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ISM AND POLLUTION PREVENTION

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ABBREVIATIONS

DOC	Document of Compliance
DWT	Dead Weight Tonnage
ECA	Emission Control Area
HFO	Heavy Fuel Oil
IBC Code	International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk Code
IGC Code	International Code for the Construction and Equipment of Ships Carrying Liquified Gases in Bulk Code
ILO	International Labour Organisation
IMCO	Inter-Governmental Maritime Consultative Organisation
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organisation
IMSBC Code	International Maritime Solid Bulk Cargoes Code
ISM	International Safety Management
LFO	Light Fuel Oil
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MARPOL 73/78	International Convention for the Prevention of Pollution, as ammended by the Protocol of 1978
MSC	Maritime Safety Committee
ODS	Ozone Depleting Substances
OILPOL 54	International Convention for the Prevention of Pollution of the Sea by Oil
PM	Particulate Matter
PSC	Port State Control

RO	Recognised Organisation
SMC	Safety Management Certificate
SMS	Safety Management System
SMSM	Safety Management System Manual
UNCLOS	United Nations Convention on the Law of the Sea
VOCs	Volatile Organic Compounds

ΠΕΡΙΛΗΨΗ

Η κερδοφόρα φύση του θαλάσσιου εμπορίου έχει οδηγήσει στην αύξηση μεταφοράς εμπορευμάτων μέσω των υδάτινων οδών ανά τον κόσμο. Η αύξηση αυτή έχει συμβάλλει, όμως, σε αντίστοιχη αύξηση εισροής ρυπαντών στο θαλάσσιο περιβάλλον, επηρεάζοντας τις παράκτιες κοινωνίες και τη θαλάσσια ζωή. Διεθνείς Συμβάσεις και κανονισμοί έχουν συνταχθεί με στόχο να μειωθεί η συμβολή της ναυτιλιακής βιομηχανίας στη θαλάσσια ρύπανση. Με αυτό τον τρόπο, θεσπίστηκε κατάλληλο νομικό πλαίσιο και ορίστηκαν ελάχιστες προδιαγραφές, που πρέπει να τηρούνται όσον αφορά στην ασφάλεια, την πρόληψη και ρύθμιση της θαλάσσιας ρύπανσης, που προέρχεται από τα πλοία.

Σκοπός της μεταπτυχιακής διατριβής είναι να προβληθούν τα μέτρα που έχει λάβει ο Διεθνής Ναυτιλιακός Οργανισμός (IMO), τα οποία αφορούν όχι μόνο στη σύνταξη των κανονισμών αλλά και στην ενσωμάτωσή τους στην πολιτική των εταιρειών, για ομαλότερη εφαρμογή και αποτελεσματικότερη επιτήρηση αυτών.

ABSTRACT

Profitable nature of ocean borne trade has led into rising of commodities transport around the globe through shipping industry. This increase has also resulted into further influx of contaminants into the marine environment, affecting coastline societies as well as marine sea life. In the direction of minimising shipping industry's contribution to marine environment pollution, various Conventions have been signed and regulations have been produced, setting appropriate legal framework and minimum standards for the maritime safety, prevention and control of marine pollution derived from vessels.

Purpose of this essay is to highlight actions taken by International Maritime Organisation for the sake of not only to produce regulations, but also to embody prevailing legal framework into company's policies, which can enable smoother incorporation of the same enhancing implementation monitoring.

Keywords: ISM Code, Marine Environment Pollution, Prevention Pollution, Shipping

CHAPTER 1: INTRODUCTION

Shipping industry constitutes the link between exporters and importers, carrying goods all around the world at low cost. In this way, countries can import commodities relatively cheaply and can export their products inexpensively. About 90% of goods are transported by water (ocean, rivers), connecting with land transport network (rail, truck) and air. As part of worldwide commerce, factors that matter most and are taken under consideration at the stage of drawing policies, come in terms of profit and loss.

Vessels not only move cargoes, their operation can also affect marine environment, port and coastal areas surroundings directly. Population living there and local economy are affected indirectly and outcome is shown in the long term. Protection or preservation of the environment refers to quality of surroundings, which is not measurable until an accident or disaster occurs, when damages and losses are recorded.

Though in some cases pollution of the environment is overseen by major financial stakeholders, its protection is essential, because it is mostly the societies on coastal states that suffer from and must live with consequences of accidents on their daily routine.

Dissertation follows a bibliographical approach. Its structure was based on HELMEPA's publication "Pollution Prevention from Ships: 30 years of HELMEPA and MARPOL", supported by Conventions produced by IMO, along with books, articles found upon search on the internet, material provided during MSc in Shipping Management Program and ABS Certification seminars.

Chapter two refers to origin and type of pollution caused by shipping industry, categories of pollutants and their impact.

Chapter three contains information regarding measures taken by IMO to mitigate shipping industry's contribution in pollution of the marine environment.

Chapter four regards background, structure and requirements of the ISM code.

Chapter five includes information on the carriers through which various conventions and regulations are incorporated, applied and monitored.

Chapter six has to do with the legal and financial importance of the ISM Code.

Conclusions and suggestion for further research are contained in Chapter 7.

Conventions mentioned cover various fields and duties of Port Facilities as well. The purpose of this essay was mostly to set the ISM Code off as the joining link between the theory of the protection of the environment as drawn in the regulations and its actual protection through the application during vessels' operation.

CHAPTER 2: POLLUTION CAUSED BY SEA TRANSPORT

Ocean-borne commerce has been and is still growing since it comprises not only one of the most energy efficient means of transport (Bhushan Tuladhar, 2014) but also a profitable way of trading commodities across the globe. Because of its remunerative nature, marine traffic has increased during past decades, so has shipping industry's contribution to pollution.

Pollution impacts caused by shipping industry may be divided in i) catastrophic and ii) chronic. (Alan Simcock, 2016).

Catastrophic impacts are noted during incidents where there is partial or total damage of the vessel due to (but not limited to) collision, fire, foundering. On the other hand, chronic impacts originated mostly from daily routine where pollutants are observed to be released into the marine environment gradually.

This chapter contains description of operational and accidental pollution, categories of pollutants produced, inserted into the marine environment along with their environmental and socioeconomic impact.

2.1. OPERATIONAL POLLUTION

Operational pollution has a chronic impact on the marine environment and is observed from the beginning of vessel's life cycle (shipbuilding), during day-to-day operation of the vessel, while the integrity of its structure remains intact, up to its dismantling:

2.1.1. SHIPBUILDING

2.1.1.1. SURFACES PREPARATION

Steel plates and frames are processed to meet standards required for construction: rolling plate, straightening sections (Stopford, 2009), shot blasting to remove rust, priming to protect from further rusting as well as to provide foundation for paint and then plates are ready for the welding machines.

2.1.1.2. ANTI-CORROSION TREATMENT

Surfaces are coated with anticorrosion paints to delay corrosion as much as possible which is the cause to deterioration of structures that may lead to respective hull failure, turning vessel unseaworthy.

2.1.1.3. ANTIFOULING TREATMENT

Coatings of antifouling paint used to delay fouling attrition as much as possible.

2.1.1.4. ENGINE ROOM

Substances used or produced in engine room during machinery running (lubricants, bilge water residues, batteries, cooling systems, boiler and engine cleaning wastewater etc.).

In addition to the above, other simultaneously performing works such as water/sandblasting, steel cutting, welding, polishing, greasing produce residues which contain copper, steel, lead fillings, rust which are usually washed down along with smaller parts of electrodes, cables, pipes etc.

2.1.2. SHIPBOARD OPERATIONS

2.1.2.1. LEAKAGE DURING LOADING AND UNLOADING

In the case of liquid bulk cargo, leakage is observed along pipes, either due to usual wear and tear of piping system or due to worn out nozzles (couplings not functioning properly). Also, lack of knowledge and/ or ignorance regarding use of specific spare parts is another factor of insufficient maintenance that can lead to leakages.

In the case of dry bulk cargo, leakage is observed due to miscalculation or negligence shown by loading/ discharging equipment operator(s), especially when loading and unloading operations take place under windy weather condition,

2.1.2.2. BALLAST AND DEBALLAST

Ballast is any liquid or solid matter that is placed in a vessel in order to:

- Control vessel's gravity centre, keep it stable enough to encounter and go through perils of high winds and heavy seas,
- Adjust trim, when carrying out a non-cargo voyage, ensuring that the propeller and rudder are sufficiently immersed so that the vessel can be manoeuvred safely,
- Balance forces of weight and buoyancy, making sure that hull stress limits are not exceeded when the vessel is either loading or discharging cargo.

2.1.2.3. CARGO HOLD CLEANING – FUEL TANK WASHING

Holds are ready to receive cargo only when they are clean, dry, well ventilated and free from any odour of the previous cargo. Usual practice in hold cleaning from dry cargo is to remove residues

from last cargo, sweep holds (when applicable), wash with sea water, rinse with fresh water and then allow holds to thoroughly dry.

In the case of oil cargo, cleaning process usually includes removal of oil residues, sludge then rinsing, steaming, and cleaning with chemicals. In this way, risk of cargo contamination, which may lead to delays in port operations or disputes (Team, 2018) , is mitigated on one hand, but input of contaminants in the marine environment increases, on the other.

2.1.2.4. BUNKERING

Refuelling is carried out either directly from shore facilities or through bunkering vessel and leakages may be observed along piping installation or on couplings, due to lack of proper maintenance.

2.1.2.5. SEWAGE

Sewage is comprised of various drainage and other wastes that are divided in black water (discharges from toilets and urinals; from medical premises, from spaces containing living animals) and in *grey water* (drainage from wash basins, wash tubs, washing machines, and galley) or other waste waters when mixed with the above mentioned drainages.

2.1.2.6. MAINTENANCE

Regular or extraordinary maintenance produce pollutants similar to those already mentioned in shipbuilding stage, with the difference that due to limited time, pollutants are not usually treated in an environmentally friendly way before being discharged into the sea, during routine or extraordinary maintenance works.

2.1.2.7. DOMESTIC WASTE

Domestic waste during domestic (day to day) routine, used for living purposes with no commercial gain (Atira, 2015)

2.1.2.8. FUEL BURNING

Main engines, auxiliary engines, gas turbines, boilers and inert gas generators burn fuel of different kind in order to propel a vessel or to generate power on board.

2.1.2.9. BIOFOULING

Biological fouling is the accumulation of aquatic organisms such as plants, algae, or small animals on submerged surfaces of the vessel

2.1.3. DEMOLITION (SCRAP)

When a vessel reaches the end of commercial life (cannot operate or be sold for continued trading), it is sold in demolition market for scrap. Dismantling, usually, is brought to completion in three stages:

2.1.3.1. PREPARATORY

Stopping up all intake apertures; pumping out all bilge water; blocking off intakes and valves; removing all non-metal objects together with potentially explosive materials/ dangerous gases.

2.1.3.2. METAL STRUCTURES REMOVAL

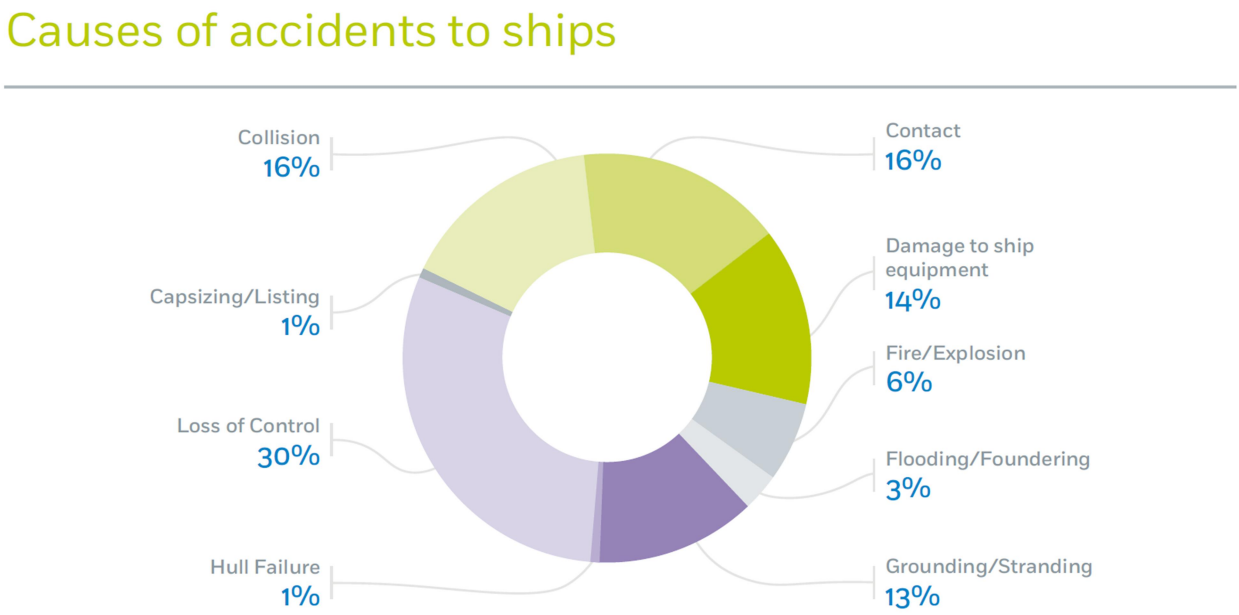
Metal structures such as masts, pipes, superstructure, deck equipment, main/auxiliary engines and equipment, pumps, decks, platform, transverse bulkheads, propeller shafts, propeller shaft bearings, upper hull sections, bow and stern end sections.

