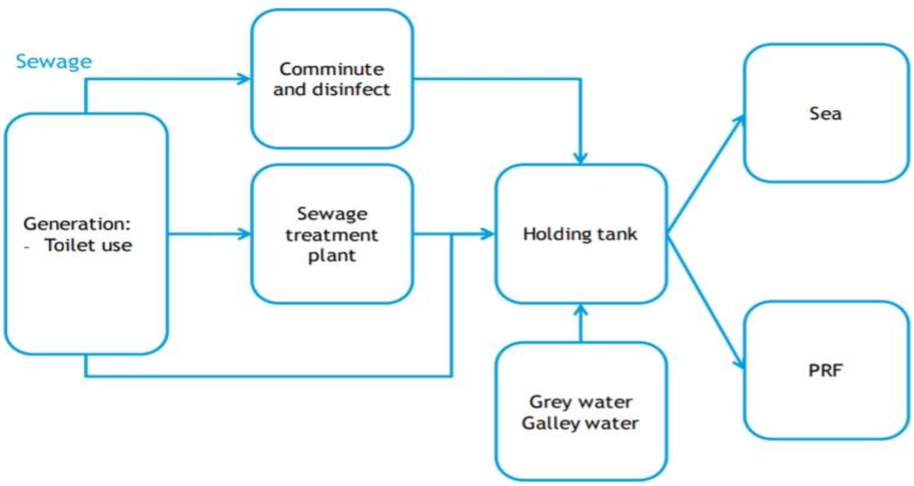
The substances referred to in this regulation, and equipment containing such substances, should be delivered to appropriate reception facilities when removed from ships (IMO, 2006d). Again, waste arising from Annex VI regulations can be discharged at sea for the purpose of securing the safety of a ship and those on-board and to save a life at sea. It is also allowed to discharge in case of discharge as a result of damage to a ship provided all precautions have been taken. Annex VI includes a regulation on SOX emissions (Regulation 14). While ships are within a SECA (SOX emission control area), the Sulphur content of fuel oil should not exceed 0.1% m/m or an EGCS (exhaust gas cleaning system) should be used. From 2020 onwards, the limit outside ECAs will be 0.5% Sulphur m/m. EGCSs produce wash water, which is not waste, and sludge. The latter is not included in the scope of this research because wastes from EGCS have been discussed significantly in the EGCS Sub-Group of the European Sustainable Shipping Forum. Therefore, this study did not audit ships with an EGCS. Regulation 16 of Annex VI on shipboard incineration allows shipboard incineration only in a shipboard incinerator and each incinerator should be approved by the Administration. Shipboard incineration is prohibited for the following substances:

– MARPOL Annex I, II and III cargo residues and related contaminated packing materials; – polychlorinated biphenyls (PCBs); – garbage, as defined in Annex V of the present Convention, containing more than traces of heavy metals; and – refined petroleum products containing halogen compounds. Shipboard incineration of polyvinyl chlorides (PVCs) is prohibited, except in shipboard incinerators for which IMO Type Approval Certificates have been issued. Shipboard incineration of sewage sludge and sludge oil generated during the normal operation of a ship may also take place in the main or auxiliary power plant or boilers, but in those cases, shall not take place inside ports, harbors and estuaries.

Outline of the report Chapters 2 through 14 provide a review of waste generation, treatment and disposal per type of waste. Each chapter contains a definition of the type of waste, a description of its management on-board ships, technologies to reduce the amount of waste, the drivers for waste generation and an estimate of the quantity of waste. In those cases where any of these issues vary over ship types, a reference is made to specific ship types involved. Chapter 15 provides an audit of waste notification forms and other observations. Chapter 16 contains the conclusions. Annex A contains the full references of literature sources. An overview of interviews and ships audited is presented in Annex B. The results from the online survey are presented in Annex C.

