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Implementation of the BWM Convention in Zhoushan Port

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IMPLEMENTATION OF THE BWM CONVENTION IN ZHOUSHAN PORT

By

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DECLARATION

I certify that all the material in this dissertation that are not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

Signature: ……..

Date: ……..

Supervised by: ……..

Supervisor's affiliation: ……..

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ABSTRACT

Title of Dissertation: **Implementation of the BWM Convention in Zhoushan Port**

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The International Convention for the Control and Management of Ship Ballast Water and Sediment 2004 (hereinafter referred to as the BWM Convention), which came into force in 2019, has a significant impact on Zhoushan with marine related industries as its pillar industries.

This paper briefly introduced the historical background of BWM Convention and the basic situation of Zhoushan port. Secondly, by using the methods of literature research and data comparison, this paper discussed the relevant measures about implementation of BWM Convention. In order to better improve the relevant domestic laws and regulations, the paper put forward own views. At the same time, this paper called on the competent authorities to actively explore more effective port state control methods, which can appropriately learn the excellent ideas and decision-making of the Convention from other countries. Finally, the paper compared the advantages and disadvantages of the ballast water management system (hereinafter referred to as BWMS) and the port receiving facilities as well as the challenges faced, and put forward the ballast water treatment methods and suggestions which are suitable for the actual situation of Zhoushan port.

Also,this paper analyzed the impact of the Convention on Zhoushan Port industries, the actual cases and relevant documents of various law enforcement departments of

the government, aiming to sort out their respective responsibilities. In addition, the article compared and sorted out the domestic laws and regulations and the implementation methods of each department, and then put forward constructive and targeted opinions.

Finally, by comparing the cost and practical operability of different processing methods, it concludes that the BWM Convention requires all parties to cooperate, regardless of the legislation, the supervision of the port state, or the technology of ballast water treatment. In the case of the port of Zhoushan, the government should provide funds and policies for ships that need to be added to BWMS, and encourage the installation of BWMS. Besides, the competent authorities and the relevant enterprises should increase the cost of investment, actively build the port reception facilities, and strive to improve the overall performance of the port of Zhoushan.

KEYWORDS: BWM CONVENTION 2004, PSC, ZHOUSHAN PORT

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LIST OF ABBREVIATIONS

BWM	Ballast water management
BWMS	Ballast water management system
DMU	Dalian maritime university
EBP	Experience-building phase
GDP	Gross Domestic Product
GEF	The global environmental protection fund
IMO	International Maritime Organization
MEPC	Marine Environmental Protection Association
PSC	Port State Control
PSCO	Port State Control Officer
USCG	The United Stated Coast Guard
UNCED	The United Nations Conference on Environment and Development
UNDP	The United Nations Development Programme
UV	Ultraviolet
VLCC	Very large crude carrier
VLOC	Very Large Ore Carrier
WMU	World maritime university

CHAPTER 1 INTRODUCTION

1.1 Research methodology and purpose

By using the methods of literature review and qualitative analysis, this paper discusses the relevant measures to deal with the BWM Convention and the implementation suggestions under the background of Zhoushan port. The contents include: improving the relevant domestic laws and regulations; actively exploring more effective port state control methods; properly learning the excellent ideas and decisions of the United States Coast Guard (USCG); comparing the advantages and disadvantages of ballast water management system and port reception facilities, as well as the challenges to be faced; and the ballast water treatment methods and suggestions suitable for the actual situation of Zhoushan port. At the same time, this paper also analyzes the impact of the Convention on the industry of Zhoushan port, and clarifies their respective responsibilities by combining with the actual cases and relevant documents of various law enforcement departments of the government.

The author expects that through these studies and discussions, some ideas and suggestions could be provided for the government and the maritime administration, and help shipping enterprises to actively respond to the BWM Convention. At the same time, it is also hoped that Zhoushan government and Zhoushan maritime administration can provide more targeted suggestions and methods for the implementation of the Convention.

1.2 Background

With the rapid development of international trade and shipping industry, ballast water loading and discharging in the world is increasing. More and more international

organizations and countries are paying attention to the health, environmental protection, marine ecology and other issues caused by ships' ballast water carrying alien organisms and pathogens. The invasion of alien organisms caused by the discharge of ballast water from ships has become the main way for the spread of harmful organisms in the ocean. It is listed as one of the four threats to the ocean by the world environmental protection foundation. It is unable to repair the marine environment through artificial improvement measures, so its impact on the marine ecological environment is often irreversible. It is estimated that the global ships carry about 12 billion tons of ballast water every year, and there are as many as 7000 species of creatures in the ballast water that travel around the world with ships every day (Zhou, Z. S., Duan, G. J., Sun, Y. P. & He, S. H., 2011).

IMO attaches great importance to the marine environmental problems caused by ship ballast water. Besides, since the end of 1980s, it has carried out a comprehensive study on bringing the problem of ship ballast water into the agenda of its marine environmental protection committee. In 2004, the International Maritime Organization (IMO) adopted the International Convention for the Control and Management of Ship Ballast Water and Sediment 2004 (hereinafter referred to as the BWM Convention), which entered into force on September 8, 2017 and China on January 22, 2019. Figure1, 2 and 3 show the development of BWM Convention.

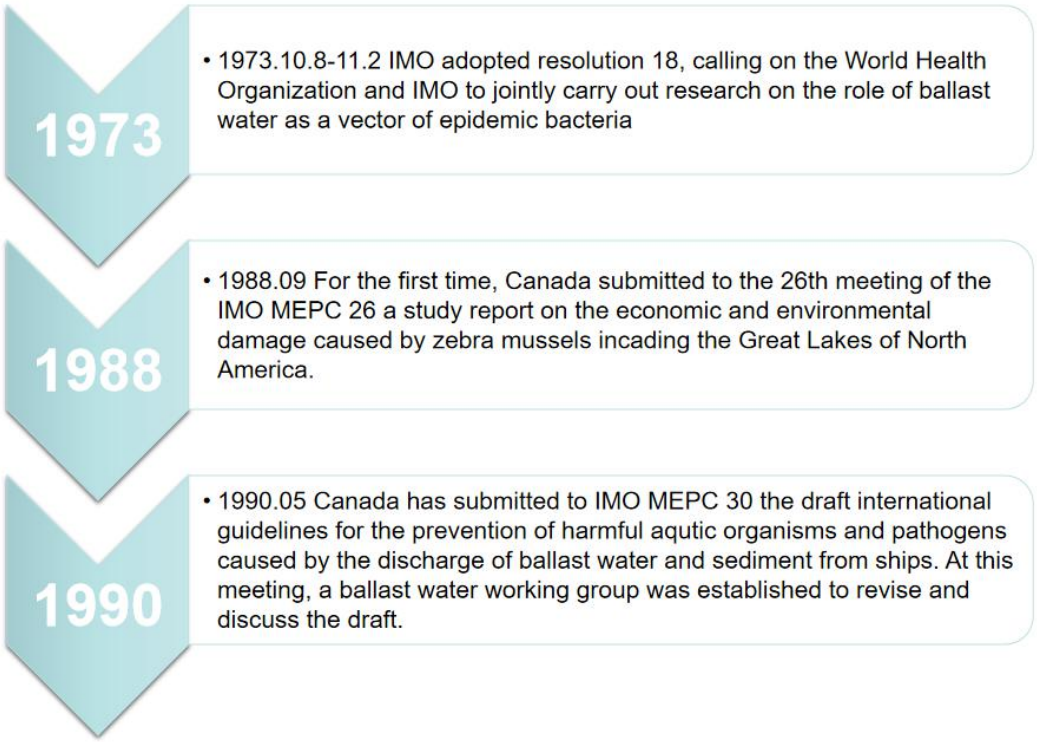

Figure 1 - The development of BWM Convention 3-1

Source: compiled by author based on Li, S.B. Huang, Y.Y. (2018). Research on the legislative development of the IMO Ballast Water Convention. *Journal of Shanghai Ocean University, 27(3).*

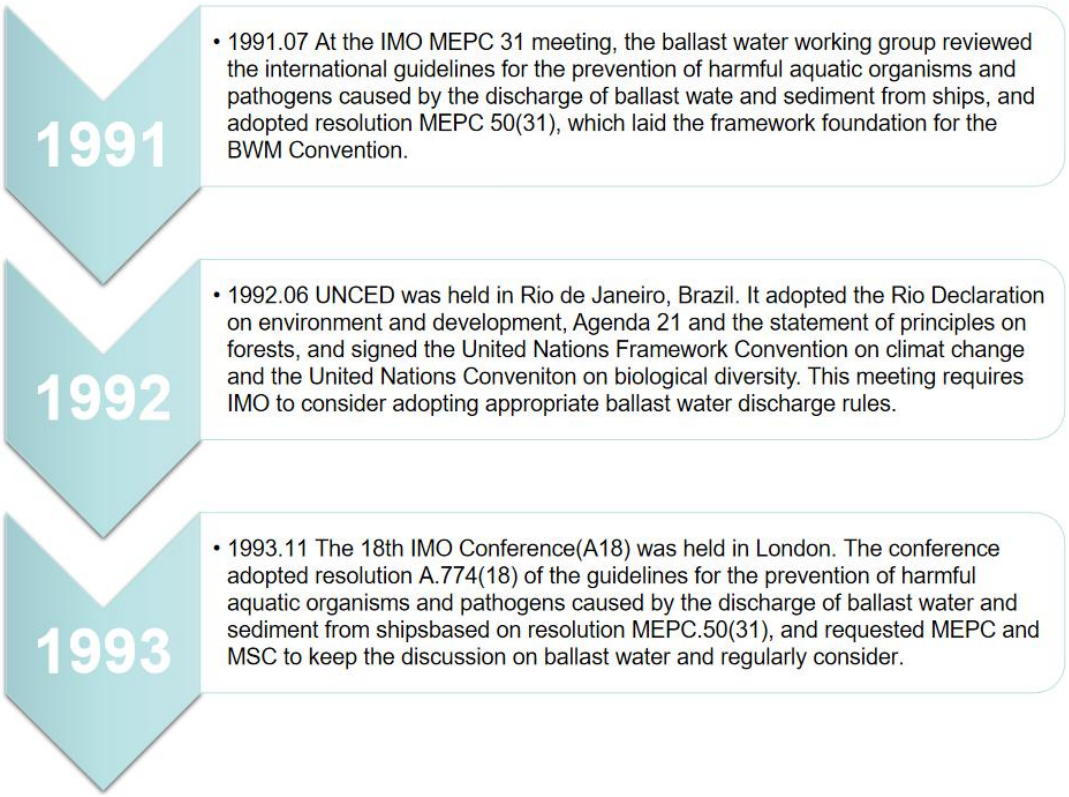

Figure 2 - The development of BWM Convention 3-2

Source: compiled by author based on Li, S.B. Huang, Y.Y. (2018). Research on the legislative development of the IMO Ballast Water Convention. *Journal of Shanghai Ocean University, 27(3).*