2.1.3.3. PANELS REMOVAL

Panels and sections are removed and then cut into smaller pieces, before being sold for reuse.

2.2. ACCIDENTAL POLLUTION

Accidents are occurrences that involve immobilisation of main engines, extensive accommodation damage, severe structural damage, rendering the ship unfit to sail, pollution (regardless of quantity), a breakdown necessitating towage or shore assistance have catastrophic impact on the environment. Impact severity depends on the rate and quantity of pollutants that are released. Most common recorded causes of accidents are:



(European Maritime Safety Agency, March 2020)

2.2.1. LOSS OF CONTROL

Loss of control may occur due to partial or total inability to operate or manoeuvre the vessel due to either loss of electrical supply to the vessel, loss of propulsion power due to machinery failure or loss of the ability to steer the ship

Other reason for a vessel to lose control is loss of containment due to an accidental spill or damage or loss of cargo or other substances carried on board a ship.

2.2.2. COLLISION - ALLISION

Collision is the result of two moving vessels striking each other and it is usually observed in places with dense traffic (in ports, straits etc.). Allision is contact between a vessel and a fixed installation (such as dock, quay, and offshore drilling rig)

2.2.3. DAMAGE TO SHIP EQUIPMENT

2.2.4. GROUNDING - STRANDING

Ship grounding is the contact of a ship on seabed or waterway side and may result in stranding, with or without damage to the submerged part of the ship's hull. It may happen due to bad navigation, adverse weather or engine breakdown.

2.2.5. FIRE - EXPLOSION

Fire is the result of uncontrolled process of combustion during which heat, smoke and/or flames are produced. Explosion is the uncontrolled release of energy that causes a pressure discontinuity or blast wave (European Maritime Safety Agency, 2019) . They may result from self-heating cargoes (covered by the IMDG Code), lithium-ion batteries overheating, cargo reacting with water, reefer units with faulty equipment, welding; sun exposure or collision with other ship.

2.2.6. FLOODING – FOUNDERING

When the submerged part of the ship's hull is damaged and water enters its structure, resulting in sinking.

2.2.7. HULL – STRUCTURAL FAILURE

Damage to hull and/or bulkheads caused by either shift of cargo, engine failure due to bad weather or poor maintenance that has impaired the strength of materials.

2.2.8 .LISTING - CAPSIZING

Uneven distribution of weight aboard, that results in the leaning of the vessel to either port or starboard at equilibrium, known also as listing. If the angle of list goes beyond the point where a righting moment will keep the vessel afloat, it will turn on its side or upside down (capsize) and potentially sink. (Wikipedia, 2020)

2.2.9. JETTISON

In the event of emergency (due adverse weather at sea, fire or other emergency situation on board), its cargo or part of the ship may be voluntarily casted away, in the common of good will. (Bennett, 2006)

2.3. MARINE ENVIRONMENT POLLUTANTS

In UNCLOS Part I Article 1.4, pollution of the marine environment is defined as

> "*the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities*".

As per UNCLOS definition of pollution of the marine environment, vessels operation and accidents caused by them, release pollutants that enter and affect sea ecosystems in various ways.

2.3.1. OIL

Crude oil consists of hydrocarbon mixtures that can contain also small amounts of organic sulphur compounds, aromatic compounds and even small quantities of nitrogen and oxygen compounds. These hydrocarbon mixtures are organic compounds and they are hydrophobic, they do not mix with water and lipophilic, they mix well with other oils. They can be found in oily residues (sludge), oily tank washing (slops), waste oil and bilge water, which constitutes a mix of fluids such as fresh and sea water, oil, sludge, chemicals and other fluids which drain into the bilge.

Once oil gets into contact with water, it is segregated in roughly three fractions: light, medium, heavy, depending on its type and physiochemical characteristics. Light fraction consists of more volatile compounds that evaporate. Medium fractions that remain on water surface form a thin film (oil slick) which can turn into emulsion in case of turbulence at the sea surface (chocolate mousse effect). Depending on weather conditions, this film can spread over large surface of the sea. Heavier fractions remain in water column; they can react chemically with dissolved oxygen forming either soluble products or persistent compounds called tars.

2.3.2. HAZARDOUS AND NOXIOUS SUBSTANCES

Besides oil, other substances can leak from vessels and enter the marine environment, putting human health, living organisms, resources, marine life in danger and simultaneously cause damage or interfere with other legitimates uses of the sea.

Chemical products are carried by ships in bulk (liquid, solids or gases) or in packaged form and are classified depending on their:

- Bioaccumulation and biodegradation
- Toxicity in the marine environment: How organisms in the marine environment react to various amounts of chemicals, ability to recover or not after contact with substance.
- Acute toxicity for mammals and humans through ingestion, skin penetration or inhalation
- Irritant and corrosive effects as well as long-term health effects
- Interference with other uses of the sea
- Physiochemical properties of the substance, such as viscosity, flammability, volatility corrosiveness etc.
- Prevailing circumstances during incident (quantity and rate of leakage, weather and oceanographic conditions etc.)

2.3.3. SEWAGE

As mentioned above, sewage water is composed of human / animal urine and faecal waste along with drainages of domicile nature. Therefore, there is high concentration of organic matter and certain amount of microbe load along with chemical quantities from cleaning products, soaps, and detergents, among others.

Organic matter is decomposed by marine microorganisms. During degradation, microorganisms consume dissolved oxygen and reduce its concentration in the water. Oxygen reduction in areas with high concentration of sewage or low water renewal (consequently, low dissolved oxygen renewal) can cause serious problems to marine life. Organic matter in combination with abundance in nutrients constitutes ideal conditions for algal growth, phenomenon known as eutrophication.

Sewage microbe load consists of pathogens (bacteria such as E. Coli, viruses etc.) that enter the marine environment which in high concentration near coastlines can constitute a threat to public health.

2.3.4. GARBAGE

Garbage encloses all kinds of victual, domestic and operational waste generated during the normal operation of the ship. It does not include fresh fish and parts of thereof generated during fishing activities. Additionally, under this category fall also plastics, food waste, domestic waste, cooking oil, incinerator ashes, operational waste, animal carcasses, fishing gear, e-waste.

Furthermore, in the case of ships that carry solid bulk cargoes, residues of hazardous or non-hazardous to the marine environment cargo are included as well.

2.3.4.1. PLASTICS

Plastics mean all garbage that consists of or includes plastic in any form, including (but not limiting to) synthetic ropes, synthetic fishing nets, plastic garbage bags and incinerators ashes from plastic products. Plastic is a synthetic material made from a wide range of organic polymers such as polyethylene, PVC, nylon, etc., that can be moulded into shape while soft, and then set into a rigid or slightly elastic form.

2.3.4.2. FOOD WASTE

Food waste is spoiled or unspoiled food substances, which include fruits, vegetables, dairy products, poultry, meat products, food scraps generated aboard ships.

2.3.4.3. DOMESTIC WASTE

Domestic waste consists of all types of waste generated in the accommodation spaces on board, not including grey water, i.e. paper, glass, and aluminum products not mentioned in noxious and hazardous substances.

2.3.4.4. COOKING OIL

Cooking oil is any kind of edible oil or animal fat used for/during preparation or cooking of food.

2.3.4.5. INCINERATOR ASHES

Incinerator ashes are ashes and clinkers result from shipboard incineration of sludge, domestic and operational waste, along with other types of garbage.

2.3.4.6. OPERATIONAL WASTE

Operational waste consists of all solid waste (including slurries) that is collected on board during normal maintenance, operations of a ship or used for cargo stowage and handling. Cleaning agents, additives contained in cargo hold and external wash water are also included in this category.

2.3.4.7. E-WASTE

E-waste comprises of electronic equipment along with its components and consumables.

2.3.4.8. CARGO RESIDUES

Cargo residues are sediments that remain on the deck and in holds upon completion of loading / discharging operations. Remnants are considered harmful to the marine environment when solid bulk cargo is classified according to the criteria of the United Nations Harmonised System of Classification and Labelling of Chemicals (GHS). If cargo does not meet GHS criteria, then its residues are considered non-hazardous to the marine environment.

2.3.4.9. ANIMAL CARCASSES

Animal carcasses include bodies of any animals that are carried as cargo and die or are euthanised during voyage.

2.3.4.10. FISHING GEAR

Fishing gear consists of physical device which is usually placed on/in the water or on the seabed with the purpose of capturing marine or fresh water organisms.

2.3.5. AIR EMISSIONS

World Health Organisation Engineers Join Council define air pollution as

> "*the presence in the outdoor atmosphere of one or more contaminants, such as dust, fumes, gas, mist, odour, smoke, or vapor, in quantities, of characteristics, and of duration such as to be injurious to precipitation, electrostatic human, plant or animal life or to property, or which unreasonably interferes with the comfortable enjoyment of life and property"* (Anon., 1980).

Further to above definition, main contribution of shipping industry to air pollution is fuel burning. Diesel/gas oil, LFO, HFO, LPG, and LNG, methanol and ethanol are usually consumed to attain propulsion or power on board.

Bunker oil used, is considered as toxic and usually comprises of residual fuel oil of high viscosity, which also contains high concentration of sulphur oxides (SO_x). For better efficiency, fuel is enriched with additives to prevent complete combustion and generate carbon monoxide (CO), besides carbon dioxide (CO_2), unburnt hydrocarbons (black carbon), nitrogen oxides (NO_x), and PM. Additionally, other air pollutants are VOCs from cargo tanks, in the case of oil tankers and ODS which are used in portable or fixed firefighting equipment, air conditioning and refrigerating systems.

2.3.5.1. SULPHUR OXIDES (SOx)

SO_x are a group of important ambient pollutants that consist of both gaseous and particulate chemical species. Sulphur oxides dissolve readily in water, and at the presence of suitable catalyst (i.e. NO_x) they form sulphurous acid (H_2SO_4), a component of acid rain, which ends up into soils, lakes, rivers and sea causing their acidification.

SO_x exposure can cause respiratory problems, may weaken defence mechanisms of the lungs, aggravate pre-existing cardiovascular disease and may cause irritation of the eyes

2.3.5.2. NITROGEN OXIDES (NOx)

NO_x refer to both nitric oxides (NO) and nitrogen dioxide (NO_2), gases more relevant to air pollution. Nitrogen oxides are main contributors to ground level ozone formation, which is harmful not only to public health but also to agricultural production, and it can react to form nitrous oxide (N_2O) which is one of greenhouse gases. In combination with intense sunlight, high temperatures at the presence of volatile organic compounds, nitrous oxides form photochemical smog which is harmful to public health. Atmospheric nitrogen oxides can also convert to nitric acid (HNO_3) contributing to acid rain, acidification of water column and eutrophication.

NO_x exposure can lead to insufficient oxygenation of tissues, hypertension, cardiac arrhythmia and can worsen respiratory diseases.

2.3.5.3. PARTICLAR MATTER (PM)

PM is initially formed during combustion and secondarily in the atmosphere, where it can float and carried away through winds. Their impact on health depends on size and composition. Particles of size smaller than 10μm can enter respiratory system and cause chronic respiratory diseases.

2.3.5.4. VOLATILE ORGANIC COMPOUNDS (VOCs)

VOCs are mixtures of light hydrocarbons, hydrogen sulphide and other compounds that have a high vapor pressure and low water solubility.

2.3.5.5. OZONE DEPLETING SUBSTANCES (ODS)

ODS are chemicals that degrade earth's protective ozone layer. Chlorofluorocarbons (CFCs) and halons were used respectively in older refrigeration and fire-fighting systems and portable equipment. ODS were also used as blowing agent in insulation foams. CFCs were gradually put

aside by Hydrochlorofluorocarbons (HCFC) as an intermediate replacement for CFCs, but are themselves still classed as ODS.

2.3.6. INVASIVE SPECIES

Due to increased ocean borne trade, invasion of alien species in marine environment has risen respectively. Vessels are carriers not only of commodities, but also of non-native species, such as bacteria, viruses, phytoplankton, molluscs, ostracea etc.

Many of the species that are transported through ballast water cannot survive in the ballast tanks environment due to absence of nutrients, food, light and oxygen, high salinity and temperature. Those who manage to do so, enter a new environment after deballast operation, multiply beyond limit in the absence of natural predators and destabilise ecosystems, due to competition between native and alien species for food and space.

Other way of alien species' introduction to ecosystems is through biofouling. Marine organisms attach to submerged parts of vessel (keel, propeller, tail shaft and rudder) and to parts that come into contact with sea water, such as sea chest, pipework, mooring devices, anchor wells, bilges, cargo spaces etc. In the beginning a thin biofilm is developed by organic matter and microorganisms forming a growing medium for larger plants and animals such as macroalgae, bivalve molluscs and worms. Rate of biofouling development depends on light and oxygen availability, temperature and salinity, availability of inorganic nutrients and ship's speed and activity. Slow or no moving vessels are ideal for biofouling development.

