

World Maritime University

# The Maritime Commons: Digital Repository of the World Maritime University

---

Maritime Safety & Environment Management  
Dissertations

Maritime Safety & Environment Management

---

8-27-2017

## Research on implementation of IMO instruments by China Hydrographic Office

Lingzhi Wu

Follow this and additional works at: [https://commons.wmu.se/msem\\_dissertations](https://commons.wmu.se/msem_dissertations)



Part of the [Public Administration Commons](#), and the [Public Policy Commons](#)

---

This Dissertation is brought to you courtesy of Maritime Commons. Open Access items may be downloaded for non-commercial, fair use academic purposes. No items may be hosted on another server or web site without express written permission from the World Maritime University. For more information, please contact [library@wmu.se](mailto:library@wmu.se).

**WORLD MARITIME UNIVERSITY**

Dalian, China

**RESEARCH ON IMPLEMENTATION OF IMO  
INSTRUMENTS BY CHINA HYDROGRAPHIC  
OFFICE**

By

**WU Lingzhi**

**The People's Republic of China**

A dissertation submitted to the World Maritime University in partial  
Fulfillment of the requirements for the award of the degree of

**MASTER OF SCIENCE**

**(MARITIME SAFETY AND ENVIRONMENTAL MANAGEMENT)**

2017

## DECLARATION

I certify that all the material in this research paper that is 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 research paper reflect my own personal views, and are not necessarily endorsed by the University.

(Signature): WU LINGZHI

(Date): June 28, 2017

Supervised by: LIU Dagang

Professor

Dalian Maritime University

---

Assessor: \_\_\_\_\_

Co-assessor: \_\_\_\_\_

## **ACKNOWLEDGEMENTS**

Time flies. With the completion of this thesis, 14 months of short and substantial graduate studies are coming to an end. Two years' campus life has given me a lot of new understanding and insights into my studies and life.

First of all, I would like to thank World Marine University and Dalian Maritime University for providing me with top educational resources and excellent learning environment, and opening a window to the new world for me. At the same time, I would like to thank all the teachers of the MSEM 2017 program, especially my thesis supervisor, Professor Liu Dagang, whose professionalism and preciseness are the precious wealth of my whole life.

Secondly, I would like to express my warmest thanks to Navigation Guarantee Center of North China Sea who offers me such a rare opportunity to learn and solid funding support, which sprinkles my life with stardust. Besides, I would like to express my warmest thanks to all of the leaders and colleagues of my office. My departure has imposed heavy workload on them, while their support has laid foundation of my valuable and successful experience.

Thirdly, I am particularly grateful to all my classmates, especially comrades and brothers of the fifth group. All the sweat and tears, all the day and night, have become my best memories.

Last but not least, my sincere thanks should also be given to my family. Because of their bearing hardship without complaint, I can safely temporarily remove the responsibility to the family and pursue the dream of further studies; because of their love and support, I have the courage of choosing to accept this rare opportunity in my thirty years of age, and enrich my experience of life.

## **ABSTRACT**

**Title of Dissertation:** Research on Implementation of IMO Instruments by  
China Hydrographic Office

**Degree:** Master of Science (M.Sc)

This paper aims to explore the methods and ways to improve the implementation of IMO instruments by China Hydrographic Office.

This paper has found out shortcomings of CHO in the implementation of IMO instruments in National Legislation of the Requirements of IMO Instruments, provision of high-quality hydrographic service including hydrographic capacity, production and distribution of nautical charts and nautical publications, promoting the uniformity in charts and nautical publications and supporting the PSC and FSC inspection of carriage of nautical charts and their equivalent, and the management of hydrographic survey ships, through making an reference of the specific requirements of IMO instruments and advanced experience of UKHO in hydrographic service, based on the assessment of status of CHO in the implementation of IMO instruments with several methods such as documentation method, data analysis and comparative study.

On the basis of the analysis of causes and key difficulties, the paper draws a conclusion that promoting Chinese ability and level of hydrographic service through National Legislation of the Requirements of IMO Instruments, hydrographic capacity building and standardized management is the most fundamental way to improve Chinese ability and level of compliance with IMO instruments.