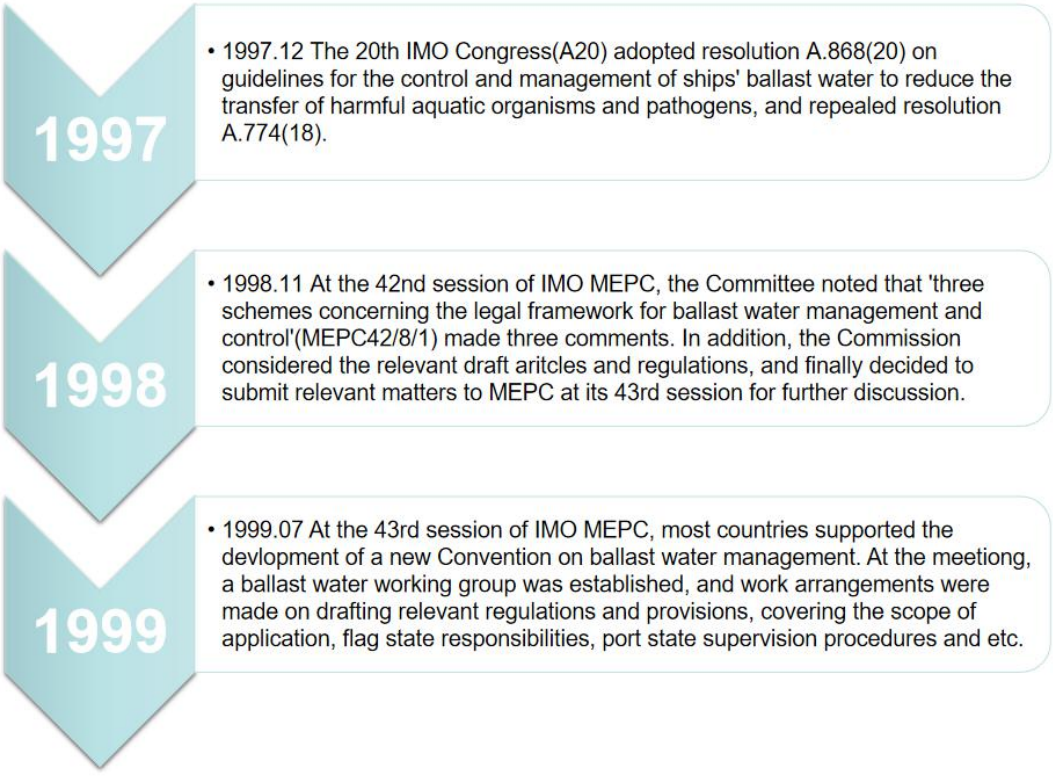

Figure 3 - The development of BWM Convention 3-3

Source: compiled by author based on Li, S.B. Huang, Y.Y. (2018). Research on the legislative development of the IMO Ballast Water Convention. *Journal of Shanghai Ocean University, 27(3).*

1.2.1 Current situation of ballast water management in China

China is not only a big port country but also a big flag country with backward ballast water management to some extent. In January 2019, China formulated these measures in accordance with the marine environment protection law of the People's Republic of China, the law of the People's Republic of China on the Prevention and Control of Water Pollution, the Regulations on the Administration of the Prevention and Control of Marine Environment from Ship Pollution and other laws and regulations as well as BWM convention. Although the regulations regulate the work system and supervision content of ballast water management to a large extent, the multi-management mode of various competent authorities in China is not conducive to the management of ballast water problems (Fei, S. S.& Zhu, X. M., 2018).

In China, ballast water management is mainly led by maritime department and health and quarantine organ, and other competent departments of transportation, ocean and fishery are involved, but the rights and responsibilities are not clear. The main responsibilities of the maritime administration are to supervise and inspect the management of ballast water and sediment of ships entering the waters under jurisdiction of China, including certificate documents, the familiarity of crew members with ballast water management operation, the operation of ballast water management system and the acceptance and disposal of ballast water and sediment, etc. At present, the frontier health and quarantine organ's management of ballast water of entry ships is mainly based on the provisions of paragraph 6, Article 78 of the detailed rules for the implementation of the frontier health and Quarantine Law of the

People's Republic of China: human excreta, garbage, waste water, waste and ballast water loaded from the cholera epidemic area shall not be discharged or removed without disinfection, The ballast water of ships from countries or regions with quarantinable infectious diseases shall be quarantined and sanitized. Ballast water from non quarantine epidemic areas is generally required to be replaced on the high seas, but there is no clear requirement for the replacement standard, the law enforcement scale is often difficult to be unified, and it is difficult to form effective control and management of ballast water of these ships. However, it is often the invasive marine organisms and pathogens carried by ballast water that cause a certain degree of pollution to our marine environment (Liu, M. J., Li, Z. S., Yu, J., Zhang, H. W., Gu, J.& Jia, S. Z., 2007).

According to the requirements of other countries, some ocean going ships in our country have begun to implement ballast water replacement, which can meet the D-1 standard, and some ships to the United States can meet the D-2 standard. However, due to the lack of relevant domestic legislation on ballast water in our country at present, the relevant competent departments can not effectively implement the inspection requirements for ocean going ships to other countries. In 2015, China Classification Society issued a BWM Convention guide, which analyzed and sorted out the control and management requirements, difficulties in the implementation process, progress of the Convention, implementation suggestions, arrangement of ballast water management system, and laid a good foundation for ballast water management and technical guidance in China. However, the guide can not be equated with laws and regulations after all. Therefore, in the face of the inevitable process of performance, China needs to make corresponding countermeasures in legislation, technical equipment, institutional mechanisms and other aspects (Li, L. N., 2016).

1.3 Zhoushan Port Introduction

Zhoushan is located at the T-junction of China's north-south sea transportation and Yangtze River water transportation. Figure 4 shows the location of Zhoushan Port. It is the only channel for the Yangtze River to connect with the open sea. It is not only the Yangtze River Delta, but the entire Yangtze River basin that backs Zhoushan. With Zhoushan Islands as the center, covering 500 nautical miles to the north, Fujian, Guangdong and Taiwan to the south, Busan, South Korea and Osaka, Japan to the East, and Zhoushan Islands as the economic hub for bulk commodity transit trade. At present, 6 of the 7 international ocean routes in China pass through Zhoushan sea area.

Figure 4 - Zhoushan's location

Source: complied by author based on Baidu Map.

Zhoushan is the city with the highest proportion of marine economy in China. In the

past five years, the proportion of added value of marine economy in GDP has changed from 68.6% to 70.2%. Zhoushan has the advantages of marine land resources and regional resources. The development of marine resources and marine economic progress also have a profound impact on the development of Zhoushan in all aspects (Zhang, L. S.& Chen, J. N., 2017).

Fishery is the traditional industry of Zhoushan, and marine fishing industry is also the traditional pillar industry of Zhoushan, Zhejiang Province. About 50% of Zhoushan's population is directly or indirectly engaged in marine fishery related work. The development of Zhoushan's marine economy depends on the marine resources in its area. Fishery has always been the traditional supporting industry of Zhoushan, which plays an important role in the proportion of Zhoushan's economy (Zhoushan decision advisory committee, 2010).

The marine environment is an important part of the global environment, and marine resources are closely related to people's lives. With the rapid development of modern economy and science and technology, the field of ocean is also receiving great attention. In recent years, with the extensive application of modern marine production technology, the marine ecological environment of Zhoushan fishing ground has been seriously polluted under the current imperfect marine resources protection and marine environment management measures (Shi, C. Y., Bai, W. W., Chen, L. Q., Chen, B. F., Li, W. D.& Yang, H. Y., 2017).

With the increase of people's social production activities, a large number of wastes are produced, which are mostly discharged without treatment. The main pollution sources are oil, heavy metals, acid and alkali, pesticides, etc., which cause the water quality of Zhoushan fishing ground to be polluted. In 2016, Zhoushan City monitored 18 sewage outlets from land-based sources into the sea. The main types of sewage outlets from

land-based sources into the sea are municipal, electroplating, textile printing and dyeing and other industries, with a total discharge of 24.8 million tons of sewage and a total discharge of 2343.5 tons of major pollutants. A large number of over standard sewage is discharged into Zhoushan coastal waters, causing damage to the water quality. The continuous deterioration of the water quality of the fishing ground leads to the imbalance of the ecosystem of the fishing ground, and the decrease of the diversity index of phytoplankton, zooplankton and Macrobenthos in the sea area, which results in the single composition of the biological structure, affects the ecosystem function of the whole fishing ground, and the self-regulation function gradually weakens (Zhu, W. D.& Jiang, Y. T., 2019).

In Zhoushan port, although the total amount of pollutants caused by ballast water displacement and discharge is not as large as the data from land-based pollution, even if the extremely small organisms in ballast water cause biological invasion to Zhoushan sea area, its negative impact will be far greater than that of land-based pollutants.

1.4 Structure of dissertation

This paper consists of five chapters. The first chapter reviews the historical background of the BWM Convention and introduces the basic situation of Zhoushan port. Then, the second chapter introduces the existing domestic and international legal framework, describes the regulatory status and deficiencies of the relevant supervisors, and puts forward relevant suggestions. The third chapter discusses the current situation of port state supervision and management, and analyzes the difficulties and challenges from all parties in the process of implementation. At the end of the 3rd chapter, it is proposed to learn from the United States USCG excellent experience and decision-making management. The first part of the fourth chapter mainly describes

the application status quo of BWMS and port reception facilities and the comparison of their advantages and disadvantages, and draws a conclusion: compared with BWMS, the state and local governments should actively promote and build ballast water port reception and treatment devices. The last part of the fourth chapter discusses the ballast water treatment method suitable for the actual situation of Zhoushan port and ship type, and draws the conclusion that BWMS and port reception equipment should exist simultaneously. The last chapter is the conclusion and suggestions including the limitation of the study and digital disruption comment.

CHAPTER 2 DOMESTIC STATUS ON REGULATIONS AND MEASURES

2.1 Existing legal framework

In this chapter, the international conventions on ballast water and sediment, as well as the corresponding domestic laws and regulations, would be scrutinized in the following sections of this chapter.

2.1.1 International part

The issue of ballast water is a global problem. The formation and promotion of BWM Convention include the unremitting efforts and advancement of various international organizations in the world. There are 22 articles and a technical annex to the Convention. The core objective of the Convention is to eliminate the risks to the environment, human health, property and resources caused by the transfer of harmful aquatic organisms and pathogens in ship's ballast water and sediment through harmless treatment.

The MEPC-50 (31) resolution was adopted by the Marine Environmental Protection Association (MEPC) in June 1991, marking the entry into force of the guidelines for the prevention of the introduction of harmful species and pathogens from ship ballast water and its sediments. In June 1992, the United Nations Conference on Environment and Development (UNCED) adopted Agenda 21. It emphasized that governments should strengthen the prevention of marine degradation, put forward the necessary management of ship ballast water discharge and formulate appropriate rules. Subsequently, IMO adopted resolution A.774 (18) in November 1993, namely guidelines for the prevention of the introduction of harmful organisms and pathogens into ballast water and its sediments. In November 1997, IMO adopted resolution A.868 (20) to issue the guidelines for the control and management of ship ballast

water and the reduction of the migration of harmful aquatic organisms and pathogens. In 1999, the International Maritime Organization (IMO) cooperated with the United Nations Development Programme (UNDP) and the global environmental protection fund (GEF) to assist developing countries to implement the IMO guidelines, namely the global project ballast water management project, and began to prepare for the formulation of the BWM Convention (Wang, S., Liu, Y., Wang, H. X.& Liu, B. Z., 2011).