CHAPTER 7

SEWAGE



Sewage is defined as drainage and other wastes from any form of toilets and urinals; drainage from medical premises (dispensary, sick bay, etc.) via wash basins, wash tubs and scuppers located in such premises; drainage from spaces containing living animals; or other waste waters when mixed with the drainages defined above (IMO, 2006b). This is generally referred to as 'black water'. It does not include grey water which is the drainage generated from dishwasher, showers, laundry, bath and washbasin drains (MEPC, 2012). The discharge of sewage into the sea is prohibited under MARPOL IV, except when the ship has in operation an approved sewage treatment plant or when the ship is discharging comminuted and disinfected sewage using an approved system at a distance of more than three nautical miles from the nearest land. Sewage which is not comminuted or disinfected may be discharged at a distance of more than 12 nautical miles from the nearest land. Within the Baltic Sea, a special area under MARPOL Annex IV, discharge of sewage from passenger ships is only permitted the ship has in operation an approved sewage treatment plant which meets specific nitrogen and phosphorus removal standards, and which has been certified by the Administration.

Sewage management and technology

A holding tank is usually the minimum system that a ship has on-board. The size of the tank should take into account the capacity for the retention of all sewage, the operation of the ship, the number of persons on-board and other relevant factors. The holding tank shall have a means to indicate visually the amount of its contents. A ship using an approved a sewage comminuting and disinfecting system shall be fitted with facilities for the temporary storage of sewage when the ship is less than 3 nautical miles from the nearest land. This type of on-board treatment system uses a physical/chemical-based system that relies on reducing the size of sewage and chlorination. There are several types of approved sewage treatment plants. The most common is an on-board treatment system that uses biological or aerobic digestion-based system (thus a mix of primary and secondary treatment), which consists of three compartments. The first chamber is similar to conventional septic tanks, where solids settle to the bottom and scum floats to the top. In the second compartment, the aeration chamber, the partially clarified wastewater is mixed with air to assist bacteria to further break down solids. In the third compartment further settling of solids and final chlorination for disinfection is added.

Most ships visited during this study had one or a combination of the systems described above. However, in one case a ship did not have a holding tank and the sewage was discharged immediately after treatment in the sewage treatment plant. Figure 6 presents the waste flow diagram of sewage. Sewage can be either collected in a holding tank, comminuted and disinfected, or treated in a sewage treatment plant. The effluent of the sewage treatment plant is either discharged directly to the sea or kept in a holding tank. Ships that do not have a sewage treatment plant collect the black water in a holding tank. The holding tank can also be used to collect grey water and/or galley water. However, grey water is not always routed to the holding tank and sometimes stored in dedicated holding tanks. Grey water can sometimes be discharged directly into the sea or mixed with sewage to be treated. It can also be recycled into the toilet flushing system. Roughly a quarter of cruise ships have Advanced Wastewater Treatment System (AWTS) installed which mix and treat grey and black water producing a bio-residual or sewage sludge that needs to be retained for discharge ashore (HELCOM, 2013). In cruise ships it is common to have a separated tank for galley water, which is discharged in accordance with the regulations for food waste. For cruise ships it is common to comminute, mix and disinfect the water prior to discharge to the sea. The ship audits show that most of the ships have a treatment plant on-board and only a few disinfect the sewage. These are predominately smaller and older vessels. Most of the time, the treated effluent is discharged in the open sea.

An example from the ship audits is presented in Table 8. The first is a chemical tanker with a crew of 24 people. On this ship sewage is being disinfected and treated in a type approved sewage treatment plant. If the ship is in the port, all of the generated effluent is delivered to PRF in the port and on the route all is continuously discharged at sea as this ship does not have a holding tank. The second ship is a ferry that has a crew of 152 people and 1,360 passengers. On this ship sewage is treated in a type approved sewage treatment plant (only 37 m3 in this case, the remainder is grey water). The third ship also treats the sewage in a treatment plant and discharges directly after treatment and disinfection. These examples show the different ways of managing sewage effluent and the difference between types of vessels.

Drivers for sewage generation The main drivers for the amount of sewage are:

– the number of crew members and passengers;

– the type of toilets: water toilets produce larger amounts of sewage than vacuum toilets;

– length of voyage;

– type of treatment: the presence of a sewage treatment plant, or comminuting and disinfection system provides different quantities of waste.