2.3.7. ANTIFOULING TREATMENT

Biofouling formed on the keel of vessels increases hull resistance in its passage through water, speed slows down; fuel consumption is raised to keep up with estimated arrival at ports, generating even more air emissions. Besides keel, this phenomenon forms obstructions in internal seawater systems, blocking or reducing entrance of water, raising maintenance cost due to clean-up needed sooner than predicted.

Taking out the ship to scrap the hull is not convenient and its cost is high (combination of clean-up expenses along with loss of income). Various treatments have been developed over time to treat biofouling, and most successful ones were those containing copper.

In the 1960 tin based paints (TBT) were used with success in reducing biofouling on vessels but later it was proved that these paints caused harm to species in the marine environment as well.

Protection of hull is attained due to paintings sloughing off releasing copper and zinc based biocides into the water column.

Conventional antifouling paints release gradually biocides into water through dissolution of water soluble part of paint until biocides is fully released. New technology antifouling paints work in the same way as conventional ones; with the difference that rate of leaching is much slower. Anti-fouling paints are usually components of multi-layer coatings that also protect ship's hull from corrosion, enhancing its sailing performance.

2.3.8. SHIP RECYCLING

Once operation and maintenance expenses exceed profit desired, the vessel completes its commercial life as mean of carriage. After last voyage, vessels head to shipyard to be broken down. At the dismantling facility, shipbuilding steel and other materials are removed from structure and sold as raw material for other uses.

Ships that are sold for scrap may contain hazardous substances such as asbestos, heavy metals, hydrocarbons, ozone-depleting substances that should be first removed in such a way so risk for human health and the environment is as low as possible.

2.3.9. WRECKS

Abandoned wrecks increase over the years, and depending on their location, they can constitute a hazard to navigation, putting crew and ship property in danger. As far as sunk cargo's nature is concerned, it may be harmful to the marine and coastal environments.

2.4. ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS

Influx of above-mentioned pollutants to the marine environment directly affects ecosystems and leads to various socioeconomic issues to coastal states as well.

2.4.1. ENVIRONMENTAL ISSUES RAISED

2.4.1.1. IMPACT TO MARINE SPECIES

In general, pollutants (and invasive alien species) undermine immune and reproduction systems of marine (native) species; they can also weaken resilience to other anthropogenic stressors. Pollutants may alter temperature, pH, concentration of various substances that can have effect on the optimal performance of many organisms, since their growth, body size, behaviour, immune defenses, feeding and reproductive success are disrupted as a reaction to surrounding changes. Marine species then can migrate to areas where conditions are similar to their original habitats if conditions allow it, or they go extinct.

In the case of oil spill or oily discharges, thin layers of oil cover plants, animals of the intertidal zone and marine mammals (i.e. sea birds, turtles etc.) on the surface of the sea which leads to drowning, hypothermia, poisoning and starvation.

Plastics are threat to marine wildlife due to acting like traps to sea creatures, leading to their suffocation and hindering of movement. In many cases, sea creatures mistake plastic pieces for foodstuff and shallow them, leading to their starvation. Plastics degrade into micro plastics under the presence UV radiation, mechanical abrasion, 'biofouling' such as microbial colonization, and other processes (Mendenhall, 2018). They can either float in water, where small fish can swallow them or they sink into seabed, mixing with other provender and finally enter food chain.

2.4.1.2. BIOACCUMULATION

As such is defined the overtime gathering of a chemical in a living organism that cannot be broken down (biodegraded) by microorganisms, such as bacteria or fungi. Many of pollutants are not broken down entirely by physical or biological processes; they remain in water column or seabed and eventually enter the food chain, reaching top predators at larger concentrations, leading to severe organic disorders.

2.4.1.3. ACID RAIN

Or acid wet deposition is the precipitation that contains sulphuric and nitric acids that have been formed upon NO_x and SO_2 reaction with water, oxygen and other chemicals.

2.4.1.4. ACIDIFICATION

Acidification is the phenomenon in which pH is reduced over an extended period of time. In high seas, acidification is observed due to high concentrations of CO_2 near surface layers, which is absorbed by seawater. CO_2 absorption triggers a reaction (National Oceanic and Atmospheric Administration, n.d.) that releases hydrogen ions leading to pH and carbonate ions reduction. Decrease of carbonate ions results in dissolution of carbonate calcium ($CaCO_3$), which constitutes the main substance of shells and skeletons formation (OECD, 2016). As a result populations of corals, molluscs, echinoderms, crustacean, oysters, mussels and other similar species are affected.

2.4.1.5. EUTROPHICATION

At presence of nutrient abundance in an aquatic system, algae growth avails and toxins may be produced that render fish and seafood unfit for human consumption. In addition to this, due to high consumption of dissolved oxygen, algae create hypoxic and anoxic zones, where fish and benthic wildlife can no longer survive and dead zones are created. Eutrophication is enhanced by high concentration of organic matter, nitrogen (derived from NO_x and NH_3 emissions) and phosphorus precipitations.

2.4.1.6. STRATOSPHERIC OZONE DEPLETION

Stratosphere is the second major layer of Earth's atmosphere and its main function is to absorb UVA and UVB radiation thanks to physiochemical properties of ozone (O_3). Without ozone layer, ultraviolet solar radiation reaching on earth is more intense, causing various health problems mostly to eyes, skin and can affect marine ecosystems due to disturbance of phytoplankton productivity (United States Environmental Protection Agency, 2018), among other problems.

2.4.1.7. GREENHOUSE EFFECT

Though ozone is beneficial in stratosphere, its presence beyond limit in lower layers may be harmful along with carbon dioxide, nitrous oxides, water vapor, methane, and chlorofluorocarbons, since they form a layer which hinders excess heat from being released to higher layers of the atmosphere. Consequently, heat is trapped between lower layers of the atmosphere, increasing average temperature leading to global warming, glacier melting, rise of sea level etc. Greater temperatures accelerate gas exchange on sea surface, intensifying acidification.

2.4.1.8. PHOTOCHEMICAL SMOG

Photochemical smog is the result of high concentrations of NO_X and VOCs under the presence of ultraviolet radiation. It is detrimental to public health causing irreversible problems to pulmonary and respiratory system; aggravate cardiovascular related diseases and irritation to vision. Smog may have negative effect on plants growth, minimising crop production and accelerates corrosion on metal, stone, painted surfaces (Science Facts, n.d.).

2.4.2. SOCIOECONOMICAL IMPACTS

As already mentioned, invasive species are major contributors in biodiversity loss due to competition between native and alien species. Imbalance occurred is depicted in the population of fishing stocks, disrupting capture fisheries and aquaculture, activities that are important for coastal economies.

Besides invasive species disrupting industry related to fish stock, biofouling can be developed on coastal infrastructure using large amounts of water, which can cause problems of mechanical origin that can harm local communities in the long run, like in the case of Zebra mussel accumulation in Monroe Power Plant in Great Lakes (Kovalak, et al., 1990).

Oil mixtures and /or spill that have not been biodegraded, along with float and/or washed out garbage downgrade the aesthetics of a coastline, turning it repellent to tourists which will be prejudicial to tourism industry and real estate interests. Local communities are affected by loss of income due to real estate devaluation along with reduction of activities around tourism and must bear also the cost of clean-up. In addition, garbage thrown into water and does not sink causes damage to vessels and small boats (i.e. fishing nets tangling propellers).

As far as public health is concerned, spread of viral or bacterial diseases can be observed, especially in areas with problematic water supply and sewage systems; food poisoning through direct or indirect consumption of toxins produced by the harmful alien species can be also a burden to public health.

CHAPTER 3: POLLUTION PREVENTION

Due to ocean borne trade's overseas nature, there was no legal framework that could regulate pollution caused by vessels, since jurisdiction of coastal states extended only to its territorial waters (Tsimplis, 2014). Up to the early 1970's, pollution damage compensation was mostly based on national law and not always attainable, as ships usually sail outside each country's territorial waters (coastal states' jurisdictions usually extends up to three nautical miles). Between 1970's-1980's, consecutive accidents in a row intensified the need for measurements to be developed and adopted to mitigate pollution caused either by daily operations on board or by accidents.

3.1. INTERNATIONAL MARITIME ORGANISATION (IMO)

Long before the Torrey Canyon oil spill in 1967, several countries pointed out the need of a permanent body that would promote maritime safety and control of pollution. Once United Nations were formed in 1948, IMCO was established during a conference in Geneva in the same year, in order to promote maritime safety:

> *"The purposes of the Organisation, as summarised 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".* (IMO, 2019)

IMCO only entered into force in 1958 and was delegated to keep these conventions up to date and to develop new conventions, issue regulations as and when the need arose.

In 1983 IMCO was renamed to IMO, a non-governmental organisation that bears the responsibility of regulating shipping, coordinating remedies to navigation, safety at sea, vessel source pollution. It has an important role in coordination of various committees, producing guidelines and promotes implementation of regulations in national legislation of its Members. Additionally, it provides training to ashore personnel and seafarers for better application of treaties.

3.2. MARPOL 73/78

In the meantime, OILPOL 54 was the first attempt to set legal framework, regarding pollution form ships. OILPOL 54 is an International Treaty that was signed in London on 12 May, which acknowledged that most oil pollution resulted from routine shipboard operations such as the cleaning of cargo tanks. As mentioned previously, at that time, normal practice was simply to wash the tanks out with water and then pump the resulting mixture of oil and water into the sea. OILPOL 54 set limits by prohibiting the dumping of oily wastes within a certain distance from land and in 'special areas' where the danger to the environment was especially acute. (Wikipedia, n.d.).

In 1967, the Torrey Canyon oil spill pushed forward the problem of pollution, since the release of 119,000 tons of crude oil (International Tanker Owners Pollution Federation, n.d.) affected not only sea life but also the economy of coastal states (Britain, France, Guernsey, and Spain) involved. In the following years, there were several measures designed to avoid such incidents, and on 17 February 1973, the International Convention for the Prevention of Pollution was signed, it was amended by the protocol of 1978 and Annexes I & II entered into force on 2 October 1983. MARPOL 73/78 sets guidelines regarding vessel construction, equipment, procedures regarding discharge at sea (where applicable). The Convention has been amended and covers other that oil sources of pollution caused by vessels, as well: (IMO, 2019).

In this chapter, emphasis is laid more on regulations, documentation proving compliance and on the responsibilities born by the company and the vessel.

3.2.1. ANNEX I – REGULATIONS FOR THE PREVENTION OF POLLUTION BY OIL

Annex I of the MARPOL set requirements regarding design, construction of vessels and management of oil operational waste under the scope of mitigating pollution form oil in the marine environment as much as possible.

Regarding oil tankers, Annex I introduced segregate ballast tanks ensuring that ballast water doesn’t mix with oil cargo and fuel oil system. Their location under cargo tanks offered an extra protection in mitigating pollution in case of grounding. Segregated ballast tank requirement was superseded by the requirement of new building oil tankers to be fitted with double hull.

In addition, protection of cargo pumproom in oil tankers of over 5,000 DWT, with double bottom, prevents rendering ballast or cargo pumping systems inoperative in case of flooding.

For the same reason (mitigating risk of oil discharge at sea in case of grounding), all types of vessels, need to have fuel oil tanks at a certain distance from both the bottom and side shell.

All vessels (regardless cargo they carry), should have tanks dedicated to receiving only

> "*Oil residues (sludge) which cannot be dealt with otherwise in accordance with the requirements of this Annex, such as those resulting from the purification of fuel and lubricating oils and oil leakages in the machinery spaces.*[1]

These tanks need to be designed and manufactured in a way that cleaning is easy and discharge only to reception facilities is unhindered.

Another requirement for all vessels is to be fitted out with oil filtering equipment that process oily mixture discharges until their concentration in oil content does not exceed 15ppm. An alarm indicating transgression of limit must be provided as well, so that discharge automatically stops.

For a vessel to prove compliance with the requirements of MARPOL 73/78 Annex I to the Authorities, it should carry a valid International Oil Pollution Prevention Certificate (IOPP), which is issued and renewed upon respective survey.

Besides IOPP certificate, all vessels need to keep an Oil Record Book- Part I – Machinery Space Operations, where records are kept regarding machinery space operations such as ballasting or cleaning of oil fuel tanks, discharge of dirty ballast or cleaning water from oil fuel tanks, collection and disposal of oil residues (sludge and other oil residues),discharge overboard or otherwise disposal of bilge water which has been accumulated in machinery spaces and bunkering of fuel or bulk lubricating oil .

Oil tankers are obliged to keep also records upon un/loading of oil cargo, internal transfer of oil cargo during a voyage, ballast of cargo tanks and dedicated clean ballast tanks, cleaning of cargo tanks including crude oil washing, discharge of ballast except from segregated ballast tanks, discharge of water from slop tanks, closing of all applicable valves or similar devices after slop tank discharge operations, closing of valves necessary for isolation of dedicated clean ballast tanks from cargo and stripping lines after slop tank discharge operations and disposal of residues in respective Oil Record Book, Part II – Cargo/Ballast Operations.