In the end, the paper makes an analysis of the limitations of this research, and puts forward some suggestions for further research.

**KEY WORDS:** hydrographic service, compliance, IMO audit scheme, capacity building, countermeasures.

## TABLE OF CONTENTS

DECLARATION .....	I
ACKNOWLEDGEMENTS .....	II
ABSTRACT .....	III
TABLE OF CONTENTS .....	V
LIST OF TABLES .....	IX
LIST OF FIGURES .....	X
LIST OF ABBREVIATIONS .....	XI
Chapter 1: Introduction .....	1
1.1 Background Information .....	1
1.2 Purpose and Objectives of Research .....	1
1.3 Methodology .....	2
1.4 Structure of the Research Paper .....	3
1.5 Chapter Summary .....	4
Chapter 2: The content and development process of Compliance with IMO Instruments .....	5
2.1 The Content of the Implementation of IMO Instruments .....	5
2.2 The Development Process of the Implement System of IMO Instruments .....	7
2.2.1 Unsatisfactory Implementation of IMO Instruments before Audit Scheme .....	7
2.2.2 The Introduction of Voluntary IMO Member States Audit Scheme .....	9
2.2.3 Transition from Voluntary Audit scheme to Compulsory Audit scheme	10
2.3 Chapter Summary .....	12
Chapter 3: Analysis of the Content of IMO Instruments Required to be Implemented by China Hydrographic Office .....	13
3.1 The Content of IMO Instruments Related to the Provisions of Hydrographic	

<i>Service</i> .....	13
3.1.1 <i>The Content of SOLAS Related to the Hydrographic Service</i> .....	13
3.1.2 <i>Technical Standards Related to Hydrographic Service Developed by IHO</i> .....	18
3.2 <i>The Content of IMO Instruments related to the Management of Hydrographic Survey Ship</i> .....	21
3.2 .1 <i>SOLAS</i> .....	21
3.2 .2 <i>MARPOL</i> .....	24
3.2 .3 <i>STCW</i> .....	26
3.3 <i>Chapter Summary</i> .....	28
Chapter 4: <i>Analysis of the Chinese Status and Achievements of Compliance with IMO Instruments</i> .....	29
4.1 <i>Organizational Structure and Management Mode of China Hydrographic Office</i> .....	29
4.2 <i>Provision of High-Quality Hydrographic Services</i> .....	31
4.2.1 <i>Hydrographic Surveying</i> .....	31
4.2.2 <i>Production of Nautical Charts and Nautical Publications</i> .....	32
4.2.2.1 <i>Production of Paper Charts and Electronic Navigational Charts</i> .....	32
4.2.2.2 <i>Nautical Publications</i> .....	36
4.2.3 <i>Distribution of Nautical Charts and Nautical Publications</i> .....	36
4.2.4 <i>Promoting the Uniformity in Charts and Nautical Publications</i> .....	38
4.2.5 <i>Supporting the Carriage of ECDIS</i> .....	39
4.2.6 <i>Supporting the PSC and FSC Inspection of Carriage of Nautical Charts and Their Equivalents</i> .....	40
4.3 <i>Management of Hydrographic Survey Ships</i> .....	40
4.3.1 <i>The Construction and Survey of Hydrographic Survey Ships</i> .....	40
4.3.2 <i>Operation of Hydrographic Survey Ships</i> .....	41