Quantity of sewage generation

Overview of the literature

The generation and collection of sewage has also been reported by several ports in their waste management plan. The port of Dudinka (Russia) has estimated an annual waste volume of both bilge waters and sewage to be 352.8 m3 for 110 calls at the port (MMPA, 2012). The port of Durres (Albania) estimated a generation of 4,354.9 m3 grey & black water in 2012 (TEN ECOPORT, 2014). The port of Tallinn (Estonia) received in 2014 a total of 11,211 m 3 of sewage based on 7,624 ships (Environmental Board, 2015). The port of Igoumenitsa (Greece) reports for passenger vessels in 2011 a total quantity of sewage of 6.3 m3 (Beza, et al., 2014). The quantity of sewage waste from in 2010 for over 26 EU ports was reported to be approx. 1,250,000 m 3 (Ramboll, 2012). The amount of sewage wastewater generation depends on the size of the ship and the type of technology used. Table 9 provides differing numbers among ship types and technologies.

Quantitative results from this study

During ship audits and interviews, information on waste water and sewage of 11 ships was collected. In addition, information was received from interviews and the internet survey. The main reason for the small number is that quantities are not recorded or monitored buthave to be estimated from the amount of water consumed or from the number of days it takes for the holding tank to fill. For the same reason, it is not always possible to distinguish between sewage (black water) and other waste waters. The amounts of waste water generated per day varied from 0.4 to 700 m 3. The amount of sewage depends on the number of passengers and the toilet type (vacuum toilets generate less black water than water closets). The amounts generated per day per person varied from 0.01 to 0.45 m 3. Of this quantity, 0.01 to 0.06 m3 is probably black water, and the remainder grey or galley water as some ships mix these in sewage holding tanks. The range of waste generated is comparable to the values found in literature, although the upper value is higher.

Conclusion

Sewage is treated in different ways and if well treated can be disposed at sea. The amount of sewage effluent generated depends on for example the number of people on-board and the type of system used. The amount of waste water generated is estimated to be between 0.04 and 0.45 m 3 per day per person. Of this quantity, 0.01 to 0.06 m3 is probably black water, and the remainder grey or galley water.

CHAPTER 8

GARBAGE

Garbage from ships can be just as deadly to marine life as oil or chemicals.

The greatest danger comes from plastic, which can float for years. Fish and marine mammals can in some cases mistake plastics for food and they can also become trapped in plastic ropes, nets, bags and other items - even such innocuous items as the plastic rings used to hold cans of beer and drinks together.

It is clear that a good deal of the garbage washed up on beaches comes from people on shore - holiday-makers who leave their rubbish on the beach, fishermen who simply throw unwanted refuse over the side - or from towns and cities that dump rubbish into rivers or the sea. But in some areas most of the rubbish found comes from passing ships which find it convenient to throw rubbish overboard rather than dispose of it in ports.

For a long while, many people believed that the oceans could absorb anything that was thrown into them, but this attitude has changed along with greater awareness of the environment. Many items can be degraded by the seas - but this process can take months or years.

Persuading people not to use the oceans as a rubbish tip is a matter of education - the old idea that the sea can cope with anything still prevails to some extent, but it also involves much more vigorous enforcement of regulations such as MARPOL Annex V.