Oil Record Books are to be thoroughly updated once above mentioned operations are carried out and available for inspection upon request.

[1] http://www.marpoltraining.com/MMSKOREAN/MARPOL/Annex_I/r12.htm

Another requirement under Annex I is the existence on board of Shipboard Oil Pollution Emergency Plan (SOPEP), which includes procedures (reporting, contacting Authorities, immediate actions etc.) that Master and Officers must follow in case of an oil pollution incident.

3.2.2. ANNEX II – REGULATIONS FOR THE CONTRIL OF POLLUTION BY NOXIOUS LIQUID SUBSTANCES IN BULK

Besides oil, there are other substances that can enter the marine environment either through tank cleaning or deballasting operations and can affect it at different rate, depending on their physiochemical properties. IMO has edited Codes and has divided chemical substances depending on their state of matter.

- Bulk liquid cargo transport is carried out under the provisions of IBC Code. The IBC Code set international design and construction standards of ships and equipment they should carry for the safe carriage of bulk liquid cargos.
- Solids in bulk cargo carriage is made under the provisions of IMSBC Code. The IMSBC Code includes guidelines for the safe stowage and shipment of solid bulk cargos, providing information on respective risks undertaken. Grain in bulk cargoes are not included in IMSBC Code, their carriage in made under the provisions of the International Grain Code.
- Gaseous cargo transportation should be effected under the provisions IGC Code. The IGC Code provides international design and construction standard of ships involved in carriage of liquefied gases in bulk and the equipment they should carry to minimise risks undertaken be ship, crew and to the environment.

In the Annex II of MARPOL there is further classification of noxious liquid substances based on the risk of marine pollution and their impact on human/marine life health, as per criteria mentioned in paragraph 2.3.2.:

- Category X incudes noxious liquid substances that are considered as major hazard to either marine resources or human health and their discharge to into the marine environment are forbidden.
- Category Y consists of noxious liquid substances that constitute hazard to marine resources, human health, cause harm to other uses of the sea and only limited discharge is permitted.

- Category Z noxious liquid discharges present minor hazard to marine resources, human health, therefore less stringent restrictions apply on their quality and quantity.
- Other Substances: discharges of ballast water or other residues or mixtures of substances that are not included in neither above mentioned categories are not subject to any requirements of Annex II.

Ballast water, residues or mixtures containing substances that are classified in any of X, Y, Z categories, should not be discharged into the sea, unless they fulfil Annex II requirements per category.

In addition to cargo substances, cleaning agents and/ or additives used for cargo hold washing should be treated in compliance with the requirements of Annexes I and II respectively.

A vessel proves compliance with requirements of MARPOL Annex II, when it carries valid International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk (NLS Certificate), along with a Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk or International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk that proves compliance with IBC Code.

Besides NLS Certificate, ships that carry substances of X,Y,Z categories, need to bear also a Procedures and Arrangement Manual (P&A Manual) approved by the Administration. The P&A Manual includes guidelines to the officers regarding the physical arrangement and operational procedures (such as cargo handling, tank cleaning, slops handling, cargo tank de/ballasting) to be followed to comply with the requirements of the Annex.

Another required document is the Cargo Record Book, which needs to be duly filled upon loading/unloading/internal transfer of cargo, mandatory prewash, cleaning of cargo tanks, tank washing discharge into the sea, ballast/deballast of cargo tanks, any accidental or exceptional discharge, and control by authorised surveyors. Additional operational procedures and remarks should be recorded as well. Cargo Record Book should be available for inspection and retained for a three-year period.

A Shipboard Marine Pollution Emergency Plan for Noxious Liquid Substances that includes procedures (reporting, contacting Authorities, immediate actions etc.) to be followed by Master and Officers, is also required to be carried onboard.

3.2.3. ANNEX III – PREVENTION POLLUTION BY HARMFUL SUBSTANCES CARRIED BY SEA IN PACKAGED FORM

Annex III applies to all vessels carrying harmful substances such as containers, portable tanks, and tank trucks. It embodies guidelines on packing, marking and labelling, cargo supporting documents, stowage, quantity limitations, exceptions and Port State Control duties on operational requirements

Harmful Substances are identified as Marine Pollutants in IMDG Code or meet the four criteria of acute and chronic toxicity, bioaccumulation and degradation in the marine environment.

Materials used for packaging must be such with the aim of mitigating marine pollution from contained substances. Packages need to be marked after the correct technical and not commercial name of substance in such a way that marking will be still readable after being immersed at sea for a long period.

Likewise, supporting documents need to mention correct technical name of each substance, along with remark of Marine Pollutant. Shipper shall provide carrier with signed certificate or declaration that cargo is properly packaged, marked, labelled as appropriate so that in case of emergency, handling of cargoes will be smoother and danger to the marine environment to be minimum as possible.

Vessels transporting harmful substances in packaged form need to carry as well a Dangerous Goods Manifest or Stowage Plan, in which harmful substances and respective classification are recorded along with their location on board.

3.2.4. ANNEX IV – PREVENTION OF POLLUTION BY SEWAGE FROM SHIPS

Under regulations of Annex IV, no raw sewage can be discharged into the water, unless some requirements are met. All vessels of more than 400 gross tonnage engaged in international voyages or are certified to carry more than 15 persons, need to be equipped with a sewage treatment system.

Sewage treatment system may consist of either a sewage treatment plant, a sewage comminuting and disinfecting system or a holding tank of the capacity for the collection and retention of all sewage, depending on vessel type, number of persons on board etc. All options need to be approved by Administration whose flag the vessel is entitled to fly. Consequently, relevant valid International Sewage Pollution Prevention (ISPP) Certificate needs to be on board.

In the case that Annex IV requirements regarding raw sewage discharge are met, a Document of approval for the rate of sewage discharge issued by Administration need to be also among documents required on board.

3.2.5. ANNEX V – PREVENTION OF POLLUTION BY GARBAGE FROM SHIPS

Annex V includes definitions regarding garbage, regulations concerning treatment and potential discharge to the sea, along with documents to be carried that prove vessel's compliance with the provisions of the Annex V. Reference is also made to the obligation of signatory states to equip ports and terminals with garbage reception facilities.

Aboard any vessel of 100 gross tonnage and certified to carry more than 15 persons, there should be a Garbage Management Plan (GMP) following IMO Guidelines in crew working language. The plan must include description of procedure such as minimisation, collection, storage, processing, disposal of garbage, instructions regarding use of the equipment dedicated for garbage handling along with the designation of person (s) in charge for smooth implementation of GMP.

Garbage may be stored in a way that health and safety hazards are mitigated as much as possible. Depending on the type of garbage, incineration is possible as per guidelines as long as incinerator meets Administration requirements

For vessels more than 400 gross tonnage, a Garbage Record Book (GRB) is required and must be kept updated and available to inspections. Entries in GRB should be made upon: garbage discharge to a reception facility or to other ships, incineration, and garbage discharge into the sea in accordance with relevant regulations of MARPOL Annex V, accidental or other exceptional discharges or loss of garbage into the sea along with date, time and position of the vessel.

Placards should be placed in areas where garbage may be produced, informing crew (and passengers) laws that apply on garbage treatment and disposal.

3.2.6. ANNEX VI– PREVENTION OF AIR POLLUTION FROM SHIPS

Annex VI of MARPOL applies to all vessels of 400 gross tonnage must hold an International Air Pollution Prevention Certificate (IAPP) that proves that the vessel complies with Annex VI regulations:

3.2.6.1. REGULATION 12 ON OZONE DEPLETING SUBSTANCES

New installations after January 2020 can contain neither CFCs (since 2005) nor HCFCs (substances that initially replaced CFCs). Deliberate emissions occurring during maintenance, service, and repair or disposal of systems or equipment are prohibited. ODS and equipment containing ODS should be delivered only to appropriate reception facilities. Each vessel is required to draw up a list with equipment containing ODS and records need to be kept in ODS Record book upon recharge (full or partial), repair or maintenance of equipment containing ODS, deliberate or non-deliberate discharge into the atmosphere, disposal at land-based facilities and supply of such substances to the ship.

3.2.6.2. REGULATION 13 ON NITROUS OXIDES

Under Tier I and II, NO_x emissions' limits are set to marine diesel engine manufacturers, in the scope for gradual reduction of said emissions. Tier III applies even lower limits of NOx emissions to vessels intending to operate within NO_x ECA's. Compliance to regulation 13 is proved at the presence of Engine International Air Pollution Prevention (EIAPP) Certificate. Marine diesel engines come along with NO_x Technical File that must be approved by the Administration.

3.2.6.3. REGULATION 14 ON SULFUR OXIDES AND PARTICULAR MATTER

Requirements that relate to the quality of fuel used and which impose stricter emission limits within ECAs. Most vessels operate within and outside ECAs, consuming fuel of different sulphur concentration. A Fuel Oil change over Procedure Manual where such procedures are described, enable crew for smooth fuel changeover and compliance with requirements. Fuel delivered and used need also to meet requirements for lower pollutants emission. Any replenishment needs to be accompanied by relevant Bunker Delivery Note recording density at 15ºC and sulphur content, among other information.

3.2.6.4. REGULATION 15 ON VOLATILE ORGANIC COMPOUNDS

Emission in tankers is controlled through installation and use of Vapour Emissions Collection System (VECS) to avoid leakages. VECS is mandatory for vessels that operate in ports and terminals that are equipped with VOC control system (an arrangement of piping and hoses used to collect vapour emitted from a tanker's cargo tanks and transport the vapour to a vapour processing unit). Every tanker transporting crude oil should also carry a VOC management Plan mentioning procedures that help minimising VOC emissions, giving consideration to additional

emissions produced during crude oil washing and nominating an Officer to be in charge for implementation of procedures on board. .

3.2.6.5. REGULATION ON SHIPBOARD INCINERAITON

Regulation clarifies which substances can be incinerated or their incineration is prohibited and need to be disposed only to adequate disposal facilities. Crew responsible for handling the incinerator should be familiarised with both equipment operation and substances that can be incinerated.

3.2.6.6. REGULATIONS ON ENERGY EFFICIENCY

Purpose of this new chapter is the reduction of greenhouse gases produced by shipping. Regulations include technical measures which promote research and technological advances in the design and construction of vessels under the scope of operating with lower fuel consumption. These technical measures are depicted through Energy Efficiency Design Index (EEDI), whose calculation data is included in EEDI Technical file which must be submitted to and verified by Administration or an authorised Recognised Organisation. Same must be retained on board through vessel's operational period. Besides technical measures, operation measures need to be taken as well and procedures to achieve this goal should be drawn and included in Ship Efficiency Management Plan (SEEMP). Purpose of SEEMP is to plan, implement best practices for energy efficient ship operation, monitor same and evaluate for further improvement. Compliance with regulations on Energy Efficiency is proved through valid International Energy Efficiency Certificate (IEEC).

All entries in record books must be signed by officers in charge, and upon page completion, Master needs to sign and stamp as well for the entries to be legally valid.

Periodical surveys are needed to show that the structure, equipment, systems, fittings arrangements, material on ship and their conditions still comply with prevailing requirements of respective annexes.

3.3. OTHER CONVENTIONS RELATING TO THE MARINE POLLUTION PREVENTION

Further to the Annexes above, other conventions have been signed with the scope of mitigating quantity of contaminants entering the marine environment.

3.3.1. INTERNATIONAL CONVENTION ON THE CONTROL OF HARMFUL ANTI-FOULING SYSTEMS ON SHIPS (AFS)

The AFS Convention prohibits application, reapplication, installation and use of paints with organotin compound biocide, such as TBT, in ships' antifouling systems, aiming avoidance of irreversible consequences on marine environment and human health.

In order to prove compliance with the Convention, vessels must carry an International Anti-Fouling System (IAFS) Certificate.

3.3.2. INTERNATIONAL CONVENTION FOR THE CONTROL AND MANAGEMENT OF SHIP'S BALLAST WATER AND SEDIMENTS

Under the provisions of the convention, vessels need to comply with either Ballast Water Exchange Standard (D1) or with Ballast Water Performance standard (D2).

3.3.2.1. D1 STANDARD

It suggests volumetric exchange of ballast water up to 95% of volume capacity. The exchange can take place at least 200nm away from coast, where depth is at least 200m. It is suggested that prevailing conditions (pH, salinity, temperature) in Deep Ocean are not ideal for viability of harmful aquatic organisms and pathogens. Ballast exchange can be achieved by means of either flow through, dilution or sequential methods.

3.3.2.2. D2 STANDARD

It suggests that ballast water exchange can take place without position restrictions (distance from shore, depth) only if viable microorganisms' concentration and dimension in discharge effluent are below limits. This can be achieved through various methods such as coagulation/flocculation method, UV treatment, and deoxygenation, among others.