2.1.2 Domestic part

The International Convention on the control and management of ballast water and sediment for ships came into force on September 8, 2017, and was formally implemented in China on January 22, 2019. At present, the Convention has been extended to the Hong Kong Special Administrative Region and entered into force on August 13, 2020.

China is not only a big port country, but also a flag country, however, the legislation of ballast water management is backward. In order to protect the marine environment, China promulgated and implemented the marine environment protection law of the People's Republic of China as early as 1982. In December 1983, the state promulgated and implemented the regulations on the prevention of marine pollution by ships and the regulations of the people's Republic of China on the prevention of marine pollution by ships. Three years later, the state promulgated the regulations on the prevention of pollution and damage to the marine environment by land-based pollutants, the regulations on the prevention of pollution and damage to the marine environment by coastal construction projects, and the prevention of pollution and damage to the environment by ship dismantling Regulations, etc. On February 25, 1999, the 13th meeting of the Standing Committee of the Ninth National People's

Congress revised the marine environment protection law of the people's Republic of China, which came into force on April 1, 2000. So far, China has formed a relatively perfect law and regulation on the supervision and management of marine pollution prevention. However, the legal system is mainly to prevent the marine environment from being polluted by land-based pollutants and ship oil. It does not involve too much into the biological invasion and pathogen transmission caused by ship ballast water and its sediments (Wang, S.,et al, 2011).

At present, there is no special law for ecological invasion in China. A small number of legal provisions related to the invasion of marine alien species and the spread of harmful pathogens are covered in the marine environmental protection law, the law of entry and exit animal and plant quarantine, the frontier health and Quarantine Law and the Fisheries Law. These laws are drafted by various competent departments. Their purpose is to protect the quality of marine environment, human health, prevent diseases and insect pests, and protect aquatic resources. The purpose of legislation is relatively clear. These laws hardly consider the ecological safety and ecological balance in the legislative process, so that in the existing legal system, there is no accountability system for protecting marine ecological safety. Various relevant competent authorities manage according to different purposes (Chen, Q. Cao, X. G. Hou, Y. Z.& Wang, Y., 2012). There is no clear division of responsibilities for ecological protection, and there is no clear law to rely on for compensation for losses caused by the functional damage of marine ecosystems (Du, X.& Li, Z. W., 2013).

In 2015, China Classification Society issued a Guide to BWM Convention, which reviewed the control and management requirements of the BWM Convention, the difficulties in the implementation process, the progress of the Convention, the implementation recommendations, and the layout of the ballast water management system. Analysis and collation have laid a good foundation for China's ballast water

management and technical guidance. After all, the guidelines cannot be equated with laws and regulations. Therefore, in the face of the inevitable implementation process, China needs to make corresponding countermeasures in many aspects such as legislation, technical equipment, and institutional mechanisms.

2.2 Current situation of government administration

Since joining the Convention, China has not established an effective supervision and management system, nor has it formed a ballast water management system. It is based only on the Frontier Health and Quarantine Law of the People's Republic of China and its implementation rules and the Marine Environment of the People's Republic of China. The relevant provisions of the Protection Law and its regulations on the prevention of pollution of sea areas by ships. Among the departments related to ship ballast water management in China, the quarantine department and the maritime department are the two most well-known institutions. The two competent authorities have different divisions of labor in ballast water management.

2.2.1 MSA current situation

In accordance with the relevant provisions of the Regulations of the People's Republic of China on the Prevention of Marine Pollution by Ships and the relevant provisions of the Marine Environmental Protection Law of the People's Republic of China, some regulations and restrictions have been made on the discharge location, discharge volume and instantaneous discharge rate of ships' ballast water. But mainly from the perspective of preventing marine pollution and ship safety, the control and prevention effects of harm caused by foreign organisms and pathogens are often limited (Liu, M. J., et al, 2007). In addition, the maritime department must also review whether the ship has special ballast tanks and the place where the ballast water can be driven from

the perspective of preventing ship oil pollution or hazardous chemical pollution. However, in actual operations, it is difficult for the department to achieve effective supervision on the harmful aquatic organisms and pathogens carried by ballast water (Zhang, X. H., Zhang, Z. L., Li, S. W., Du, J. Li, P.& Tian, Z. G., 2018).

2.2.2 Inspection and Quarantine Agency current situation

At present, the inspection and quarantine agency are mainly in accordance with Article 78, paragraph 6 of the Implementation Rules of the Frontier Health and Quarantine Law of the People's Republic of China for the management of ballast water of incoming ships:

> "*The ballast water installed in the cholera epidemic area, without disinfection, it is not allowed to discharge or unload,quarantine and sanitize the ballast water from ships of countries or regions affected by quarantine infectious diseases.*"

Ballast water on-board ships from non-quarantine infectious disease areas is generally required to be replaced on the high seas, but there is no clear requirement for replacement standards, and the scale of law enforcement is often difficult to unify, and it is difficult to form effective control of the ballast water of these ships. However, it is often the invasive marine organisms and pathogens carried by these ballast water that cause a certain degree of pollution to the marine environment of our country (Liu, M. J., et al, 2007).

In addition, whether the ballast water is discharged or not and what treatment measures should be taken are determined by inspection and quarantine agency based on the ship's Ballast Water Declaration Form. However, regardless of the authenticity of the declared contents in the Ballast Water Declaration Form, compared with the

United States and Australia, the submission of the Ballast Water Declaration Form in China is relatively late. It is possible to make the declaration by the inspection and quarantine agency before the decision was made, the ballast water had been discharged. Therefore, it is necessary at least to advance the submission time of the Ballast Water Declaration Form, so that this system will not be in vain.

2.2.3 Other authorities current situation

Besides maritime departments and inspection and quarantine departments, other competent authorities also have their own related measures. The Ministry of Agriculture has established a database of invasive alien species in China, in which marine alien invasive species can be queried. The Ministry of Environmental Protection has released four batches of List of Invasive Alien Species in China. All coastal provinces in China have monitoring agencies and research institutions concerned about biological invasion (Fei, S. S., et al, 2018). Administration for Port & Shipping is responsible for the management of port reception equipment. What is missing is the effective integration of these existing resources.

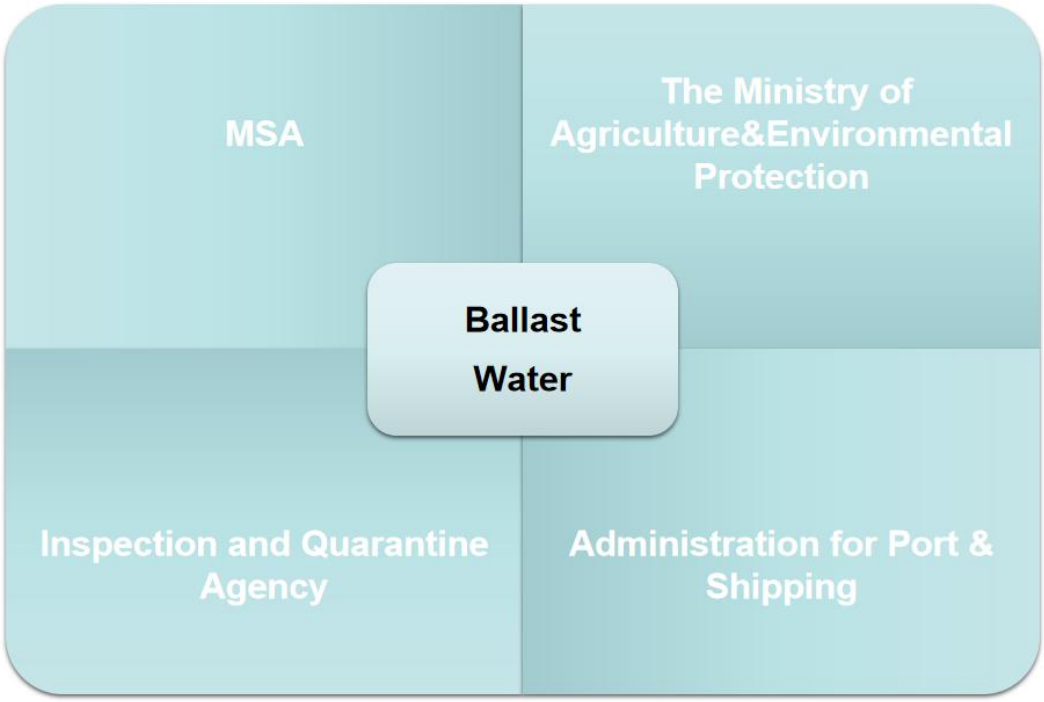

Figure 5 - Responsibility cross chart

Source: complied by author.

In the actual work of ballast water management, as shown in figure 5, there is a serious phenomenon that various law enforcement agencies are not clear about their powers and responsibilities, and shirk each other. Although the harmfulness of foreign organisms in ship's ballast water is great, they are relatively hidden and will not break out immediately. This is why the law enforcement agencies do not pay enough attention to them. The marine environmental protection related departments covered by the Marine Environmental Protection Law alone include the State Environmental Protection Administration, the Maritime Safety Administration, the Oceanic Administration, the General Administration of Quality Supervision, Inspection and Quarantine, and the Fisheries Bureau of the Ministry of Agriculture. The number is large, resulting in the division of labor between the various administrative departments. Unclear and decentralized management, each department can easily focus on the interests of its own department, thereby ignoring the overall interests.

The chaos of law enforcement agencies and the overlapping and staggering of law enforcement have made it difficult to manage the invasion of ballast water alien organisms. All departments should strengthen good communication and division of labor and make full use of human and material resources. For the management of ship's ballast water, it is best to divide the powers and responsibilities of various departments in a more effective law to reduce the occurrence of mutual prevarication and no efficiency (Chen, Q., et al, 2012).

2.3 Suggestions about legal framework

A complete legal system is the basis and guarantee for the implementation of the BWM Convention. In the existing laws and regulations for the prevention and control of biological invasion of ship ballast water, both the content and the legislative technology are not complete enough. As a higher-level law, marine environmental protection law should add provisions on environmental damage caused by alien biological invasion in ballast water and become a guiding law in this respect. The regulations on the prevention and control of marine environmental pollution by ships, the frontier health and Quarantine Law, and the measures for the entry inspection and Quarantine of international ships, as the subordinate laws, further refine the rules on biological invasion of ballast water (Kuang, H., 2010). In recent years, the research and drafting of the shipping law have been put on the agenda. The regulations on the prevention and control of marine environmental pollution by ships and the measures for the administration of entry inspection and Quarantine of international navigation ships fall within the scope of ship management, which can be considered as the chapters of the shipping law for unified legislation.

In terms of legislation technology, the mandatory provisions should be adopted more, and the norms of appointment should be effectively connected with the corresponding

international conventions or laws and regulations. Decentralized management and law enforcement mode is not conducive to the management of ship ballast water. At present, the management mode of strip division in China is not conducive to the ballast water problem management (Wang, A. M., Xu, B. F., Chen, Z. H.& Liang, W., 2007).