MARPOL Annex V

<table>
<tr><th>Type of garbage</th><th>Ships outside special areas</th><th>Ships within special areas</th><th>Offshore platforms (more than 12 nm from land) and all ships within 500 m of such platforms</th></tr>
<tr><td>Food waste comminuted or ground</td><td>Discharge permitted ≥3 nm from the nearest land, en route and as far as practicable</td><td>Discharge permitted ≥12 nm from the nearest land, en route and as far as practicable</td><td>Discharge permitted</td></tr>
<tr><td>Food waste not comminuted or ground</td><td>Discharge permitted ≥12 nm from the nearest land, en route and as far as practicable</td><td>Discharge prohibited</td><td>Discharge prohibited</td></tr>
<tr><td>Cargo residues[1] not contained in wash water</td><td rowspan="2">Discharge permitted ≥12 nm from the nearest land, en route and as far as practicable</td><td>Discharge prohibited</td><td>Discharge prohibited</td></tr>
<tr><td>Cargo residues[1] contained in wash water</td><td>Discharge permitted ≥12 nm from the nearest land, en route, as far as practicable and subject to two additional conditions[2]</td><td>Discharge prohibited</td></tr>
<tr><td>Cleaning agents and additives[1] contained in cargo hold wash water</td><td rowspan="2">Discharge permitted</td><td>Discharge permitted ≥12 nm from the nearest land, en route, as far as practicable and subject to two additional conditions[2]</td><td>Discharge prohibited</td></tr>
<tr><td>Cleaning agents and additives[1] in deck and external surfaces wash water</td><td>Discharge permitted</td><td>Discharge prohibited</td></tr>
<tr><td>Carcasses of animals carried on board as cargo and which died during the voyage</td><td>Discharge permitted as far from the nearest land as possible and en route</td><td>Discharge prohibited</td><td>Discharge prohibited</td></tr>
<tr><td>All other garbage including plastics, synthetic ropes, fishing gear, plastic garbage bags, incinerator ashes, clinkers, cooking oil, floating dunnage, lining and packing materials, paper, rags, glass, metal, bottles, crockery and similar refuse</td><td>Discharge prohibited</td><td>Discharge prohibited</td><td>Discharge prohibited</td></tr>
<tr><td>Mixed garbage</td><td colspan="3">When garbage is mixed with or contaminated by other substances prohibited from discharge or having different discharge requirements, the more stringent requirements shall apply</td></tr>
</table>

MARPOL Annex V seeks to eliminate and reduce the amount of garbage being discharged into the sea from ships. Unless expressly provided otherwise, Annex V applies to all ships, which means all ships of any type whatsoever operating in the marine environment, from merchant ships to fixed or floating platforms to non-commercial ships like pleasure crafts and yachts.

Although the Annex is optional[1], it did receive a sufficient number of ratifications to enable entry into force on 31 December 1988. Today, more than 150 Countries have signed up to MARPOL Annex V.

MARPOL Annex V generally prohibits the discharge of all garbage into the sea, except as provided otherwise in regulations 4, 5, and 6 of the Annex, which are related to food waste, cargo residues, cleaning agents and additives and animal carcasses. An overview of the MARPOL Annex V discharge provisions can be accessed here. Exceptions with respect to the safety of a ship and those on board and accidental loss are contained in regulation 7 of Annex V

Under MARPOL Annex V, garbage includes all kinds of food, domestic and operational waste, all plastics, cargo residues, incinerator ashes, cooking oil, fishing gear, and animal carcasses generated during the normal operation of the ship and liable to be disposed of continuously or periodically. Garbage does not include fresh fish and parts thereof generated as a result of fishing activities undertaken during the voyage, or as a result of aquaculture activities.

To assist Governments, ships and port operators in implementing relevant requirements under MAPROL Annex V, MEPC has developed and adopted the Guidelines for the implementation of MARPOL Annex V, known as a living document, the latest of which is resolution MEPC. 295(71).

Port reception facilities

The effectiveness of ships to comply with the discharge requirements of MARPOL depends largely upon the availability of adequate port reception facilities, especially within special areas. Hence, MARPOL Annex V also obliges Governments to ensure the provision of adequate reception facilities at ports and terminals for the reception of garbage without causing undue delay to ships, and according to the needs of the ships using them.

As provided in regulation 8.3, Small Island Developing States (SIDS) could satisfy the requirements for providing adequate port reception facilities through regional arrangements when, because of those States' unique circumstances, such arrangements are the only practical means to satisfy these requirements. Parties participating in a regional arrangement must develop a Regional Reception Facility Plan, taking into account the guidelines developed by IMO[2].

Special areas

The special areas established under Annex V are:

- The Mediterranean Sea area
- The Baltic Sea area
- The Black Sea area
- The Red Sea area
- The Gulfs area
- The North Sea area
- The Wider Caribbean Region and
- The Antarctic area.