Vessels need to carry a Ballast Water Management Plan, approved by Flag Administration, which includes procedures for: safe ballast water exchange, cleaning and disposal of sediments accumulated in ballast tanks, coordination with coastal Authorities for ballast water discharge

within national waters; actions needed for proper implementation of Convention requirements, designation of Officer in charge of the implementation. A Ballast Water Record Book needs also to be duly filled upon: ballast water pumping, treatment, and recirculation, discharge at sea or disposal to Port Reception Facilities, accidental or other exceptional uptake or discharges of ballast water, and to be kept on board available for inspection, for a 3 year period.

Compliance with the above is proved through valid International Ballast Water Management Certificate.

3.3.3. THE HONG KONG INTERNATIONAL CONVENTION FOR THE SAFE AND ENVIRONMENTALLY SOUND RECYCLING OF SHIPS

The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships requirements are relevant to the design, construction, operation and preparation of vessels in a safe and environmentally friendly sound operation of ship recycling installations.

Under regulation 4 provisions, the installation or use of hazardous materials on ships prohibits / restricts use of asbestos, ODS, polychlorinated biphenyls (PCBs), organotin compounds based anti-fouling paints and systems (IMO, 2015).

Regulation 5 requires that every existing and new building vessel must bear an Inventory of Hazardous Material where specific location and approximate quantity of hazardous substances contained in vessel's structure and equipment are recorded along with clarification that the vessel complies with regulation 4.

Compliance with the Hong Kong convention is proved through Certificate on Inventory of Hazardous Material, which is issued upon completion of initial survey; renewed every 5 years and final survey is conducted before vessel arrives at Ship Recycling Facility.

CHAPTER 4: INTERNATIONAL SAFETY MANAGEMENT (ISM) CODE

As mentioned in chapter 3, IMCO came into force in 1958. One of its first tasks was to adopt a new version of the International Convention for the Safety of Life at Sea (SOLAS) (IMO, 2019).

4.1. SOLAS

In 1914, after the Titanic disaster, maritime nations gathered in London and adopted SOLAS Convention, with the purpose of setting minimum requirements; establish procedures, preparedness to minimise casualties and losses in case of emergency.

Since 1914 has been superseded by SOLAS 1929, SOLAS 1948, SOLAS 1960 and SOLAS 1974.

SOLAS Convention purpose was to establish rules for the safe construction of ships, the safety equipment with which vessels are required to be fitted and to set minimum standards under which vessels should operate to avoid accidents (Lorenzon, 2014), preserve life at sea and prevent pollution of the marine environment.

Flag States that have ratified the SOLAS Convention ensure that ships that fly their flag comply with its requirements and are provided with corresponding certificates that prove their compliance with SOLAS regulations. Compliance is verified along whole vessel's commercial life via inspections and audits at periodical intervals, as mentioned in Flag State Administration paragraph.

Current SOLAS Convention includes Articles that set general obligations, amendment procedure, followed by an Annex divided in 14 Chapters: (IMO, 2019)

Chapter I - General Provisions: It includes regulations regarding the survey and issuance of certificates that prove compliance with requirements, along with provisions for the control of ships in ports of other Contracting Governments.

Chapter II-1 - Construction - Subdivision and stability, machinery and electrical installations: It deals with watertight integrity of the ship, especially for passenger vessels.

Chapter II-2 - Fire protection, fire detection and fire extinction: This chapter elaborates the means and measure for fire protection in accommodation, cargo spaces and engine room for the passenger, cargo and tanker ships.

Chapter III - Life-saving appliances and arrangements: Description of all the life-saving appliances and their use in different situations.

Chapter IV – Radiocommunications: Requirements of Global Maritime Distress Safety System (GMDSS), Search and Rescue Transponder (SART), Emergency Position Indicating Radio Beacon (EPIRB) etc. for both cargo and passenger vessels are included in this chapter.

Chapter V - Safety of navigation: This chapter contains passage planning, navigation, distress signal for all the seagoing vessels of all sizes, from boats to VLCCs.

Chapter VI - Carriage of Cargoes: Chapter 6 regards storage and securing different types of cargo and containers, (oil and gas cargo excluded).

Chapter VII - Carriage of dangerous goods: Chapter 7 defines the International Maritime Goods Code for storage and transportation of dangerous goods.

Chapter VIII - Nuclear ships: The code of safety for a nuclear-propelled ship is stated in this chapter.

Chapter IX - Management for the Safe Operation of Ships: Requirements of the International Safety Management Code for ship owners and the operators are described.

Chapter X - Safety measures for high-speed craft: Safety code for the high-speed craft is explained.

Chapter XI-1 & 2 - Special measures to enhance maritime safety and security: Special and enhanced survey for safe operation, other operational requirements and International Ship and Port Facility Security (ISPS) code is briefed in this chapter.

Chapter XII - Additional safety measures for bulk carriers: In this chapter, additional safety requirements for above 150 meters length bulk carriers are included.

Chapter XIII - Verification of compliance: This chapter was adopted on 22 May 2014 which requires all the Contracting Parties to undergo periodic audits by the approved organisation following the audit standard to verify compliance with and implementation of the present Convention.

Chapter XIV - Safety measures for ships operating in polar waters: It deals with the ships that intend to operate within the Arctic and Antarctic areas and need to carry relevant Polar Ship Certificate.

4.2. ISM CODE

Chapter IX of SOLAS Annex makes mandatory the International Safety Management (ISM) Code, which requires a safety management system to be established by the ship owner or any person who has assumed responsibility for the operation of the ship (the Company).

ISM Code is a set of instructions that facilitates the implementation and application of numerous Conventions, regulations etc. issued by IMO, regarding safety at sea and prevention pollution in company's safety management system.

The need to create such a code rose after the investigation and root cause analysis of various accidents, which showed that such accidents would have been avoided, should there be a specific predefined procedure to follow.

HISTORY OF ISM CODE

The reoccurrence of very high profile maritime losses during the 1980s and early 1990s resulted in the revelation of poor safety management procedures and lack of communication not only onboard but also between the company and the vessel.

For example, in the case MS Herald of Free Enterprise accident in 1987, the immediate cause of the accident was the absence of assistant boatswain, as he was asleep instead in duty position and failed to close bow-door, which resulted in the entrance of water into the ferry.

Further investigation showed that probable causes of the accident were:

Negligence: the assistant boatswain had opened the bow doors, he went to his cabin where he fell asleep and did not listen the call announcement on the loudspeaker that the ship was ready to sail, therefore he did not close the bow doors, as he should.

Poor communication and lack of directions: Due to pressure to leave the berth, chief officer (loading officer at that moment) could not remain on G deck until the doors were closed and left position before assistant boatswain returned. In this way there was failure in ensuring that the bow doors would close before departure. Consequently, this critical information was not relayed and the Captain ordered departure without knowing that the bow doors were still open.

The official accident report highlighted that there was not sufficient communication between ship operators and shore-based managers and that delegation of duties and responsibilities was not adequately clear.

Summarising, the above, the main cause of F/B Herald of Free Enterprise was the lack of safety procedures and faulty relay of information.

As a response to several similar accidents (i.e. MS Estonia, MS Scandinavian Star) and in order to make a stand against the phenomenon of substandard vessels, the IMO proceeded with development of guidelines that concerned shipboard and shore-based management,

> "*recognising the need for appropriate organisation of management to enable it to respond to the need of those on board ships to achieve and maintain high standards of safety and environmental protection.*
>
> *Recognising also that most important means of preventing maritime casualties and pollution of the sea from ships is to design, construct, equip and maintain ships and to operate them with properly trained crews in compliance with international conventions and standards relating to maritime safety and pollution prevention*"[2]

and proceeded with the adoption of resolutions A.647 (16) and A.741 (18).

Resolution A.647 (16) embodies the Guidelines on Management for the Safe Operation of Ships and for Pollution Prevention.

Resolution A.741 (18) establishes the International Management Code for the Safe Operation of Ships and for Pollution Prevention (ISM Code) as mandatory in 1993 and in 1994 it was incorporated by IMO as new Chapter IX in SOLAS.

The Code entered into force on 1st July 1998, for passenger vessels, tankers, bulk carriers, high speed crafts and as of 1st July 2002 for other vessels and ever since until 2017 several amendments through MSC's resolutions[3], as proposed, entered into force and fully updated into fifth edition of 2018.

The purpose was to provide a framework for the proper development, implementation and assessment of safety and pollution prevention management in accordance with good practices to Managers and Operators.

Their objective was to ensure safety, to prevent human injury or loss of life, and to avoid damage to the marine environment, and to property.

[2] IMO Resolution A.647(16)
[3] MSC.104 (73), MSC.179 (79), MSC.273 (85), MSC.353 (92), MSC.428(98)

Shipping is an industry with wide range of activity and shipping companies are based worldwide; companies operate fleet whose vessels belong in various categories. Due do this diversity, SMS cannot be the same for all companies, since they operate under different requirements (types of vessels) and wide range of different conditions (National Legislation and legal framework). Consequently, the guidelines are more based on general principles and objectives to promote evolution of sound management and operating practices within the industry, rather than a set of specific rules / instructions to be followed.

Due to its international character, shipping industry requires uniformity of environmental measures and regulations for ships to the greater extent possible, as otherwise it may become subjected to unilateral legal provisions and demands by each coastal State (Tsimplis, 2014).

The Code is divided in two parts: Part A refers to implementation and part B to certification and verification.

4.3. PART A – IMPLEMENTATION

4.3.1. OBJECTIVES

As per ISM Code, PART A, Par. 1.2, the objectives of the Code are to ensure safety at sea, prevention of human injury or loss of life, and avoidance of damage to the marine environment and to property. For the objectives to be attained, the SMS should contain:

- Safe practices in ship operation and a safe working environment,
- Assess all identified risks to its ships, personnel and the environment,
- Establish appropriate safeguards and continuously improve safety management skills of personnel ashore and aboard ships, including preparing for emergencies related both to safety and environmental protection.

Therefore, SMS should ensure compliance with mandatory rules, regulations in force and that the applicable Codes, guidelines and standards recommended by the IMO, Administrations, Classification Societies and maritime industry organisations are taken into account.

4.3.2. FUNCTIONAL REQUIREMENTS FOR A SAFETY MANAGEMENT SYSTEM

In compliance to the above-mentioned objectives to be attained, the SMS must contain safety and environmental protection policies; the Company must ensure that afore mentioned policies are duly adopted and preserved by both ship and shore based personnel of all management levels.

Instructions and procedures to ensure safe operation of ships and protection of the environment in compliance with relevant international and Flag State legislations should be embodied in the SMS.

Levels of authority and lines of communication between shore personnel and crew on board should be clarified and documented. Procedures for reporting accidents and non-conformities with the provisions of the code, preparing for and responding to emergency situations and for internal audits and management review should be developed and enforced accordingly.

4.3.3. COMPANY RESPONSIBILITY AND AUTHORITY

Owners must report to the Administration who oversees the operation of the vessel, in case operation management is carried out by different entity. Under this article, an organisation chart (Flow chart) depicting office persons in charge with corresponding duties along with brief description of their responsibilities and authority regarding management, performance or verification affecting safety and prevention pollution, should be mentioned in SMS documentation. Company needs to ensure that adequate resources such as equipment and material, personnel and trained auditors with experience is company's ship types; technical resources, time and funds along with shore based support are available as to enable the Designated Person(s) Ashore carrying out their duties. Commitment from top management, competence, attitudes and motivation of individuals at all levels, will achieve all goals as established.

4.3.4 .DESIGNATED PERSON(S) ASHORE (DPA)

The Company must designate one or more qualified individual(s) that will act as a connecting link between the Company and the vessel. That person needs to have direct access to the top management to ensure adequacy of resources (both monetary and human) for more efficient monitoring and implementation of the SMS. Since the DPA oversees the daily operation of the Company and fleet in compliance to the SMS, proceeds with potential rectifications / corrective actions, must clearly and adamantly present independent judgment and skills as to avoid any conflict of interest to smoother and more effective monitoring / auditing of all departments, especially in cases where DPA's profession status is embodied in a Company's departments (i.e. Operations or Technical Manager).

DPA's responsibility and authority need to be documented in the SMS; duties should include not only monitoring, but also verification of the safety and pollution prevention aspects of operation of each ship.

4.3.5. MASTER'S RESPONSIBILITY AND AUTHORITY

The Company must define and document Master's responsibility regarding the implementation of safety and environment prevention pollution policy, motivation of crew to act based on policies, appropriate orders and instructions given in a clear and simple manner, control that standards are met, periodical review of the SMS and report potential deficiencies to the management ashore.

The SMS should also include a clear statement as far as Master's overriding authority and responsibility are concerned to act and make decisions with respect to safety and pollution prevention and to request company's assistance when deemed necessary.

4.3.6. RESOURCES AND PERSONNEL

The Company should ensure that the Master is a qualified individual, fully conversant with Company's SMS and all the necessary support is provided by the Company with a view to be able on performing duties safely and in the most efficient manner.

Company should ensure that the vessel is manned with qualified, certified and medical fit seafarers, in accordance with STCW requirements, in order to encompass all aspects maintaining safe operations on board (IMO, 2018).