The division of management makes the marine management power too decentralized to clearly define the division of powers among various units. Moreover, the decentralized system is short-sighted and confuses right and wrong because of the small group doctrine. Each unit starts from the interests of its own department and does not consider the overall interests, so it has a short-sighted view and confuses right and wrong (Yang, Q. S., Chen, F.& Xiong, H. C., 2005), even sacrificing long-term interests for the immediate interests and sacrificing for the interests of the department other sector interests (Kuang, H., 2010). The confusion of law enforcement agencies and overlapping in law enforcement make it more difficult to manage alien biological invasion in ballast water. All departments should strengthen good communication and division of labor and cooperation, and make full use of human and material resources. For the management of ship's ballast water, it is better to divide the powers and responsibilities of various departments in a highly effective law, so as to reduce the situation of mutual prevarication and over-staffing (Chen, Q., et al, 2012).

CHAPTER3 PORT STATE CONTROL UNDER BWM CONVENTION

China's accession to BWM Convention is of great practical significance. On the one hand, it means that China's international ocean going ships must meet the requirements of the IMO convention; on the other hand, it means that China can implement port state control (PSC) inspection on non-Chinese ships berthing at Chinese ports.

Resolution MEPC. 290 (71) clearly stipulates that in the stage of experience accumulation in the implementation of the BWM Convention, as long as the ship is correctly installed with the approved ballast water management system, the ship operates and maintains the ballast water treatment system in accordance with the approved ballast water management plan and equipment instructions. The ballast water treatment system itself shows that the system is in normal operation; and the port is informed before discharging the ballast water due to the defects in the ballast water management system of China. The port state cannot impose sanctions, warnings, detention or deportation on ships because they do not meet the D-2 discharge standard of BWM Convention. However, during the PSC inspection, depending on the actual situation on site, the ship may face sanctions, warnings, detention or expulsion, if the ballast water sampling inspection results show that it does not meet the D-2 emission standard and does not meet the above conditions (Wang, N., Liu, M. H., Zhang, B., Liu, T., Shi, W. T.& Lu, Y. Y., 2019).

3.1 PSC inspection current status

The port state control inspection was conducted on March 17, 1978, when the Liberian oil tanker Amoco Cadiz ran aground on the coast of Brittany, France, causing a serious oil spill of 230000 tons. The main purposes of PSC inspection are mainly

aimed to improve the safety and pollution prevention of sea water, to improve the living conditions on board, as well as to eliminate low standard ships, and to avoid distorted competition between ports.

PSC inspection about ballast water and sediment can be divided into 4 steps and summarized as follows:

- Preliminary examination. It focuses on the inspection of certificates and documents, and confirms that the designated officers on board effectively implement ballast water management. Whether the ship holds the valid International ballast water management certificate, document of compliance or ballast water management plan. Whether the ship has the ballast water record book and meets the requirements of the BWM Convention.Whether the ship takes measures according to the schedule specified in the Convention to meet the D-2 ballast water discharge performance standard of the Convention (Liu, L. D., Sun, Y. J.& Li, H. B., 2019).
- Detailed inspection. PSCOs should confirm that the ship's ballast water management is effectively carried out in accordance with the ballast water management plan, and that the ballast water treatment system is effectively operated in accordance with the operation instructions and the ballast water management plan. Whether to carry out detailed inspection depends on the following points:

1. The ship does not hold a valid certificate (International ballast water management certificate or document of compliance). Lost, invalid or expired, lack of ballast water management plan, lack of ballast water record book, or ballast water record book does not meet the requirements of the BWM Convention, the records in the ballast water record book can not reflect the actual situation of ballast water management;

2. There is a significant discrepancy between the status of the ship or its equipment and the details of the certificate or lack of maintenance;

3. The ship owner is not familiar with it the basic process of ballast water management system or failure to implement ballast water management system;

4. Receiving feedback and complaints about violation of ballast water management system (Tang, F. B., Xu, Z.& Yang, X. Z., 2017).

If necessary for PSC inspection, indicative analysis of ballast water shall be carried out. Indicative analysis can quickly and roughly evaluate the biomass in the sample and compare with the D-2 emission standard to obtain the comparison results.

Ballast water must be sampled and analyzed in detail when necessary. The detection limit of appropriate method can be used to determine the accurate concentration of organisms, and then determine whether the ship meets the D-2 ballast water discharge standard stipulated in BWM Convention (Wang, N.,et al, 2019).

Theoretically, PSC inspection should be carried out according to the above four steps, is it really completely consistent with this in fact. In the process of writing the paper, it consulted PSCOs of the maritime department to understand the actual situation of ballast water management inspection in detail. In practice, PSC inspection does not carry out ballast water sampling analysis on international ships at present, but focuses more on the verification and inquiry of various record books and management plans. In addition, the inspection of ballast water management is not a necessary item for every PSC inspection, and it is a random sampling situation. There is some room for improvement in PSC on-site inspection of ballast water management.

As various problems have not been solved, IMO introduced an experience-building phase for the BWM Convention in 2015. It is hoped that a package of amendments to the Convention will be formulated to solve these technical problems in a certain time

after the Convention is entered into force by collecting, analyzing and reviewing the data of the implementation of the Convention. It is also decided that during the period of experience accumulation, as long as the ship's operation is in line with the provisions of the Convention, the competent authority shall not punish the occasional excess of standard caused by the ship's control. According to the administrative measures, China's experience-building phase is from January 22, 2019 (the date when the Convention enters into force for China) to December 31, 2023.

IMO divides the experience-building phase of BWM Convention into three stages: data collection, data analysis and convention review. It started with the entry into force of BWM Convention and finally a package of priority amendments came into force. It aims to allow Port States, Flag States and stakeholders (e.g. ship owners and operators, ballast water management system manufacturers and accredited organizations) to:

1. Collect and submit data related to the implementation of the BWM Convention;

2. Participate in the analysis of the data by the ballast water review group;

3. The text of the ballast water convention should be reviewed to identify the areas where the Convention needs to be improved, and then a package of amendments to the Convention will be formulated.

In general, the experience-building phase of BWM Convention is more like a product to promote countries to join the BWM Convention. Nevertheless, in order to enable the Convention to be accepted by all countries as soon as possible and meet the conditions for its entry into force, IMO chose to avoid the current problems and temporarily grant immunity to some of the problems and moved the solution of these problems to the implementation of the Convention to find solutions for the practical problems raised by various countries. It can be foreseen that IMO may extend the

term of EBP if the priority issues mentioned by IMO cannot be solved during the period of BWM Convention EBP.

As an important line of defense for maritime safety and pollution prevention, port state control and inspection has played an important role in promoting the safety of ship navigation and marine environmental protection, and has attracted the attention of the international shipping community (Lu, J. G., Xin, J.& Lin, Y. M., 2018). After the regional development, the globalization development and cooperation of PSC inspection has become the general trend. The globalization of PSC will seek closer cooperation and contact between various memoranda and their port countries.

3.2 Difficulties for implementing the convention

The difficulties of implementing the contract are miscellaneous, and they mainly come from the following points.

3.2.1 No Applicable Penalty for illegal emissions in domestic law

At present, China is in the early stage of the implementation of the BWM Convention, and the relevant legal system has not been modified. The existing laws have not yet clearly classified the ballast water of ships as pollutants.

As far as the marine environmental protection law is concerned, only article 62 of the marine environment protection law refers to ballast water. This article states that

> *"in the sea area under the jurisdiction of the People's Republic of China, no vessel or relevant operation may discharge pollutants, wastes, ballast water, ship garbage and other harmful substances into the sea in violation of this regulation"*

The separation of ballast water and pollutants makes the control of ballast water not applicable to the supervision and punishment of illegal discharge of pollutants in laws and regulations such as the marine environment law and the pollution prevention regulations. For example, although Article 73 of the marine environment law stipulates that the act of discharging pollutants in excess of the standard will be punished by more than 20000 RMB and less than 100000 RMB, even if the ballast water discharged by the ship exceeds the standard, it cannot be punished.

At the same time, throughout the current domestic legal system, there are only penalties for not reporting before discharging ballast water. Anti-pollution regulations only impose a fine of less than 20000 RMB for failing to report the discharge of ballast water before operation in the pollution prevention regulations. Nevertheless, the customs quarantine only deals with the situation that the ship ballast water from cholera epidemic areas fails to declare before discharge according to the frontier health and Quarantine Article 110 of the detailed rules for the implementation of the law, which stipulates that punishment in the range of more than 1000 RMB but less than 10000 RMB. Such punishment is relatively minor and cannot meet the requirements of article 8.3 of the Convention[1].

3.2.2 Violations in EBP

From January 22, 2019 to December 31, 2023, the experience-building phase of China's BWM Convention is divided into three stages: data collection, data analysis and convention revision. The Convention states that during this period, if the ship's ballast water management system meets the requirements of the approved ballast

[1]Article 8.3 of the Convention: sanctions imposed by a state party in accordance with the laws provided for in this Convention shall be severe enough to prevent violations of this Convention anywhere.

water management plan and manufacturer's instructions, the self-monitoring device of the ballast water management system will indicate the system is whether in operation or the port state has been informed of the deficiencies of the ballast water management system before discharging any ballast water. Even if the sampling test results do not meet the requirements of convention D-2, the ship shall not be punished.

At present, many shipping enterprises are not familiar with the Convention. They simply believe that the PSC inspection will not impose sanctions such as detention, expulsion and administrative punishment on the illegal ships during this period, which is contrary to the original intention of effective protection of the ecological environment in the waters of Port States.

3.2.3 Port reception facilities

G5 guidelines suggest that the ballast water reception facilities should be installed in the port, which should be able to receive ballast water and sediment from ships to avoid harm to the environment, human health, property and resources. Although there are no mandatory requirements for these facilities in the Convention, reception facilities are necessary in some cases. For example, if a ship is in breach of the Convention, the port state authority may order the ship to leave the port, or replace ballast water in certain areas, or to discharge to an available reception facility. In addition, some small ships do not meet the installation requirements of the ballast water management system, and the old ships may be removed and withdrawn from the market at any time. Therefore, many shipowners do not intend to install ballast water treatment devices. The ballast water reception facilities will provide economic leasing methods for these owners to maximize the service life of the ship (Song, P. F., 2020).

The construction of port reception facilities and the proper reception and disposal of ballast water and sediment are still in the stage of research and exploration. According to the investigation, the foreign ship repair shipyard basically has no strict treatment measures for the sediment removed from the ballast tank. Only a small part of the sediment has been sampled and tested by the inspection department. Generally, it can only be directly piled up and land filled on the shore, lacking more effective harmless treatment measures. Due to insufficient attention, the sediments are often directly discharged into the water. To sum up, the domestic port reception and processing facilities have not fully met the performance standards.