These are sea areas where for recognized technical reasons relating to their oceanographic and ecological condition and the particular character of traffic, such as heavy maritime traffic, low water exchange, extreme ice states, endangered marine species, etc., the adoption of special mandatory methods for the prevention of marine pollution by garbage is required.

Port State control

Provisions to extend port State control to cover operational requirements as regards prevention of marine pollution were adopted in 1994 and entered into force on 3 March 1996. Like similar amendments to the other MARPOL Annexes, regulation 9 of Annex V makes it clear that port State control officers can inspect a foreign-flagged ship at a port or an offshore terminal of its State "where there are clear grounds for believing that the master or crew are not familiar with essential shipboard procedures relating to the prevention of pollution by garbage".

Placard

Regulation 10.1 also requires every ship of 12 meters in length or over and every fixed or floating platform to display placards notifying passengers and crew of the disposal requirements of the Annex; these placards should be written in the working language of the ship's crew and also in English, French or Spanish for ships travelling to other States' ports or offshore terminals.

Garbage management plan

All ships of 100 gross tonnage and above, every ship certified to carry 15 persons or more, and every fixed or floating platform must carry a garbage management plan on board, which includes written procedures for minimizing, collecting, storing, processing and disposing of garbage, including the use of the equipment on board (regulation 10.2). The garbage management plan must designate the person responsible for the plan and be written in the working language of the crew. Resolution MEPC.220 (63) provides the *2012 Guidelines for the development of garbage* management *plans*.

Garbage Record Book

Implementation and enforcement is also the focus of regulation 10.3, which requires all ships of 400 gross tonnage and above and every ship which is certified to carry 15 persons or more engaged in voyages to ports and offshore terminals under the jurisdiction of another Party to the Convention and every fixed or floating platform to provide a Garbage Record Book and to record all disposal and incineration operations.

The date, time, position of the ship, description of the garbage and the estimated amount incinerated or discharged must be logged and signed. The Garbage Record Book must be kept for a period of two years after the date of the last entry. This regulation does not in itself impose stricter requirements - but it makes it easier to check that the regulations on garbage are being adhered to as it means ship personnel must keep track of the garbage and what happens to it. It could also prove an advantage to a ship when local officials are checking the origin of discharged garbage - if ship personnel can adequately account for all their garbage, they are unlikely to be wrongly penalized for discharging garbage when they have not done so. Appendix 2 of MARPOL Annex V provides a standard form for a Garbage Record Book.

Cargo residues

Cargo residues are defined as the remnants of any cargo which are not covered by other Annexes to the present Convention and which remain on deck or in holds following loading or unloading. They include loading and unloading excess or spillage, whether in wet or dry condition or entrained in wash water, but do not include cargo dust remaining on deck after sweeping or dust on the external surfaces of the ship (regulation 1.2 of Annex V). In addition to this definition, MARPOL Annex V also stipulates that only those cargo residues that cannot be recovered using commonly available methods for unloading could be considered for discharge.

A simplified overview of the regulations regarding the discharge of cargo residues under MARPOL Annex V can be accessed here. As a general rule, cargo residues which contain substances classified as harmful to the marine environment (HME) must not be discharged at sea, but have to be taken to port reception facilities. Regarding the discharge of cargo residues which do not contain any HME substances, the Annex establishes different requirements depending on whether they are contained in wash water or not.

Solid bulk cargoes must be classified and declared by the shipper as to whether or not they are harmful to the marine environment, in accordance with the criteria set out in appendix 1 of MARPOL Annex V.

Shipboard incinerator

The Standard Specification for Shipboard Incinerators (resolution MEPC.244(66)) covers the design, manufacture, performance, operation and testing of incinerators designed to incinerate garbage and other shipboard waste.