The Company should establish procedures to ensure that:

- All signing on crew are familiar with Company's policies and procedures prior embarkation and
- All onsigned crew, or those being promoted to new assignments while on board, are duly and fully familiar of all aspects related to safety and environmental protection, assigned to their duties including training on all lifesaving (LSA) and firefighting protection equipment (i.e. SOLAS training manual, muster list, SOPEP etc.) including proper hand and taking over. Training to support the SMS should be provided and documented.
- All crew has a good understanding of the content of the SMS.

- SMS should be written in a common working language or in a language understood by persons involved. It is imperative to mention that all crew on board can communicate effectively and carry out their duties as a crystal clear evidence of SMS implementation.

4.3.7. SHIPBOARD OPERATIONS

The Company should establish procedures, plans and instructions including checklists as appropriate, for key shipboard operations (i.e. Navigation – Port Operations- Technical, Deck and Engine Operations, Cargo handling, Mooring Unmooring – Anchoring, Bunkering, Towing, External Communication etc.) concerning the safety of the personnel, ship and protection of the environment. The various tasks should be defined, assigned to qualified personnel and documented.

4.3.8. EMERGENCY PREPAREDNESS [4]

Potential emergency shipboard situations should be identified beforehand; procedures and instructions should be developed and documented in order to respond to them in the most efficient way. Full scale drills and exercise schedule should be established so that crew will be prepared and not trying to figure out what to do at the time of an emergency. In this way, emergencies may be prevented and consequences occurred, mitigated. The SMS should provide for measures ensuring company's response to hazards, accidents and emergency situations evolving on ships.

Response to potential shipboard situations should include:

- Allocation of duties and responsibilities on board,
- Actions to be taken to mitigate consequences and regain control,
- Lines of communication on board and with the office during the emergency,
- Procedures for requesting assistance from third parties if needed and
- Checklists to aid in monitoring and reporting.

Potential shipboard situations should be documented in Shipboard Contingency Plan, that should include response actions in case of fire, damage to ship (caused by collision, grounding, flooding or critical equipment failure), pollution, personnel accidents, cargo related accidents (unexpected list, cargo shifting), emergency assistance to other ships, among others.

[4] Refer to the Guidelines for a structure of an Integrated System of Contingency Planning for Shipboard Emergencies adopted by IMO by resolution A.852 (20) as amended.

4.3.9. REPORTS AND ANALYSIS OF NON-CONFORMITIES, ACCIDENTS AND HAZARDOUS OCCURRENCES[5]

In the SMS, procedures should be provided for report, investigation and analysis of non-conformities, accidents and hazardous situations. Any deviation (near miss, accident, hazardous occurrence) from established procedure is encountered as non-conformity which could jeopardise human safety, environmental conditions, ship and/or cargo. If not treated, then it could evolve into major non-conformity; an identifiable deviation that poses serious threat to the human safety, environmental conditions, ship and/or cargo, which requires immediate corrective action. The corrective action includes the detection of non-conformity, investigation on identification of root cause and records of the same to be filed. Upon completion of root cause analysis, recommendations need to be developed including measures intended, to prevent reoccurrence. A reasonable period of time should be foreseen for new procedures to be implemented and corrective action to be followed up and verified for effectiveness through internal audits.

4.3.10. MAINTENANCE OF THE SHIP AND EQUIPEMENT

The Company should establish procedures for proper maintenance on board the ship in accordance and compliance to relevant rules and regulations in force and to any additional requirements set by the Company principals and always related to the normal shipping practice. To achieve the latter, ship's hull, constructions, machinery and equipment should be inspected at regular intervals and any non-compliance observed should be reported and an immediate corrective action should be taken.

Additionally, records of any non-conformity reports, root cause analysis and corrective actions should be kept as an evidence of compliance and for future reference. Critical equipment whose sudden failure may lead to hazardous situations should be defined, documented and tested on a regular basis either they are on standby arrangement or they are not in continuous use. A Planned Maintenance System should be drawn up and established, especially for all machineries (including overhauling as per running hours, usage, manufacturer's recommendations, repairs needs to be done, calibration etc.) in the sake of effective operation and of good order. Lack of and / or poor maintenance could lead to operational failure, damages, excessive crew workload and in several cases incidents affecting safety of the crew, vessel and environmental disasters.

[5] Refer to the Guidance on Near-Miss reporting (MSC-MEPC.7/Circ.7)

4.3.11. DOCUMENTATION

Procedures should be established and implemented regarding proper follow up of related documents and data as evidence that the SMS is properly implemented, monitored and controlled. Documents should be posted properly at appropriate corresponding locations, any reviews, revisions should be duly incorporated therein by authorised personnel and any obsolete ones to be disposed and/ or removed from the content of corresponding files.

Any document within the SMS constitutes the Safety Management Manual (SMM), which must be kept in a form as set more effective by the Company including shipboard manual which should be on board and kept always updated. Manuals are kept electronically and / or in hard copy and respective method of control must be clarified and documented.

4.3.12. COMPANY VERIFICATION, REVIEW AND EVALUATION

Verification of safety and prevention pollution activities duly complying with the SMS, is evidenced and duly documented by Company's internal audit procedures both on board and ashore. Audits performed mainly on annual basis, unless otherwise on demand of unscheduled audit for the purpose to verify that ISM related tasks comply with Company's responsibilities. SMS's effectiveness through established procedures should be evaluated, and corrective actions should be taken when deemed necessary.

Personnel carrying out audits should be independent to the areas being audited, unless same not feasible due to Company's structure and status. Audit results should be presented and / or relayed to all personnel directly involved to the audited field. In case of major non-conformities (included but not limited to the value of other non-conformities or deficiencies observed) Company Management and / or authorised personnel should proceed to appropriate corrective actions and / or revisions of the SMS.

4.4. PART B – CERTIFICATION AND VERIFICATION

As an evidence of compliance that the Company fulfils requirements set by the ISM Code, is the Document of Compliance (DOC) which is issued by Flag Administration or Recognised Organisation, upon successful completion of audit and review of Company's SMS. Auditing authority inspects and reviews the ship's SMS and each implementation prior to issuing a DOC.

As aforementioned, DOC is issued as evidence of Company's compliance to the Code and confirms the type of ships which may be operated by the Company (i.e. in case a Company's fleet includes bulkers, containers and/ or tankers, Company will be issued three different DOCs).

Valid for five years from the date of completion of initial audit and it is / they are subjected to Intermediate Audits (every year) compliances.

The original DOC certificate is kept within the Shipping Company while its copies to be kept to the ship along with their SMCs. The SMC means a document issued to a ship, which signifies that the Company and its shipboard management operate in accordance with the approved SMS. It is a certificate issued to an individual ship. The SMC issued by the Flag Administration after successful completion of initial audit or fulfilment or Interim SMC requirements. The validity of SMC, after initial audit is five years from the next date of expiry and it is subjected to intermediate audit.

The DOC can only be issued after an initial audit of the concerned ships with three or more months of SMS implementation. In case of any irregularity found during audit, the DOC can be then withdrawn.

Additionally there are different types of DOCs (Abhishek, 2020):

4.4.1. INTERIM DOC

An Interim document of compliance certificate is issued to a company when it is newly set up or is in a transition state, it adds a new type of vessel in its fleet or when a ship changes flag. The concerned company is then required to present an SMS implementation plan and a period of 12 months is given to comply with the ISM requirements.

The company with interim DOC shall undergo an initial audit within the 12 months period validity period of the document. For a new company, a further document review is required prior to conducting an audit by the administration. In case if a new ship is added to the fleet the company shall undergo additional audits within 12 months; the validity period of interim DOC.

4.4.2. SHORT TERM DOC

A short-term DOC is issued for five months to cover the period required to obtain a final or full-term DOC issued by Flag administration. This Document is issued by the administration auditor on the very day of satisfactory completion of initial, annual, or renewal audits.

The short-term DOC is to be kept as the proof of satisfactory completion of the audit till you receive the final full term DOC Certificate from the flag state. It is the responsibility of the flag state authority to issue a DOC or SMC; whatever appropriate prior to the expiry of Short Term Certificate.

4.4.3. FINAL DOC

The full term or final DOC is issued to a company upon the successful completion of an initial audit with full compliance to the ISM Code requirements. The issued DOC certificate shall be valid for the next 5 years from the last date of the Audit; subjected to an Annual audit report carried to ensure compliance.

In the event when the auditor finds a major Non Conformity in the audit; the DOC certificate must be withdrawn.

CHAPTER 5: IMPLEMENTATION AND MONITORING

In this chapter, reference is made to the main entities that incorporate, enforce and monitor regulations and directives produced, in the direction of safety of life at sea and pollution prevention of the marine environment to be accomplished.

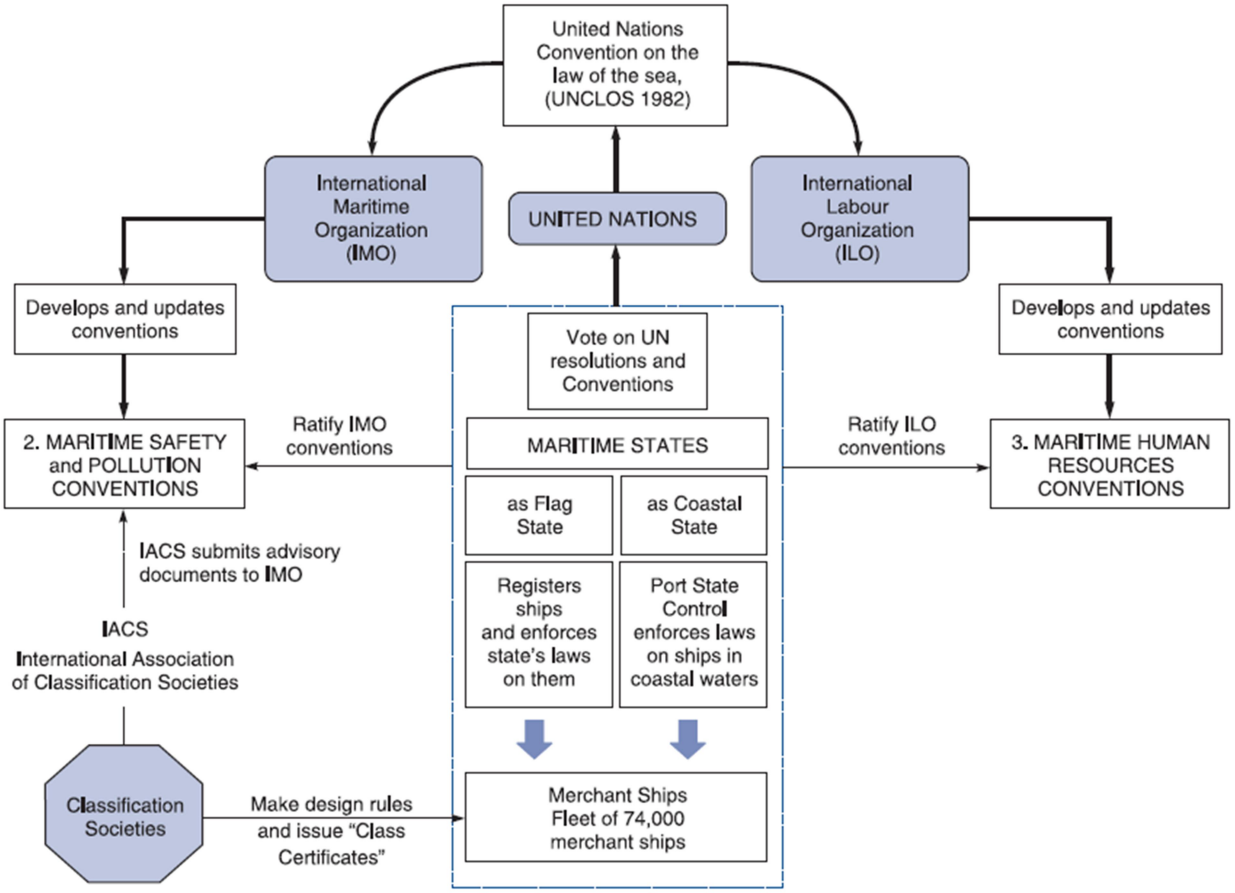


Figure 16.1

[6]

5.1. FLAG STATE ADMINISTRATION

The same way a factory or a static plant is part of a particular country, a ship needs to belong to a state, so as not to operate outside the law. Under UNCLOS provisions, every ship must sail under one flag and each country has the right to have ships flying its flag. As a vessel has to

[6] Martin Stopford, Maritime Economics, 2009, Routledge, p.657

belong to one country, it needs to comply with the state's regulations and laws. Likewise, the state may provide protection, when deemed necessary. The Flag Administration sets civil and legal frame under which ship operators may perform their economic activity, such as:

- Fiscal regimes, foreign exchange controls, fees etc.
- Legal regimes which include limitation of liability, mortgage & litigation laws
- Ownership requirements
- Bilateral or multilateral agreements which accord special rights to its ships which might include cargo sharing, taxation, and right of entry
- Manning requirements, nationality, recognition of certificates, manning scale and wage scales
- The vessel is subject to the country's exclusive jurisdiction on the high seas

The state has jurisdiction under its internal law over each ship along with its Master, officers and crew in respect of administrative, technical and social matters. Consequently, a flag country has laws and regulations covering:

- Standards of construction, equipment and survey of its ships
- The manning of ships, labour conditions and the training of crews
- Safe navigation of ships
- Reduction and control of marine pollution
- Investigation of casualties evolved on its fleet.