3.2.4 Other difficulties

Other difficulties are briefly illustrated as follows:

- Challenge to the knowledge of inspectors: The approved ballast water system has various principles and forms. The inspectors shall have sufficient on-site experience to determine whether the ship's handling is carried out according to the records in the logbook. It is difficult to judge whether the ballast water management system will bring safety and pollution impact to the ship and the environment;
- Check the personnel equipment: For example, the equipment and carrying of quick inspection equipment. In addition, it is more difficult for inspectors to sample and send for inspection. The sampling container, storage temperature, transportation time and detection method are uncertain.
- Check the personnel equipment: For example, the equipment and carrying of quick inspection equipment. In addition, it is more difficult for inspectors to sample and send for inspection. The sampling container, storage temperature, transportation time and detection method are uncertain. However, it is difficult to

carry out sampling cooperation with third-party laboratories, and it is also difficult to send back the test results and punish them (Zhu, D. T., Zhao, Y. X.& Liu, X. F., 2019).

3.3 Learn from USCG management experience

There are still many difficulties to be solved in the process of China's implementation of the contract, but China can learn from USCG and its experience of ballast water management. The main body of implementing international conventions is the state, and it is the common responsibility of the relevant national authorities to establish a sound management system. Although there is no law to specify the competent department of marine biological invasion, the responsibilities of various departments concerned in protecting marine ecological environment are certain. Instead of each department having some regulatory authority, it is better to study USCG' methods, centralize the management authority in one department, and make the regulations supported by mandatory laws and regulations.

3.3.1 Brief introduction of ballast water management of USCG

In the United States, the USCG as the authority in charge of ballast water management, has enforced the ballast water management plan since June 21, 2012. The plan is applicable to all domestic and foreign non-recreational vessels equipped with ballast tanks and sailing in the waters of the United States, and is applicable to all ports. Acceptable methods for ballast water management are：

- Ballast water exchange. The ship needs to complete all ballast water exchange within 200nmiles offshore and 200m deep before ballast water discharge.
- Treatment system/ballast water discharge standard. Ships berthing at U.S. ports and preparing to discharge ballast water require BWMSs meeting U.S. discharge

standards (same as IMO D-2).

The regulations also require all vessels to:

(1) clean ballast tanks to remove sediment;

(2) flush anchors and chains when retrieving anchors;

(3) remove dirt from hull, piping and hold on a routine basis;

(4) maintain a ballast water management plan with anti-fouling sediment and ballast water management procedures;

(5) report to be submitted 24 hours before arrival.

The uptake control of ballast water management is to avoid the discharge or absorption of ballast water in the area, which may directly affect the marine biological refuges, marine restricted areas, marine parks or coral reefs.

Reduce or avoid the absorption of ballast water in the following areas and situations:
(1) areas where harmful organisms and pathogens (e.g. toxic algal blooms);

(2) areas near the outfall of sewage;

(3) areas near fishing operations;

(4) areas with low tide or turbid tidal flow;

(5) dark areas where bottom organisms may rise in the water column;

(6) propeller may disturb sediment;

(7) while gathering area and mainstream boundary area.

The discharge criteria for ballast water management are that the treatment system must be approved by the USCG and meet the following criteria:

(1) For organisms of minimum size greater than or equal to 50μm, the discharge of ballast water per cubic meter shall contain less than 10 organisms;

(2) For organisms greater than or equal to 10μm and less than 50μm, the discharge of ballast water shall contain less than 10 organisms per milliliter;

(3) The microbial index shall not exceed:

- The aggregation of virulent cholera arc bacteria (serotypes O1 and O139) less than 1 cfu per 100 ml;
- Ecoli, less than 250 cfu per 100 ml;
- Enterococcus, per 100 ml less than 100 cfu collection (Wang, X. L., Wang, L. & Zhang, D., 2013).

The approach to the en route management process is that the coast guard will allow the master, owner, operator, agents or staff responsible can hardly satisfy the ship ballast water exchange, because its route is 200 nautical miles or more for a long time not into offshore waters. Marine reserves the ballast water on board, or because the captain for reasons of safety or stability, in the great lakes region and the Hudson river north of the George Washington bridge discharge ballast water (Wang, X. L., et al, 2013). If the ship requires a USCG approved ballast water management system, the coast guard will not allow discharging. If the processing system stops working for any reason, the ship should also report the fact to the nearest USGC commander as soon as possible.

3.3.2 Suggestions

It is well known that all ships and companies attach great importance to PSC inspection of USCG, and that USCG's ballast water standards and inspection are very strict. USCG is able to have such a strong means of influence, not only due to the

support of laws and regulations, but also due to the professional abilities of USCG'S PSCOs.

The United States has enacted a number of laws and regulations related to the Coast Guard, which have ensured the status of administrative law enforcement, improved the efficiency of operations, optimized the allocation of various resources, and formed a powerful weapon for the management and law enforcement of the Coast Guard. First, the scope of laws and regulations is very broad, including the functions, nature and organizational structure of their work, such as the Coast Guard Authorization Act. It also includes a variety of operational laws and regulations, such as fisheries protection, marine environmental protection, port and waterway safety, and combating smuggling and illegal immigration. Second, laws and regulations related to each specific law enforcement task are sound and subdivided. Third, laws and regulations are constantly improved and amended. Fourth, the United States Coast Guard has a clear legal framework. These comprehensive and scientific legal systems provide a strong guarantee for the coast Guard's scientific, civilized and safe law enforcement. At the same time, these laws also promote the continuous healthy and stable development of the Coast Guard itself, and the coast Guard members' familiarity with the law is one of the reasons for effective enforcement.

Clear and comprehensive mission, excellent military equipment, scientific operational principles and solid legal support constitute the core competence of USCG. Of course, the coast guard has other core competencies, such as good education and training, cohesive core values, and a large volunteer team (Meng, X. H.& Qin, Q., 2013).

China should learn from the enforcement and strength of USCG law enforcement, and we should learn from USCG from both legislative and executive levels. The maritime departments of the main competent authorities for the implementation of the BWM

Convention should be centralized and unified, and the enforcement power should be endowed with through the improvement of laws, and more high operational level PSCO should be cultivated. However, in the specific data details of ballast water management, it is not necessary to meet the same high standards as it is, in other words, we are not able to achieve this level. As for the actual situation in China, we should try our best to make Chinese international ships comply with the requirement of the IMO BWM Convention during the experience-building phase, including the requirements for aquatic organisms, the time required ships to install BWMS, the certification requirements for BWMS, and the alternative ways to meet the standards, etc.

We do not blindly follow all the characteristics of the USCG, but we need to study its core capabilities and learn from its reasonable capabilities to promote China's marine law enforcement and management to make further scientific achievements in the future, and its various businesses will be more and more integrated into the world maritime industry.

CHAPTER4 COMPARISON OF THE PRACTICABILITY OF BWMS BETWEEN PORT RECEPTION FACILITY

Although ship ballast water has a great impact on the ecological balance of marine environment, its function cannot be denied. As the organisms carried in ballast water

are brought to a new sea area, it will bring certain harm to the new sea area, so some inactivation measures are needed to eliminate the invasion and damage of new species to the sea (Chen, L. Q., Li, Y. K., Hou, J. L., Li, K.& Chen, Y., 2005). This chapter would like to introduce the current situations of ballast water management system and port reception facilities, and compare the two from the aspects of economy, safety and operability to provide the ideas of ballast water management for shipping enterprises or coastal authorities.

4.1 Current situation of BWMS

According to the regulations of IMO, the treatment of ship ballast water must be carried out in accordance with the rules of safety, efficiency, environmental protection, operability and economy. Before the promulgation of the BWM Convention, the treatment of ballast water was mainly realized by replacement of ballast water. After the promulgation of the Convention, the replacement treatment method of ballast water cannot meet the requirements of the BWM Convention D-2 for microorganism, so it needs further treatment. From the perspective of the Convention, ballast water replacement is a transitional management mode. The ballast water to be installed in the ship should be treated and the D-2 standard should be met before it can be discharged. At present, the important channel to achieve this goal is to install BWMS in ships to treat ballast water. BWMS type approval shall be conducted by the competent authority in accordance with the guidelines for approval of ballast water management systems (G8 guidelines) formulated by IMO. If the BWMS uses active substances for biological killing, the final approval of IMO based on the approval procedure for ballast water management systems using active substances (G9 guideline) should also be obtained.

At present, more than 60 ballast water management systems have been successfully

developed or developed by various countries and companies in the world. However, only five ballast water management systems have been approved by USCG, including Optimarin treatment system and OceanSaver management system in Norway, Pure ballast management system in Sweden, BalClor management system in China and Ecochlor management system in the United States. The research and development of ballast water management system in China started behind other countries. The main research and development unit include Qingdao Shuangrui company, COSCO Group, Tsinghua University, Dalian Maritime University and Qingdao Haidewei company (He, D. T., 2019).

Nowadays, the main ballast water treatment technology is divided into three categories: mechanical treatment method, physical treatment method and chemical treatment method. In addition, the mechanical treatment method of ship ballast water is mainly used as a pretreatment method of ballast water treatment, which is often combined with physical and chemical methods. In the working process, the management system is mainly divided into two steps: the first step is to separate and remove the large particle pollutants in ballast water through filtration technology; the second step is to inactivate microorganisms by UV and electrolysis (Hou, Y. H., Feng, L. J., Zhang, D. H., Yao, S.& Li, X. G., 2018).

China BalClor ballast water management system is the first ship ballast water management system developed, designed and produced by China with completely independent intellectual property rights, which is divided into three steps of filtration, electrolysis and neutralization. Seawater was first automatically backwashed filter to remove particulate pollutants greater than 50μm. After electrolysis, the sodium hypochlorite solution produced by electrolysis can kill plankton, pathogens and their larvae or spores. Finally, through the neutralization system, the residual chlorine concentration in ballast water is less than IMO standard value and discharged. In 2017,

BalClor ballast water management system was awarded the USCG Type Approval Certificate, and it became the first manufacturer of Marine ballast water treatment system in Asia and the fourth in the world.

With the full implementation of the Convention, ship manufacturing enterprises not only need to install ballast water management system in new ships, but also install ballast water management equipment on existing old ships in batches. However, any installation and use of ballast water management equipment should be approved by the corresponding classification society and IMO. In the actual process of trial use, use and promotion of all kinds of ballast water management system equipment, as the main user of the shipping enterprises have encountered all kinds of risks and challenges, which is also an important reason why the BWM Convention has not been able to enter into force for a long time.

In addition, compared with the old G8 guidelines, IMO new G8 guidelines put forward more stringent requirements in terms of type certification and system reliability of vessel ballast water, which are quite different from the old G8 guidelines. IMO new G8 guidelines is the most comprehensive, strict and authoritative international convention and standard on ballast water treatment at present, and it has become a mandatory standard to be gradually implemented in October 2018. According to industry insiders, a number of previous investigations have shown that no matter what technology is used in ballast water management system, a significant proportion of hardware or software failures such as sensors cannot handle ballast water properly. With the increase of ship ballast water detection and the implementation of the new G8 guidelines, the problem that the ballast water management system certified according to the old G8 guidelines cannot meet the standard is more and more obvious.

4.2 Current situation of port reception facility

The BWM Convention is not a convention for ship's ballast water treatment equipment, but a convention for the management of ballast water discharge. That is, no matter whether the ship is equipped with ballast water treatment equipment, as long as the microbiological index of the discharged ballast water meets the D-2 standard, it meets the requirements of the Convention.