Verification of compliance

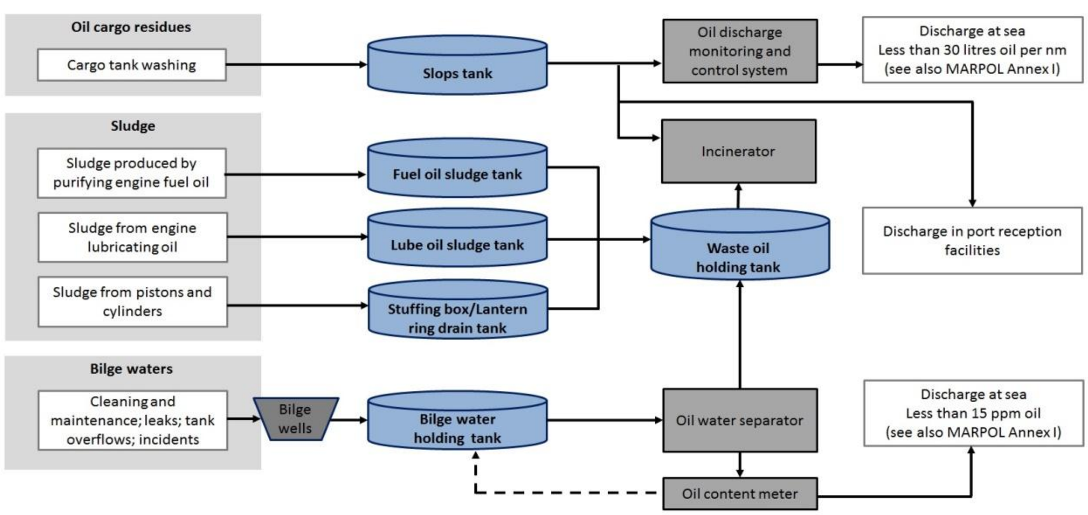
Chapter 2 of MARPOL Annex V provides that Parties must use the provisions of the Code for Implementation in execution of their obligations and responsibilities and be subject to the IMO Member State Audit Scheme (IMSAS) in accordance with the audit standard to verify compliance with and implementation of the Annex. The mandatory IMSAS commenced from 1 January 2016,

Polar Regions

Chapter 3 of MARPOL Annex V makes use of the environment-related provisions of the Polar Code mandatory and requires that ships trading the Polar Regions must comply with strict environmental provisions specific to the harsh conditions in Polar waters – the Arctic waters and the Antarctic area.

CHAPTER 9

Oily Bilge Water



Introduction

Bilge water is a mixture of liquids that are collected in the bilge of a ship. It is made of a mixture of fresh water, sea water, oil, sludge, chemicals and various other fluids that drain into the Bilge. Sea water and fresh water can find its way to the bilge wells due to drainage from the deck, leakage in the pipe lines, leaky pump and valve glands from machinery or spillages in the engine room. Bilge water is generated through condensation, leakages and cleaning. As a general rule, bilge water contains oil from the engine rooms; hence the term ‘oily bilge water’. Any liquid entering the bilge system including bilge wells, bilge piping, tank top or bilge holding tanks is considered to be oily bilge water (Lloyd's Register, 2008). All vessels have oily bilge water, although the quantities for recreational vessels are minimal.

Oily bilge water management and technology

The bilge water can be managed by retaining it on-board in a tank and discharging it to a port reception facility or it can be treated on-board with an OWS. This on-board treatment system is designed to remove the oily part from the vessel bilge water prior to the discharge of the treated bilge water. Bilge separator technologies have advanced in recent years to improve the effectiveness of oily bilge water treatment. Most of the tested bilge separators by the US Coast Guard were treatment systems that combined a gravity oil-water separator (OWS) or centrifuge with one or more additional unit operations that ‘polish’ the bilge water effluent to reduce concentrations of emulsified oil (EPA, 2011). Even though there are several technologies to separate the water and oil, such as absorption/adsorption, biological treatment, coagulation/flocculation, flotation and membranes, the most frequently found technology during the ship audits are the ones based on density differences between oil and water. This type of treatment can reduce the quantity of bilge water by 65–85%. MARPOL has regulated that all ships over 400 gross tons (GT) are required to have equipment installed on-board that limits the discharge of oil into the oceans to 15 ppm when a ship is en route. They are also required to have an oil content monitor (OCM) and a bilge alarm to detect if the treated bilge water meets the discharge requirements. The system consists of a three-way valve that makes it possible to retain treated bilge water on-board in case the discharge does not comply with the requirements. Figure 3 presents the waste flow diagram of oily bilge water, based on the ship audits and interviews and confirmed by the internet survey. Oily bilge water is collected in a holding tank (the oily bilge tank) and either disposed of directly to a port reception facility or, more often, treated in an OWS. The clean water is generally discharged to sea. The oil fraction from the oil/water separator is usually fed into a waste oil or sludge tank and treated as such (see also (EPA, 2008); (Friends of the Earth, 2009))