IMO is responsible for regulations regarding the use of the seas through several international Conventions and its main activities include safety of human life at sea, prevention of marine environment pollution, as well as the settlement by international law of the sea disputes. Along with ILO, they hold the ultimate responsibility for setting statutory requirements for shipping to address the safety and security of ships and those on board, as well as for protection of the environment. They also ensure a regulatory level playing field, allowing a compliant ship flying the flag of one State to trade internationally and in doing so, facilitating the efficiency of global trade.

A flag State that is a member of IMO, shall implement applicable international rules and standards concerning, especially, the safety of ships and persons on board and the prevention of pollution of the marine environment.

Vessels that fly the Flag of a state that is member of IMO need to comply with states' laws and regulations regarding registration of ships and with applicable international rules and standards concerning, especially, the safety of ships and persons on board and the prevention of pollution of the marine environment. Therefore valid documents that prove the right to fly its flag along with other valid relevant documents, including those required by international conventions to which the State of registration is a Party, need to be available on board.[7]

To ensure that a vessel complies with international rules and standards in force, the Flag State surveys its fleet through nominated Administration officers or surveyors of Recognised Organisations (R.O.) at periodical intervals. This procedure is also known as the External Safety Audit, during which it is examined whether specific requirements for Safety and Pollution Prevention are met.

Besides vessel's duties, the Flag state takes measures to ensure that the owner(s), operator(s) or other any person(s) held accountable for the management and operation of states' fleet can be easily identified by person that have a legitimate interest in obtaining such information, they comply with the principles of the registry and that are in accordance with the laws, regulations and ratified conventions.

Registries in general are categorised as:

- Traditional /national/ closed registries that are open only to ships of its own nation, i.e. they allow only vessels that are owned by companies or persons that are residents of that country. In a closed registry, the tax is charged on the earnings.
- Flag of Convenience /International /Open registries which have virtually no restrictions and are often suspected to register substandard vessels due to relaxation of standards. Hiring of foreign crew at wages lower than those payable to domestic crew as in national registries, and taxation based on tonnage constitute enticing benefits for the ship owners.

Each maritime authority has two different roles, first as a 'flag state' and second as a 'coastal state' (Stopford, 2009).

[7] Annex I, List of Certificates and documents required to be carried on board ships

As a ‘flag state’, it is the primary legal authority that governs the activities of merchant ships and is responsible for regulating all aspects of the commercial and operational performance of vessels flying its flag. Flag state’s participation in treaties or conventions contributes to laying down international laws.

As a ‘coastal state’, it monitors maritime laws implementation on ships that navigate in national territorial waters, through port state controls.

5.2. CLASSIFICATION SOCIETIES

The Classification Societies are independent private entities focusing on the study, development and surveillance of the technical side of ship structural safety. They establish and maintain standards for the classification of vessels and offshore structures.

To ensure vessel’s seaworthiness, diverse requirements need to be met and fulfilled regarding its structural strength, the integrity of its hull’s essential parts along with its appendages. Likewise, the authentication of the reliability and function of its propulsion, steering systems, power generation, alongside other features and auxiliary systems built into the ship, is essential r to maintain on-board services for safe operation.

Marine vessels and offshore structures are classified according to the soundness of their structure and design and need to comply with rules that are designed to ensure minimum standard of stability, safety, environmental impact etc. The process of verification that the above criteria are met is known as classification and it is usually carried out by a classification society.

They sit in a unique position when it comes to collating research and data because they are involved with ships through their entire life cycle. As such, they have first-hand data and experience of the design approval process, from new building (including the certification of materials, equipment and components) and the surveys of ships in-service.

Most of vessel’s certificates are issued by the Classification Societies for and on behalf of Flag Administrations.

5.2.1. PLAN APPROVAL – CLASSIFICATION PROCESS

Stage in which it is confirmed that the design of material, hull, equipment, outfitting, main machinery components and systems, electrical systems, cargo refrigerating installation (if

applicable), instrumentation and automation systems, lifesaving appliances, complies with Classification rules, IMO Conventions, national requirements, international standards (i.e. ISO) .

Class is assigned to vessel when relevant materials and components as mentioned above are not only designed, but also manufactured in compliance with Class Rules, International and National Regulations and recognised standards. To verify that material manufacture fulfils prerequisites, surveys (such as initial hull and initial machinery surveys) need to be carried out (IACS, 2020).

Once the vessel starts operating, a proper follow up is needed in the direction to ensure that the operation of the vessel occurs in a way that hull, equipment and machinery keep complying with Class Rules, and Statutory requirements set by Flag Administration and recognised standards in force, so that the vessel keeps being seaworthy and safe. This follow up is achieved through periodical, non-periodical and special cases surveys.

5.2.2. PERIODICAL SURVEYS

Periodical surveys include annual surveys, an intermediate survey and a class renewal/special survey (held every 5 years), bottom/docking, tailshaft and boiler surveys.

5.2.2.1. ANNUAL SURVEY

Annual survey consists of an inspection of loadline, hull, equipment and machinery items, firefighting equipment of the ship along with some tests in order for the attending surveyor to confirm that the vessel's general condition is in line with class requirements. In the case of liquid bulk carriers additional items are inspected:

Oil tankers: Deck foam and inert gas systems; steering gear; hull, machinery and equipment

Chemical tankers: Steering gear, structure, equipment, fittings, arrangements, and materials

Gas carriers: Steering gear, structure, equipment, fittings, arrangements, and materials

If annual survey is completed successfully, then the Class proceeds with endorsement of certificates.

5.2.2.2. INTERMEDIATE SURVEY

Intermediate Survey is a thorough annual survey where ballast tanks and cargo spaces are inspected additionally and is held on about half way special surveys. In the case of oil tankers, in addition to annual survey items, piping systems, cargo tanks and electrical circuits in dangerous zones are also inspected. An inspection of the keel is also essential to corroborate that its

structure hasn't been damaged/ corroded. In this case, an underwater inspection while the ship floats is arranged and further actions may be ordered, if necessary, according to the findings.

5.2.2.3. CLASS RENEWAL – SPECIAL SURVEY (S/S)

S/S includes extensive in-water and, in most cases, out-of-water examinations, to verify that the structure, main and essential auxiliary machinery, systems and equipment of the ship remain in a condition which satisfies the relevant Rules. Hull is being examined with the help of ultrasonic thickness measurements and tests as specified in classification rules and as deemed necessary by the attending surveyor. Purpose of the S/S is to evaluate the structural integrity of the vessel, to point out areas with probable corrosion, significant deformation fractures, damages or other structural deterioration that may put safety of both crew and vessel in jeopardy.

5.2.3. NON-PERIODICAL SURVEYS

Non periodical surveys are held in the cases of damage, voyage repair, and conversion in the structure of the vessel. During damage survey, the nature, location and extent of the damage is assessed so that i)the necessary repairs with a view to the unrestricted conformation of class are recorded or ii)temporary repairs and/or other measures/conditions necessary are determined in order to enable the ship to proceed to the repair harbour.

5.2.4. CHANGE OF CLASS SURVEY – IACS

Most known and trustworthy Classification societies are members of International Association of Classification Societies. The IACS has two main aims: to introduce uniformity into the rules developed by class societies and to act as the interface between class societies.

Throughout vessel's commercial and operative life, there may be a change in the classification society. For this purpose, classification societies have been under pressure from ship-owners and regulators to standardise their rules, since non-standard rules mean design work classed by one society may not be acceptable to another, causing unnecessary cost and delays.

The process of transfer of Class is simpler when both societies belong to IACS, whose members are internationally recognised:

American Bureau of Shipping (ABS)
Bureau Veritas (BV)
China Classification Society (CCS)

Croatian Register of Shipping (CRS)
Det Norske Veritas- Germanischer Lloyd (DNV GL)
Indian Register of Shipping (IRS)
Korean Register (KR)
Lloyd's Register (LR)
Nippon Kaiji Kyokai (Class NK)
Polish Register (PRS)
Registro Italiano Navale (RINA)
Russian Maritime Register of Shipping (RS)

Upon authorisation by Flag State Administration as Recognised Organisations (R.O.), Classification Societies may also conduct statutory surveys.

5.3. PORT STATE CONTROL

As already mentioned, as a 'coastal state', Flag Administration may enforce maritime laws on ships sailing within its national territorial waters. Coastal states bear the responsibility to ensure that activities within their jurisdiction don't cause damage to the environment.

Port Sate Control (PSC) is the operational, functional, statutory inspection within which national authorities inspect vessels of foreign Administrations under scope of verifying compliance of the vessel and its equipment with the requirements of international regulations, as well as its manning and operation compliance with these rules.

Most IMO's important technical conventions contain provisions for ships to be inspected when they visit foreign ports to ensure that they meet requirements of below mentioned Conventions:

- International Convention on Load Lines, 1966, as amended;
- Protocol of 1988 relating to the International Convention on Load Lines, 1966, as amended;
- International Convention for the Safety of Life at Sea, 1974, as amended;

- Protocol of 1978 relating to the International Convention for the Safety of Life at Sea, 1974;
- Protocol of 1988 relating to the International Convention for the Safety of Life at Sea, 1974;
- International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978 relating thereto, as amended;
- International Convention on Standards for Training, Certification and Watchkeeping for Seafarers, 1978, as amended;
- Convention on the International Regulations for Preventing Collisions at Sea, 1972;
- International Convention on Tonnage Measurement of Ships, 1969;
- Merchant Shipping (Minimum Standards) Convention, 1976 (ILO Convention No. 147);
- Maritime Labour Convention, 2006, as amended;
- International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001;
- Protocol of 1992 to amend the International Convention on Civil Liability for Oil Pollution Damage, 1969; and
- International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004

Port State Controls started as a backup to Flag State regulations implementation (IMO, 2019). Practice, though, has shown that they can be very effective due to the facts that regular inspections ensure that regulation implementation is done on a daily and regular basis, not only in the event of external safety audits. PSC constitute direct and effective means to reduce the number of substandard ships along with their contribution to improve safety of ships at sea and to prevent marine pollution.

5.3.1. MEMORANDUM OF UNDERSTANDING (MoU)

Accordingly, a recommendation concerning regional cooperation in the control of ships and discharges was adopted by the IMO. As a result of this resolution, it was the Paris Memorandum of Understanding (Paris MoU) in July 1982, which formed the first regional cooperation by gathering 14 European countries. Since then, several countries have signed and accepted similar MoU's around the world with the scope of eliminating substandard shipping, ensuring maritime safety and prevention of pollution. Nowadays, below regional collaborations have been formed:

- European and North Atlantic Regional Memorandum of Understanding (Paris MoU): It was established on 1st July 1982 by 14 European countries. Nowadays, 27 maritime Administrations have signed the Paris MoU, covering the waters of the European Coastal States and the North Atlantic basin from North America to Europe. Paris MoU aim is to eliminate the operation of substandard ships through and harmonized system of Port State Controls.
- Asia-Pacific Region (Tokyo MoU): It was formed on 1st December 1993 and consists of 21 maritime authorities, aiming to the establishment of an effective PSC regime in the Asia-Pacific region through the cooperation of its member and the harmonization of their activities, to the elimination of substandard shipping so as to promote maritime safety, to the protection of the marine environment and to safeguard working and living conditions onboard ships.
- Latin American Region (Acuerdo de Viňa del Mar) founded in 1992 including 15 maritime authorities of Central and South America countries.
- Caribbean Region (Caribbean MoU) was established in 1996. It counts 20 maritime authorities with mission and main objectives the elimination of substandard ships in the region through harmonised PSC system and securing compliance of ships with international conventions/standards
- Mediterranean Region (Mediterranean MoU) formed in 1995 and consists of ten maritime authorities.
- Indian Ocean Region (Indian Ocean MoU) founded in 1999 and counts 20 maritime authorities.
- Black Sea Region (Black Sea MoU) was established in 2000 consists of 6 maritime authorities.
- West and Central Africa Region (Abuja MoU) came into effect in 1999, composed of 18 maritime authorities.
- Arab Stated of the Gulf (Riyadh MoU) established in 2004 aiming to achieve safe, secure and efficient shipping in the maritime jurisdictions in the Gulf region and consists of six maritime authorities.
- United States Coast Guard (USCG) may not be member of any MoU, but is an observer at several MoUs and undertakes effective PSC in cooperation with them. The coast guard

carries out three basic roles, which are further subdivided into 11 statutory missions. The three roles are maritime safety, maritime security and maritime stewardship.

- Australian Maritime Safety Authority (AMSA) is a statutory authority responsible for the regulation and safety oversight of Australia's shipping fleet and management of Australia's maritime obligations. The authority has jurisdiction over Australia's exclusive economic zone and was established in 1990. AMSA aims to protect the marine environment by administering programs to prevent and respond to the threat of ship-sourced marine pollution and together the Australian Marine Oil Spill Centre, managing Australia's National Plan to combat pollution of the sea by oil and other noxious and hazardous substances.