IMO recommends four potential ways to meet the requirements of the BWM Convention:

- Ships do not discharge ballast water.
- Ships use IMO and the ballast water management system approved by the port state (especially the ship equipment).
- The ships use the port receiving and processing facilities approved by the port state to replace their own treatment.
- The ships use the municipal public water of the port state as the ship's ballast water, such as self-contained water.

Under the existing conditions, due to technical and economic constraints, the first and fourth approaches are basically not applicable. Therefore, the second and third methods are the most practical ballast water solutions. In addition, IMO adopted the guidelines for ballast water reception facilities (G5 guidelines) in 2006 to encourage government agencies and commercial units around the world to develop the technology (Zhang, L., 2020).

In addition to providing emergency services for all arriving vessels, the ballast water

port reception and treatment facilities mainly provide regular ballast water treatment services for the following two types of ships: Super large ships (such as VLCC, VLOC) are characterized by large discharge capacity of ballast water and low frequency of ballast unloading (less voyages) . If the installation of ballast water management system is considered, the operation and maintenance cost will be very large, and the cost performance ratio is low; small and old ships are characterized by small engine room space and low power load capacity, which cannot meet the requirements for the installation of ballast water management system. In addition, the old ships with long service life may be disassembled and withdrawn from the market at any time. Thus, shipowners will not plan to install ballast water management system. The development of ballast water port reception and treatment facilities will provide new and more economical leasing models for these ship owners to help them survive the economic crisis by extending the operating life of ships as much as possible (Zhang, B.& Zhang, L., 2018). What's more, in terms of water treatment and utilization, the port ballast water reception and treatment facilities also show great potential value. For example, for areas where fresh water resources are very scarce, ships can use water sources of irrigation water as ballast water to enter ballast tanks at the port of departure and discharge ballast water to the reception facilities at the port upon arrival. This can not only meet the needs of ships but also replenish fresh water resources for the port of destination.

Nowadays, some ports in the world have built ballast water reception facilities, such as Flotta Oil Wharf in Scarpa Bay, whose ballast water reception facilities mainly serve oil ships, which are upgraded on the basis of the original ballast water reception equipment, and can receive and handle large-capacity ship ballast water (Wang, X. F., 2009). DAMEN, a Dutch company, provides shore-based ballast water treatment services for eight ports in Northern Europe, fixing ballast water systems in containers for easy storage and transfer (Sun, Y. M., 2002). India is already exploring the use of barges to install ballast water management system as port ballast water reception

facilities. And some countries, such as the United States, Turkey and Brazil, have also carried out theoretical verification of ballast water reception facilities (Zhang, J., 2006). Although some examples of ballast water reception facilities have been built, it should be said that the development of global ballast water reception facilities is still slow, unable to effectively solve various problems encountered in the process of implementing the treaty (Wang, X. F., 2009).

With the increasingly strict law enforcement by environmental protection and maritime authorities and the improvement of discharge standards, it is foreseeable that ballast water port treatment services will be transformed from emergency to daily work. In the future, whether the ballast water port treatment service is equipped or not may become an important factor influencing the customer satisfaction evaluation of port service. As a new type of water treatment technology and application, ballast water port treatment mode is faced with challenges in policy, technology, market cognition, customer acceptance and other issues in the current implementation process. However, the current issue of ballast water discharge management not only becomes the biggest obstacle for sea-going ships to effectively implement the BWM Convention, but also an important factor restricting port operators' ability to meet domestic environmental protection requirements (Wang, X. F., 2009).

4.3 Comparison of BWMS and port reception facility

In this section, it compared BWMS and ballast water port reception facility from multiple perspectives. Although the research on BWMS has never stopped in the shipping industry, with the gradual improvement of ballast water discharge standard and PSC inspection severity, even if the shipping company has invested a huge cost to upgrade and install BWMS for the ship, in the actual operation, the ballast water sampling test results will still be unqualified due to temperature, storage,

transportation and other reasons after sampling. Therefore, in this chapter, it analyzed the reasons why shipping enterprises and ships are not willing to install BWMS. At the same time, it also introduces the advantages of ballast water port reception facility and the challenges still to be faced in its promotion.

Compared with the traditional ship ballast water treatment equipment, the ballast water port reception and treatment facilities have great differences in installation carrier, treatment mode, technical process, environment, safety requirements and other aspects (See Table 1).

Table 1 - Technical comparison

	Ballast water port reception facilities	**Ship's ballast water treatment equipment**
Installation carrier	Port waste-water treatment plants, docks, barges, trucks can be used as mobile or fixed installation carriers, there is no requirement for ship space, electrical load.	It shall be installed in the engine room or deck of the ship and shall have requirements for the installation space and electrical load of the ship.
Treatment process	Provide services outside the ship with the help of equipment, power and personnel outside the ship.	With the aid of the equipment, power and personnel of the ship, the ballast water treatment is completed in the ship.

Optional technical process	It mainly uses on-line instantaneous treatment technology, such as UV, flotation, precipitation, chlorine disinfection, micro-filtration, ultra-filtration, reverse osmosis, etc.	Various technologies, such as UV, electrolysis, ozone, electrocatalysis, deoxidation, membrane treatment.
Environmental requirements	As long as the environmental conditions of the port area are suitable, it is suitable for most of the technical processes.	The harsh environment of engine room and ballast tank may cause some technologies to fail.
Safety	There is no risk of corrosion or explosion to the ship, and no chemical hazard to the crew.	May pose corrosion, explosion and chemical hazard to ship and crew.
Limiting factor	For shipowners, it is not affected by restrictive factors.	It is affected by certificate, route, space, energy consumption, water temperature, turbidity, salinity and other conditions.
Intelligentization and communication	Meet IMO BWM Convention, equipment and port state requirements.	Meet IMO BWM Convention, equipment requirements.
Upgrading	The space is sufficient, and the number of upgrading objects involved is small, so the subsequent upgrading and renovation is simple.	The space is limited, and each ship equipment needs to be upgraded. The program is complex and the workload is heavy.

Source: Zhang, B.& Zhang, L. (2018). Research on the application of ship ballast water port receiving and processing facilities. *Journal of Shanghai Ocean University, 27(003)*

4.3.1 Disadvantages of BWMS

Shipping enterprises need to face many problems in implementing the Convention, especially in the aspect of ship retrofitting BWMS. Even if the ship has been installed with ballast water management system approved by IMO and other major classification societies and the system is in normal operation, poor treatment effect will still occur frequently due to the change of water quality conditions and beyond the use limit of the system. It believes that the reasons leading to limited penetration of BWMS can be roughly divided into five categories:economic factors, standard factors, safety factors, force majeure factors, human factors.

- Economic factors:

In order to fully implement the provisions of the BWM Convention, shipping enterprises must invest a large amount of money to renovate existing ships and install ballast water management system equipment. As shown in table 2, the price of ballast water management system equipment, under the background of today's shipping industry downturn, the addition of high cost will cause a lot of pressure for shipping companies. Therefore, some shipping enterprises may delay implementation or purchase cheap inferior devices, even don not comply with the behavior of the convention, which will have a negative influence on the formation of the implementation of the convention.

Table 2 - The equipment purchase cost of each type of ballast water treatment system

Type of processing system	Guide price($)	Wholesale-price($)
Filtration and UV treatment	933333	840000

Filtration and chemical treatment	946667	852000
Deoxidation and cavitation treatment	640000	600000
Electrolysis and electrolysis chlorination	666667	600000
Filtration, deoxidation and cavitation	—	—

Source: Zhong, Z.Y. (2017). The impact of the implementation of "Ballast Water Convention" on Shipping Enterprises -- risks and challenges. *Navigation technology, 5.*

The equipment of ballast water management system on the ship has a high cost of refitting and daily operation, and the operation and maintenance cost of some systems is even higher than the initial installation cost (KING, D. M., HAGAN, P. T.& RIGGIO, M., 2012) (see Table 3 and 4). Therefore, in addition to requiring shipping enterprises to install relevant equipment, it is also required to operate the system in accordance with relevant provisions of the Convention, which is still quite difficult.

Table 3 - Installation cost of ballast water treatment system equipment of different ship types

Ship-types	**The new building cost**	**Modification fee($)**	**Modification service fee($)**
VLCC	23000-62000	67000-136000	96000-197000
Oil tanker	18000-58000	63000-119000	92000-100000
Ro-ro ship	18000-61000	33000-120000	24000-170000
Container	23000-62000	57000-128000	91000-180000

ship above 8000TEU			
Container ship above 2500TEU	18000-56000	47000-106000	67000-131000
Panamax bulk carrier	18000-56000	54000-115000	86000-142000
Capesize bulk carrier	18000-62000	73000-143000	74000-169000
Note: The service fee after modification depends on the use of the crew			

Source: KING, D. M. HAGAN, P. T. RIGGIO, M. (2012). Preview of global ballast water treatment markets. *J Mar Eng & Technol*, *11(1).*

Table 4 - Annual operating fee of BWMS

Shiptypes	**Filtration /UV($)**	**Filtration/chemical ($)**	**Deoxidation/ cavitation($)**	**Electrolysis/electrolysis chlorination($)**
VLCC	11000	296000	9000	17000
Oil tanker	11000	142000	9000	17000
Ro-ro ship	11000	37000	9000	17000
Container ship above	11000	82000	9000	17000

8000TEU				
Container ship above 2500TEU	11000	44000	9000	17000
Panamax bulk carrier	11000	56000	9000	17000
Capesize bulk carrier	11000	10000	9000	17000

Source: KING, D. M. HAGAN, P. T. RIGGIO, M. (2012). Preview of global ballast water treatment markets. *J Mar Eng & Technol*, *11(1).*

Additionally, in order to achieve the objectives set out in the BWM Convention, special operational and operational training shall be provided for full-time crew members. However, there is a lack of professional training institutions to train professional seafarers for ballast water treatment under realistic conditions, and the relatively high cost of training and new seafarers' salary will discourage shipping enterprises (Zhong, Z.Y., 2017).

- Standard factors:

Many problems exist in the current standards of the BWM Convention and the lack of a specific and clear definition of Marine microorganisms (FIRESTONE,J.& CORBETT, J. J., 2005). If these problems cannot be properly and promptly solved, they will cause problems to the inspection of the implementation of the Convention (e.g., PSC inspection). What's worse, the difference and change of the actual ship

environment make the test standard of ballast water greatly different from the actual test results (such as salinity, temperature and turbidity). Therefore, the above situation may lead to the risk that the aquatic organisms in ballast water fail to meet the standard after the ship is installed with IMO certified equipment and operated according to the regulations. The ship is therefore detained by PSC due to defects, disrupting the daily operation of shipping enterprises, and generating huge economic and legal risks.

- Safety factors:

Installation of ballast water management system may pose a safety hazard to ships. Ballast water management system in most cases has not been considered in the construction of the ship plan, and ship building is a huge, complex and comprehensive project, so the installation of ballast water management system could affect the existing ship structure (especially the smaller ships), and even endangers the safety of structural (Wei, Y. & Wang, T. Y., 2014). In addition, side effects from the operation of the ballast water management system are also a safety concern. For example, electrolysis in the ballast water management system may lead to corrosion of the hull and damage to the hull structure in bad weather, endangering the lives of the crew and the safety of the ship.