Drivers for oily bilge water generation

Overall, the general policy of the ships visited during this study is to minimize the contamination of bilge water with lubricants, grease, cleaning fluids and other wastes before it accumulates in the lowest part of a vessel. Even so several factors are driving the generation of oil waste. Oily bilge water generation varies and depends on factors such as the size of the ship, engine room design, preventative maintenance, and the age of the components on the ship (EPA, 2008). When asked, most of the chief engineers interviewed reply that while the overall procedure is to keep the bilge clean in practice the main drivers for oily bilge water generation are condensation and leakages in the engine room. This is determined by the weather conditions and change in temperature as well as by cleaning and maintenance of the machine room. For yachts, the oily waste is only from lubricating oil and depends on operation hours of the generator and main engine. The online survey indicates other drivers for oily bilge water such as the type of engine, the age of the engine and the type of fuel burnt as well as the engine running hours per day.

Quantity of oily bilge water generation

Overview of the literature. The reported quantities of oily bilge water vary among type of waste and among ports. An average ship generates 20 m3 per month of oily bilge water (EMSA, 2008). Literature provides several estimations of oil waste for cruise ships. For oily bilge water, a typically large cruise ship will generate an average of 8 metric tons per day. A moderate sized cruise ship with 3,000 people will generate 25,000 gallons (95 m3) of oily bilge water in a week, equivalent to 3,571 gallons (13.5 m3) per day (Friends of the Earth, 2009). EPA (2008) provides the daily volume of bilge water production based on ship tonnages (Table 4). These figures could be used to calculate the production per person and per GT. However, no clear relationship with passenger numbers and ship tonnage can be found.

Quantitative results from this study

During ship audits and interviews, information on bilge water generation of 19 ships was collected (see Annex B for an overview on data availability). The amounts generated per day varied from 0.01 to 13 m 3 . The median value in our small sample was 0.3 m3 per day and most of the ships generate less than 0.5 m3 per day. This is in line with information gathered during interviews and in the internet survey. There is a weak correlation of the amounts generated with the size of the ship, which is to be expected because larger ships have larger engine rooms and other areas in which more water vapour can condensate. The amount of oily bilge water generated per 1,000 GT varied from 0.003 to 0.86 m 3 /day. The latter value is an outlier; most of the ships generate less than 0.01 m3 of oily bilge water per 1,000 GT per day and the median value in our small sample was 0.02 m3 per 1,000 GT per day. There was no correlation with the fuel consumption of the ship. Literature also provides a wide range of bilge water production and an average of 0.67 m3 per day which lies within the range of this research.

Conclusion

Oily bilge water is a type of waste generated during normal operations of the engine room and thus applicable to all types of vessels. The management of oily bilge water can be achieved in two ways, either storage of the bilge water to dispose at a PRF or treatment of the bilge water in an OWS and the subsequent discharge of the separated oil to a PRF and the water to the sea. Oily bilge water can be stored on-board in a holding tank, thus the amount that is disposed is not always the same as the amount being generated as the ship can elect to keep waste on board if it has sufficient capacity for its storage to the next port of call. The generation of oily bilge water depends on several factors, including the size of the ship, the design of the engine room and the age of the engine. The amounts generated per day varied from 0.01 to 13 m3 (with larger ships generally generating more than smaller ships), the median value in our small sample being 0.3 m3 per day or 0.02 m3 /1,000 GT per day. The amount can be reduced by 65-85% by using and oil water separator and discharging the water fraction into the sea.

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