Forming regional cooperation ensures PSC effectiveness; makes vessel's monitoring easier among same MoU's maritime administrations and saves time from unnecessary inspections. Paris MoU and Tokyo MoU inspectors follow up THETIS database with findings from inspections, national PSC are informed on ships due for inspection providing data on ship's particulars, previous reports within MoU and then each vessel is assigned a Ship Risk Profile (SRP), which determines priority for inspection.

If there are clear grounds that a vessel does not comply with the operational requirements of international conventions (i.e. SOLAS, MARPOL), Port State has the authority to detain a ship from proceeding to the sea, until these deficiencies are rectified at its satisfaction.

If a deficiency is raised in one vessel that needs to be rectified before arriving to following port, relevant port authority is notified in order to follow up rectification. In this way, Port State Control contributes directly in monitoring of regulations application and indirectly in the elimination of substandard ships from the shipping industry.

5.3.2. MoU ANNUAL REPORTS

Every year, MoUs' publish annual reports on Port State Control regarding inspections, their findings and outcome (deficiencies, detentions) based on which Flag Administrations are categorised in black, grey and white flags. The "White, Grey and Black (WGB) list" presents the full spectrum, from quality flags to flags with a poor performance that are considered high or very high risk. The list results from a total number of inspections and detentions over a 3-year rolling period for flags with at least 30 inspections in the period (Paris MoU, 2021). Should any vessel be put in any MoU's black list, it is more likely that PSC will board to inspect it. As per

annual reports uploaded to Electronic Quality Shipping Information System (EQUASIS, 2020), categories with most deficiencies issued are:

- Certificates & Documentation: deficiencies related to ships' trade & statutory certificates, crew certificates and other important documents as they were found missing or expired.
- Safety of Navigation: up to date nautical publications, officers' inadequate familiarisation with Electronic Chart Display and Information System (ECDIS) etc.
- Fire safety: deficiencies concerning (but not limited to) oil accumulation in engine room, firefighting equipment readiness, fire detection & alarm system, fire doors/openings in fire resisting divisions
- Pollution prevention: deficiencies regarding (among others) oil filtering equipment, control of discharge, pumping, piping and discharge arrangements, oil discharge monitoring and control systems, oil & oily mixtures from machinery spaces, antifouling plan, ballast water treatment system
- Working and living conditions: requirements of Maritime Labour Convention (MLC 2006) are not duly met
- Safety Management: deficiencies raised in fields of maintenance of ship & equipment, safety and environmental policy, reports of accidents and hazardous occurrences, emergency preparedness among others.

CHAPTER 6: IMPORTANCE OF THE ISM CODE

6.1. LEGAL ASPECTS OF THE ISM CODE

Every Company whose Flag Administration is signatory to SOLAS Convention, is obliged to operate in compliance with the ISM Code, therefore a valid DOC and respective SMC(s) need to be issued for its fleet to operate legally .

At evidence of major non-conformities, the Flag Administration may withdraw DOC and respective SMC(s), which constitutes failure to comply with the Code, thus supporting an action in negligence and/or breach of a statutory duty of care. Consequently, this occurrence may lead to termination of insurance cover, since Clause 13.1 of the International Hull Clauses requires:

> *"the Owners or the party assuming responsibility for operation of the vessel from the Owners shall hold a valid Document of Compliance in respect of the vessel as required by chapter IX of the International Convention for the Safety of Life at Sea (SOLAS) 1974 as amended and any modification thereof"*

If a Company and its fleet do not comply with regulations signed by Flag Administration, then the Administration may waive coverage provided, occurrence that can affect civil legal information (as mentioned in paragraph 5.1) associated to the ship, which is important to financing of the vessel (banks, investors). Any cancellation or withdrawal of above-mentioned certificates may endanger financial capacity of owners' company.

6.2. PROPER MAINTENANCE

As mentioned in paragraph 4.3.10, lack and/or poor maintenance could affect safety of the crew, vessel and may result in environmental disaster. A thoroughly implemented PMS can not only prevent the above, but also can preserve (even increase) vessel's value, feature important in conclusion of a loan agreement. In addition, proper maintenance reduces potential non-conformities that may lead to insurance claims or increased insurance premiums and prolongs equipment fitness to use before its wear and tear.

CHAPTER 7: CONCLUSION

This essay was written in the aim of accentuating the need to monitor implementation of regulations produced to mitigate pollution of the marine environment caused by shipping industry.

Acknowledging shipping industry's connection with pollution of the marine environment (see ch.3) was the first step towards finding a solution on reducing oil pollution caused by ocean borne transport. Subsequently, MARPOL 73/78 set regulations broadening sources of marine environment pollution originated by vessels.

ISM Code's aim is to instil a sense of safety and environmental consciousness which should be reflected in policies drawn, thus implemented. Incorporation of the ISM Code in SOLAS Convention established communication between the vessel and the Company, curtailing Company's unawareness of policies' inadequate implementation on board.

DOC withdrawal at evidence of major non-conformity, which constitutes noncompliance to the Code, may induce legal and financial sanctions than could cast doubt upon Company's solvency. Practice has shown that safety and prevention pollution are usually superseded by profit (Theotokas, 2018), therefore further research could point out benefits and /or losses due to non-compliance to the ISM Code.

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ANNEX A

FAL.2/Circ.131
MEPC.1/Circ.873
MSC.1/Circ.1586
LEG.2/Circ.3
19 July 2017

LIST OF CERTIFICATES AND DOCUMENTS REQUIRED TO BE CARRIED ON BOARD SHIPS, 2017

1. All ships to which the referenced convention applies

International Tonnage Certificate (1969)
International Load Line Certificate
International Load Line Exemption Certificate
Coating Technical File
Emergency Towing Procedure
Construction drawings
Ship Construction File
Noise Survey Report
Stability information
Damage control plans and booklets
Manoeuvring booklet
Evaluation of the alternative design and arrangements
Maintenance plans
Onboard training and drills record
Fire safety training manual
Fire control plan/booklet
Fire safety operational booklet
Operations manual for helicopter facility
Statement of acceptance of the installation of replacement release and retrieval system to an existing lifeboat
Muster list and emergency instructions
Ship-specific Plans and Procedures for Recovery of Persons from the Water
Training manual
Radio record
Minimum safe manning document
Voyage data recorder system – certificate of compliance
AIS test report
Nautical charts and nautical publications
LRIT conformance test report
International Code of Signals and a copy of Volume III of IAMSAR Manual

Records for pilot ladders used for pilot transfer
Records of navigational activities
Cargo Securing Manual
Material Safety Data Sheets (MSDS)
Safety Management Certificate
Document of Compliance
Continuous Synopsis Record (CSR)
Ship Security Plan and associated records
International Ship Security Certificate (ISSC) or
Interim International Ship Security Certificate
International Oil Pollution Prevention Certificate
Oil Record Book
Shipboard Oil Pollution Emergency Plan
International Sewage Pollution Prevention Certificate
Document of approval for the rate of sewage discharge
Garbage Management Plan
Garbage Record Book
International Air Pollution Prevention Certificate
International Energy Efficiency Certificate
Ozone-depleting Substances Record Book
Fuel Oil Changeover Procedure and Logbook (record of fuel changeover)
Manufacturer's Operating Manual for Incinerators
Bunker Delivery Note and Representative Sample
EEDI Technical File
Ship Energy Efficiency Management Plan (SEEMP)
Technical File
Record Book of Engine Parameters
Certificates for masters, officers or ratings
Records of daily hours of rest
International Anti-fouling System Certificate
Declaration on Anti-fouling System
International Ballast Water Management Certificate
Ballast Water Management Plan
Ballast Water Record Book
Certificate of insurance or other financial security in respect of civil liability for bunker oil pollution damage
Certificate of insurance or other financial security in
respect of liability for the removal of wrecks

2. In addition to the certificates listed in section 1 above, passenger ships shall carry:

Passenger Ship Safety Certificate
Decision support system for masters
Search and rescue cooperation plan
List of operational limitations

Special Trade Passenger Ship Safety Certificate,
Special Trade Passenger Ship Space Certificate

Certificate of insurance or other financial security in respect of liability for the death of and personal injury to passengers

3. In addition to the certificates listed in section 1 above, cargo ships shall carry:

Cargo Ship Safety Construction Certificate

Cargo Ship Safety Equipment Certificate

Cargo Ship Safety Radio Certificate

Cargo Ship Safety Certificate

Ship Structure Access Manual

Cargo Information

Bulk Carrier Booklet

Document of authorization for the carriage of grain and grain loading manual

Enhanced survey report file

Dedicated Clean Ballast Tank Operation Manual

Condition Assessment Scheme (CAS) Statement of Compliance, CAS Final Report and Review Record

Subdivision and stability information

Record of oil discharge monitoring and control system for the last ballast voyage

Oil Discharge Monitoring and Control (ODMC)
Operational Manual

Crude Oil Washing Operation and Equipment Manual (COW Manual)

STS Operation Plan and Records of STS Operations

VOC Management Plan

Document of approval for the stability instrument

Certificate of insurance or other financial security in respect of civil liability for oil pollution damage

Certificate of insurance or other financial security in respect of civil liability for oil pollution damage

4.In addition to the certificates listed in sections 1 and 3 above, where appropriate, any ship carrying noxious liquid chemical substances in bulk shall carry:

International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk (NLS Certificate)

Cargo Record Book

Procedures and Arrangements Manual (P & A Manual)

Shipboard Marine Pollution Emergency Plan for Noxious Liquid Substances

5.In addition to the certificates listed in sections 1 and 3 above, where applicable, any chemical tanker shall carry:

Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk Or International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk

6.In addition to the certificates listed in sections 1 and 3 above, where applicable, any gas carrier shall carry:

Certificate of Fitness for the Carriage of Liquefied Gases in Bulk

International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk

7.In addition to the certificates listed in sections 1, and 2 or 3 above, where applicable, any high-

speed craft shall carry:

High-Speed Craft Safety Certificate

Permit to Operate High-Speed Craft

8.In addition to the certificates listed in sections 1, and 2 or 3 above, where applicable, any ship carrying dangerous goods shall carry:

Document of compliance with the special requirements for ships carrying dangerous goods

9.In addition to the certificates listed in sections 1, and 2 or 3 above, where applicable, any ship carrying dangerous goods in packaged form shall carry:

Transport information

Dangerous goods manifest or stowage plan

10.In addition to the certificates listed in sections 1, and 2 or 3 above, where applicable, any ship carrying INF cargo shall carry:

International Certificate of Fitness for the Carriage of INF Cargo

11.In addition to the certificates listed in sections 1, and 2 or 3 above, where applicable, any Nuclear Ship shall carry:

Operating Manual for nuclear power plant

A Nuclear Cargo Ship Safety Certificate or Nuclear Passenger Ship Safety Certificate, in place of the Cargo Ship Safety Certificate or Passenger Ship Safety Certificate, as appropriate.

12.In addition to the certificates listed in sections 1, and 2 or 3 above, where applicable, any Ship operating in Polar waters shall carry:

Polar Ship Certificate

Polar Water Operational Manual (PWOM)

Special purpose ships

Special Purpose Ship Safety Certificate

Offshore support vessels

Offshore Supply Vessel Document of Compliance

Certificate of Fitness for Offshore Support Vessels

Diving systems

Diving System Safety Certificate

Passenger submersible craft

Safety Compliance Certificate for Passenger Submersible Craft

Dynamically supported craft

Dynamically Supported Craft Construction and Equipment Certificate

Mobile offshore drilling units

Mobile Offshore Drilling Unit Safety Certificate

Wing-In-Ground (WIG) Craft

Wing–in–ground Craft Safety Certificate

Permit to Operate WIG Craft

Noise levels

Noise Survey Report

ANNEX B

REGIONAL MoU's LATEST ANNUAL REPORTS

Annual Reports where deficiencies per category are recorded:

PARIS MoU: https://www.parismou.org/2020-paris-mou-annual-report-"dealing-pandemic"

TOKYO MoU: http://www.tokyo-mou.org/doc/ANN20-f.pdf

ACUERDO DE VIÑA DEL MAR: https://alvm.prefecturanaval.gob.ar/

CARRIBEAN MoU: https://caribbeanmou.org/sites/default/files/annual_report_2019b.pdf

MEDITERRANEAN MoU: http://medmou.org/Annual_rep.aspx

INDIAN OCEAN MoU: https://iomou.org/HOMEPAGE/pdf/Annual_Report/AnrRep2020.pdf

BLACK SEA MoU: http://www.bsmou.org/downloads/annual-reports/BSMOU-AR-2020.pdf

ABUJA MoU: http://www.abujamou.org/index.php?pid=jfjygkghjstat19

RIYADH MoU: https://riyadhmou.org/annualreport.html

USCG:https://www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/CG-5PC/CG-CVC/CVC2/psc/AnnualReports/annualrpt2020a.pdf

AMSA: https://www.amsa.gov.au/port-state-control-australia-2020-annual-report