- Force majeure factors:

Force majeure refers to the influence of bad weather, war and so on in the course of ship navigation. In the actual situation, the ship encountered bad weather is more common. The risks of safe sailing are already so great that it is difficult for crews to operate ballast water management systems in bad weather or if they suddenly fail. In such a case, the ship may not be exempted from inspection of the provisions of the BWM Convention by local law enforcement authorities, resulting in the ship being detained for rectification for non-compliance with the provisions of the Convention.

- Human factors:

Some studies have pointed out that the more advanced technology systems on board the ship, and more likely it is to cause hidden dangers to the safe navigation of ships. In the absence of sufficient manning, the implementation of the BWM Convention will inevitably increase the daily work load of crew members, which may lead to the urgent situation and even accidents caused by crew fatigue. Therefore, the risk of human factors caused by the implementation of the Convention should receive enough attention from all parties, especially the maritime administration (Zhong, Z.Y.,2017).

4.3.2 Advantages of port reception facility

There are many benefits and conveniences for ballast water to be treated by reception facility through shore-based ports. Both shipping companies and ships, as well as crew members themselves, are beneficiaries of ballast water port treatment.

If the port reception facility is used to treat the ballast water, the ship does not need to install the vessel's ballast water management system, and the duty and responsibility of its ballast water treatment can be transferred to the port, which does not have to comply with IMO regulations and discharge testing standards. According to the site conditions and the needs of ships, ballast water port treatment services can be carried out flexibly at the wharf front, sea anchorage and storage areas. As long as the wharf type and operation area are planned and classified, the ballast water treatment equipment suitable for various types of terminals can be designed. For example, some ships with large tonnage need to discharge ballast water when they leave the anchorage and move to the wharf berth. At this time, the ballast water treatment service mode of mobile barge can be selected. Besides, the new wharf can be planned

in advance, and the ballast water on each berth will be discharged, collected and transmitted through pipelines, and finally received and treated at the rear of the wharf.

For the centralized treatment of ballast water port, the number of ships that need to be installed with ballast water treatment system will be greatly reduced, which is conducive to the saving of equipment cost and crew training cost of shipping company, as well as the saving of social resources. Compared with the ship's own ballast water management system, in terms of economy, the ballast water port treatment service mode has incomparable advantages: firstly, the ballast water treatment is more centralized, resulting in scale effect; secondly, the operators are more professional, the equipment operation is reasonable, and the maintenance cost is less (Zhang, L., 2020).

From the perspective of environmental protection, because the ballast water port treatment scheme has more design ideas and can meet the more severe water quality challenges, it can meet the more stringent discharge standards, so as to better protect the marine environment and maintain human health and safety (Brown, Caldwell and Bay Engineering., 2008). Whether it is based on physical or chemical methods of ballast water microbial inactivation principle, its equipment power consumption will gradually increase. If the ship uses its own processing equipment, the main engine of the ship will consume a lot of fossil fuel in the port or offshore area, and the accumulated ship exhaust emissions will inevitably cause serious port air pollution. In addition, a large number of ship main engine start-up will also bring about the port noise pollution problem. If ballast water port treatment services are used, cleaner shore power can be used instead.

According to the statistics of Indian classification society, the number of ports that need to be equipped with port reception and processing facilities is far less than the

number of ships. 2500 ports serve 40000 ships, which are distributed in 650 ports in 44 Asian countries. Only 2400 port reception facilities can serve 18000 regional ships (MEPC 66/INF.17.). In this way, the operators can be more professional (COHENAN., 1998), the operation and maintenance are more convenient and fast(COHENAN,FOSTERB., 2000), and the ship and crew are safer, there is no chemical pollution and explosion risk, and the emission accident risk is low (AQIS., 1993). At the same time, this is conducive to centralized monitoring of emission control and port state supervision and inspection, sufficient space and design redundancy ensure superior performance. Flexible conditions allow for the modification or addition of new processes to meet the changes of the Convention and the updating of emission thresholds (Zhang, B., et al, 2018).

As a new type of ballast water treatment technology and port emergency technology, ballast water port reception facility provides a new solution for ship ballast water treatment, and also provides a strong guarantee for further protection of offshore and port marine ecological environment. This technology has certain historical inevitability and practical feasibility foundation. At the same time, compared with ship ballast water management system, ballast water port reception facilities have incomparable advantages in technology, application and economy, which are more green, economic and efficient.

4.3.3 Challenges of port reception facilities

Although the BWM Convention has unified requirements on the ballast water reception facilities and has been clearly defined by G5 guidelines, it has not been widely promoted in the current application practice. In the future development, it is believed that the comprehensive popularization of port reception facilities needs to face many challenges.

◆ Emission management and standards:

First of all, there is no inspection requirement in the BWM Convention for ships that need to be modified to use ballast water reception facilities. Although IMO has developed the BWM Convention Inspection Guidelines (Resolution A. 1120 (30), Annex 4), the International Association of Classification Societies (IACS) uniform requirement UR-M74 (Rev. 1) on the inspection of the BWM Convention has been formulated. However, it is only a requirement for the installation of ballast water management system on ships, and there is no unified standardized inspection specification for ships using ballast water reception facilities. This makes the implementation of the ballast water management plan lack of safety guarantee, which is not conducive to the development of ballast water reception facilities and the implementation of the contract by the competent authority. Secondly, there is no uniform standard for ship shore connection of ballast water reception facilities. In practice, different types of ships have different requirements for discharge diameter, flow rate and pressure, and there is no unified standard in the guidelines for ballast water reception facilities. Therefore, it may be necessary for ships to try several times to select the correct connection diameter, which seriously affects the efficiency of ship handling and increases the working pressure of crew (Qiu, G. L., 2011).

◆ Domestic laws and regulations:

According to the investigation, it is found that for the newly planned and designed port terminals, the environmental protection agencies require them to provide ballast water port emergency treatment services. Some ports have already considered the requirements of ballast water port emergency treatment (Zhang, L., 2020). It can be predicted that the problems of ballast water port treatment and discharge management may involve the joint law enforcement of multiple departments at the same time, resulting in a series of problems such as discharge standards, leading departments,

laws and regulations documents, emergency plans and so on. However, there are no similar laws, regulations and management procedures in China. The reality is that the port side is at a loss and in a dilemma. On the one hand, due to the environmental impact assessment requirements, we have to have the capacity of ballast water port treatment services. On the other hand, due to the imperfect laws and regulations, we worry that the purchased equipment can not really meet the relevant requirements.

◆ Equipment standard:

It is reported that there are only three manufacturers (PACT inChina, Damen in the Netherlands and BWC in the UK) who really develop ballast water port solutions worldwide. In addition to the differences in treatment mode, parts and materials, operation control logic, and operation stability, the most important differences between ballast water port equipment and ship equipment include: Online, rapid one-time processing capacity of port equipment;Secondary treatment or long-term chemical contact treatment capacity of marine equipment;Port equipment shall be equipped with a sludge (sediment) disposal function to cope with large amounts of mud-water mixtures resulting from back-washing of filters (RYAN, H. PETER, S. S.& KEVIN, J. R., 2016). In most cases, it is difficult for port operators to identify their real needs and process quality when selecting ballast water port solution manufacturers. It is suggested to establish relevant equipment standards and admittance threshold, clarify the main functions of equipment, technical route, anti-corrosion material of core parts, core inactivation dose, no secondary pollution and other technical problems.

◆ Ship-shore joint:

For most ships, the ballast water loaded is discharged from multiple outlets on both sides of the ship's side. As some of the outlets may be located below the waterline, there will be great challenges. It is found that only a few ships (scientific research

ships, government service ships, oil tankers, etc.) can discharge all their ballast water through the main pipe on the deck, while the port operators can connect with the ship's deck main pipe through the universal joint, and finally transfer the ballast water to the shore or the third-party barge for treatment (Zhang, L., 2020), which is shown in figure 6. It is suggested that both the port side and the ship side carry out infrastructure and pipeline renovation work at the same time. The deck position of the ship shall be equipped with ballast water main pipes for discharging or transferring ballast water. The port side shall be equipped with common shore connections, pipelines and operation auxiliary facilities.

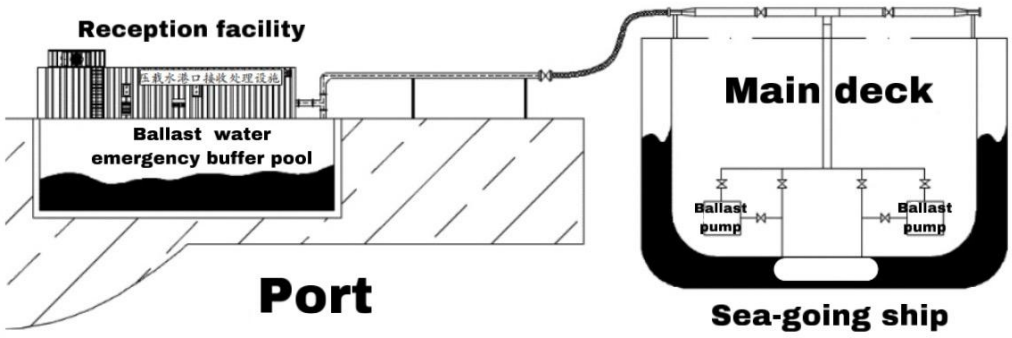

Figure 6 - Ship-shore joint method

Source: Zhang, L. (2020). Problems and development prospect of ballast water port treatment. Port technology, 31-43.

◆ Ship sediment treatment:

In most ballast water treatment processes, a large amount of filter backwash sludge is inevitably produced. If the process takes place on a ship's ballast water management system, it can be returned directly to the original waters, and this operation does not violate the requirements of the BWM Convention. On the contrary, if the ballast water port reception facility is connected to ships from abroad, the backwash sludge generated in the treatment process here cannot be discharged at will. This is because

currently it is not possible to assess the presence of unknown organisms from other sea areas and their hazards in ship sediments. Especially for ships coming from epidemic areas, they should be treated with caution and properly handled (Zhang, L., 2020).

The construction of ballast water reception facilities does not mean that the ballast water management system manufacturers will be severely hit, on the contrary,it will promote the development of related upstream industries and drive local economic growth. China and even the world should actively participate in the formulation and modification of relevant rules to facilitate the use of ballast water reception facilities.

4.4 Suggestions for Zhoushan port to implement BWM Convention

Zhoushan, as the fishing base of the East China Sea and at the mouth of the Yangtze River, has a huge number of ships and complicated types every year. In order to better implement the BWM Convention, Zhoushan should start from the actual situation of the port, and take measures from the following aspects: deep-sea fishing vessels, seagoing merchant ships, ship repair and construction industry and other relevant port facilities. Since the measures proposed by the competent authorities and laws and regulations have been mentioned before in the article, they will not be repeated here.

- Deep-sea fishing vessels:

According to the data, the number of Chinese deep-sea fishing vessels was 2512 in 2015 and 2900 in 2017 (including ships under construction). In 2018, there were 37 deep-sea fishery qualified enterprises in Zhoushan City, and 564 deep-sea fishing boats were put into operation[2].

[2] Website: http://www.zjso.gov.cn/zs/dcxx/dcfx/201909/t20190919_94246.shtml

The footprints of Zhoushan fishing vessels have spread all over the high seas of the three oceans and the exclusive economic zones of more than 10 countries, and the total output value of offshore fisheries has exceeded 10 billion yuan. At present, Zhoushan City has built a number of offshore fishing bases in Peru, Fiji, Uruguay, Cook Islands, Papua New Guinea and other places. Apart from Uruguay, which has not yet joined any MoU, deep-sea fishing vessels with a total tonnage of more than 400 tons and equipped with ballast tanks may be subject to port state control and inspection. In Zhoushan port, although the number of deep-sea fishing vessels with ballast tanks of more than 400 tons is small, the number of vessels still under construction and meeting the requirements will definitely increase in the future[3].

Due to the complex diversity of navigation and operation areas, the particularity of fishing operations, and the requirements of preservation and transportation of catch, deep-sea fishing vessels generally require a lower center of gravity and a strict limit on their minimum draft depth (Gu, M. T., 1988). In addition, the space in the cabin of fishing boats is tight, so the ballast method mainly adopts fixed ballast (Jia, F., 1990& Liu, D. L., Yu, X., Jia, J. B., Sun, F. S.& Luan, T., 2014). The simple ship type diagram of fishing boat is shown in the figure 7. A fishing vessel with ballast tanks shall meet the BWM Convention if it calls at the ports of other Contracting States for loading, unloading, or replenishment. The D-2 standard's requirements are met by the addition of a ballast water management system. Unlike fat big European boats, slender Chinese deep-sea fishing boat ship form, the space is relatively narrow, and the ballast water management system usually need a larger space, so the ship design and construction put forward higher requirements, especially for existing ship, in the original adding ballast water management system in the engine room will be very difficult (Li, S. Y., Cao, J. J., Li, Y., Yang, H.& Zheng, J. L., 2018).

[3] Website: http://www.zhoushan.cn/rdzz/ggkf2018/zsggkf2018/201812/t20181229_909603.shtml

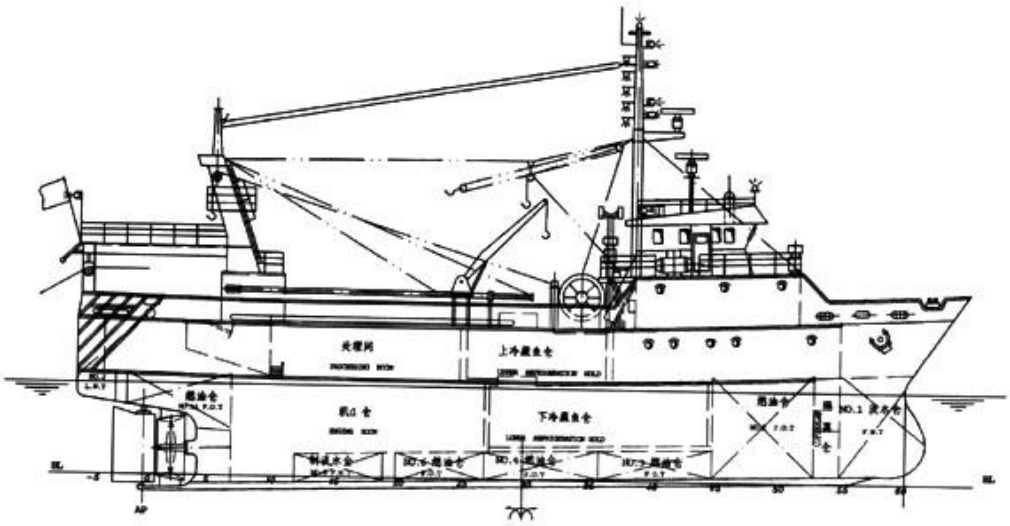

Figure 7 - The simple ship type diagram of fishing boat

Source:

https://pic.sogou.com/d?query=%E6%B8%94%E8%88%B9%E8%88%B9%E5%9E%8B%E5%9B%BE&mode=1&did=6

Ballast water management systems typically cost between $200, 000 and $3 million. That is more than the cost of some small, deep-sea fishing boats. Moreover, adding the equipment would lead to an increase in power consumption and the size of the generator set, which most fishermen would not accept such a high price.

This paper suggests that the municipal government should introduce support policies, cooperate with various deep-sea fishing companies to give financial support to the ocean fishing boats in need, and give incentives and preferential policies to the ships that take the initiative to install and transform, so as to encourage the fishing boats to actively fulfill their obligations.

- Sea-going merchant ships and shipping companies:

At present, there are about 20 international shipping enterprises and 51 international shipping vessels in Zhoushan, among which 43 are under the gross tonnage of 10,000. In order to fulfill the requirements of the BWM Convention, ships (owners) need to invest a large amount of money in ship retrofitting and equipping with the corresponding ballast water management system. It is estimated that it would cost about $500,000 for a 100,000 tonnage bulk carrier to fully meet the required standards. Therefore, the installation of ballast water management system will increase the construction and operation costs of ships, leading to higher freight rates. International vessels are in relatively good condition and have relatively high operating and profit potential. In the long run, owners may choose ballast water management system or reduce the existing market share. But if shipowners choose to withdraw from the international shipping market, Zhoushan international shipping trade will cause greater adverse impact. As the main body of implementing the Convention on ballast water, the ships and shipping companies engaged in the operation of international routes should combine their own reality, according to the requirements of the convention business strategy adjustment actively, carry out relevant preparations in advance, including perfecting the safety management system, equipped with relevant certificates and documents, take effective measures or install ballast water management system, for the crew to carry out targeted training, enhance the competitiveness of ship operation, reduce may have technical or management.

- Shipyard:

With the entry into force of the BWM Convention, the ship may be put into dock for repair in nearly one year, and the interval time is shorter than that of normal maintenance. However, according to the major ship repair and construction enterprises in Zhoushan, there are basically no existing ships to install the system except for new ones. It is expected that the number of ships installed with ballast

water management system will increase after 2-3 years or more. At the same time, because ship owners usually purchase ballast water management system by themselves, and ship repair enterprises are only responsible for on-site installation and commissioning, so the profit brought by adding ballast water treatment system to ship repair enterprises is limited. All shipyards can train relevant technical personnel in advance and purchase the necessary technical equipment properly, so that the staff can keep up with the pace of international performance. Once it comes to the peak of BWMS installation, the work can be carried out more smoothly and the efficiency can be improved, which can also attract more orders and improve the profits of the shipyard.

- Port reception facility and related infrastructure:

Although the establishment of a ballast water and sediment reception facility is not a mandatory requirement of the BWM Convention, it is considered that the port state government should provide necessary supplementary measures to those ships which are unable to meet the requirements of ballast water management due to special reasons, especially when the ship is repairing or cleaning the ballast tank, the sediment in the tank must be properly disposed of. Therefore, Zhoushan port administrative department should promote the construction of facilities for reception and disposing ballast water at the port (including shipyard), and implement the qualification and dynamic supervision of reception units.

In addition, as a coastal port, Zhoushan has a very large amount of sand in the sea water, which is far beyond the test conditions stipulated in G8 guidelines, which makes the ballast water management facility of ships unable to be used in these areas. If the port has built the ballast water reception facility, the port can solve this technical problem according to its own water area characteristics. Once there is no pressure of port state control and inspection, more international ships will be attracted to berth

and trade in Zhoushan port, and the economic development of Zhoushan port will be accelerated.

CONCLUSIONS

According to statistics, 80% of the world's international trade goods are completed by ship transportation, so ship transportation, especially ocean freight transportation, is an extremely important link in the global logistics network. The uncontrolled discharge of ballast water will lead to the invasion of alien marine organisms into the local waters and spread in large numbers, thus breaking the balance of marine ecosystem, endangering fishery resources and affecting public health. The prevention of harmful species invasion is very important for the protection of marine biodiversity

and environment. The International Convention on the control and management of ballast water and sediment provides legal constraints for this. Therefore, the entry into force and implementation of the BWM Convention is indeed in line with the needs of social development, which is conducive to the long-term development of ocean shipping and the global marine ecological balance.

In order to ensure the global consistent performance of the BWM Convention, the requirements of the relevant IMO recognize the formulation and the necessity of the provisions of the convention relevant guides. Therefore, 14 technical guidelines were successively established since 2004,, including approval guideline of ballast water management system (G8) in April 2018, in IMO MEPC.72 session by becoming mandatory rules, and similarly the use of active material approval procedure of ballast water management system (G9) may also be forced to change in the future. As one of the members of the implementing countries, China should also accelerate the improvement of relevant domestic laws and regulations, and introduce more detailed and coercive measures to ensure the smooth implementation of the implementation.

The Guidelines for Port State Supervision of the BWM Convention were discussed and approved at the 28th Committee of the Tokyo Memorandum held in Vladivostok in September 2017. The guidelines are intended to provide basic guidance for port State inspections to verify compliance with the requirements of the BWM Convention. From January 22, 2019, the BWM Convention officially entered into force in China, and China carries out responsive port state monitoring and inspection in accordance with the convention. However, relevant laws and regulations in China are not mandatory, which also hinders the implementation of the contract. We can learn more excellent experience from foreign countries, such as the legal integrity and mandatory of USCG in the United States. The competent authority should also study the PSC inspection content of ballast water in depth, so that the ballast water that may have

problems from foreign countries will not pollute the aquatic ecology of China.

This paper compares the advantages and disadvantages of BWMS and port reception facility from the perspectives of economic cost, environmental protection degree and human nature, etc. The port reception and handling method is more conducive to national management and the survival and development of shipping enterprises, as well as ecological environment protection than BWMS in many aspects. The country and even the world should actively promote the port reception facilities, and ports should be equipped with domestic research equipment as soon as possible, accumulate relevant experience, train professional personnel, break through the blockade of foreign companies on this technology. At present, the BWM Convention is still in the experience-building phase, and China has also issued the Measures for the Supervision and Management of Ship Ballast Water and Sediment. As an effective means to meet the requirements of the Convention, the reception facilities of ballast water ports provide a strong guarantee for the further protection of marine environment and the diversity of ecological species.

Last but not least, according to the status quo of the BWM Convention implementation in China and the impact analysis on Zhoushan Port, Zhoushan Port should focus on strengthening measures to cope with international exchanges and cooperation, and take the initiative to make preparations for the port implementation. Zhoushan has a rich fishery and port resources, and has a large number of shipyard. In addition, according to the actual situation of the port and the principle of sustainable development, Zhoushan should improve the comprehensive capacity of all relevant parties to perform the BWM Convention.

The implementation of the BWM Convention in China has to deal with many difficulties and arduous tasks. Its implementation will drive another round of

industrial adjustment and capacity elimination in the international shipping industry, and the technical strength of ships and supporting industries is still a necessary condition for a shipping power. In the process of studying the implementation of the Convention, researchers and practitioners should also give more thought, no matter from the port state supervision and management or ballast water treatment system technology, they should strive to lead China to the road from implementing the Convention to leading the international maritime trend.

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