4.3.3	<i>To Prevent Marine Pollution from Hydrographic Survey Ships</i> .....	42
4.4	<i>Chapter Summary</i> .....	42
Chapter 5:	<i>Shortcomings of CHO in the implementation of IMO instruments</i> .....	43
5.1	<i>National Legislation of the Requirements of IMO Instruments</i> .....	43
5.2	<i>Provision of Hydrographic Service</i> .....	44
5.2.1	<i>Hydrographic Capacity Building</i> .....	44
5.2.2	<i>Production of Nautical Charts and Nautical Publication</i> .....	47
5.2.3	<i>Distribution of Nautical Charts and Nautical Publication,</i> .....	50
5.2.4	<i>Promoting the Uniformity in Charts and Nautical Publications</i> .....	51
5.2.5	<i>Supporting the PSC and FSC Inspection of Carriage of Nautical Charts and Their Equivalents</i> .....	52
5.3	<i>Management of Rental Fishing Vessels Used for Hydrographic Surveying.</i>	53
5.4	<i>Chapter Summary</i> .....	54
Chapter 6:	<i>The Measures of and Suggestions on Improving the Implementation of IMO Instruments by CHO</i> .....	55
6.1	<i>Strengthening the Study of Countermeasures for IMO Member State Audit</i>	55
6.2	<i>National Legislation of the Requirements of IMO Instruments</i> .....	57
6.3	<i>Improvement of the Capacity and Level of Hydrographic Service</i> .....	58
6.3.1	<i>Capacity Building of Hydrographic Surveying</i> .....	58
6.3.2	<i>Production of Nautical Charts and Nautical Publications</i> .....	62
6.3.3	<i>Distribution of Nautical Charts and Nautical Publications</i> .....	62
6.3.4	<i>Promoting the Uniformity in Charts and Nautical Publications</i> .....	64
6.3.5	<i>Supporting the PSC and FSC Inspection of Carriage of Nautical Charts and Their Equivalents</i> .....	65
6.4	<i>Improving the Management of Hydrographic Survey Ships</i> .....	66
6.5	<i>Chapter Summary</i> .....	67
Chapter VII:	<i>Conclusions</i> .....	68

<i>7.1 Summary</i> .....	68
<i>7.2 Limitations</i> .....	69
<i>7.3 Implications for Further Research</i> .....	70
REFERENCES .....	72

## LIST OF TABLES

Table 2.1	Relation between the 10 IMO Instruments and China	6
Table 3.1	IHO Publications	19
Table 3.2	Chapters of the Annex of SOLAS	22
Table 3.3	Relation between the Annexes of The MARPOL Convention and China	25
Table 3.4	Annex of the Present STCW Convention	27
Table 4.1	Comparison Table of Chart Categories between IHO Standard and Chinese National Standard	33
Table 4.2	Number of Charts of China By Sea Area	35
Table 4.3	Statistics of Distribution Sites of Nautical Charts and Nautical Publications	38
Table 5.1	Comparison Table of Planned Charts in 2006, 2009 and 2012	45
Table 5.2	Main List of Nautical Charts and Nautical Publications Produced by the UKHO	48

## **LIST OF FIGURES**

Figure 1.1	The Structure Diagram of The Paper	4
Figure 4.1	The Structure Chart of China Hydrographic Office	30
Figure 4.2	The Structure Chart of Chinese Distribution Network of Nautical Charts and Nautical Publications	37
Figure 6.1	Management Mechanism of the Implementation of IMO Instruments Based On ISO 9001 Quality Management System	57

## **LIST OF ABBREVIATIONS**

AIS	Automatic Identification System
BDS	Beidou Navigation Satellite System
CCS	China Classification Society
CHO	China Hydrographic Office
COLREG	The Convention on the International Regulations for Preventing Collisions at Sea, 1972, as amended
CORS	Continuously Operating Reference Stations
DGPS	Differential Global Positioning System
EAHC	East Asia hydrographic Commission
ECDIS	Electronic Chart Display And Information System
EEZ	Exclusive Economic Zone
ENC	Electronic Navigational Chart
FSC	Flag State Control
GIS	Geographic Information System
GPS	Global Positioning System
HPD	Hydrographic Production Database
IENC	Inland Electronic Navigational Chart
IHO	International Hydrographic Organization
ICONS	International Commission on Shipping
IMO	International Maritime Organization
ISM Code	International Safety Management Code
LL	The International Convention on Load Lines,1966
MARPOL	The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto, as amended

MSA	Maritime Safety Administration
MSC	Maritime Safety Committee
NOAA	National Oceanic and Atmospheric Administration
POD	Print on Demand
PSC	Port State Control
SAF	Flag State Performance Self Assessment Form
SOLAS	International Convention for the Safety of Life at Sea,1974
STCW	The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended
TONNAGE	The International Convention on Tonnage Measurement of Ships, 1969
UAV	Unmanned Aerial Vehicle
UNCLOS	United Nations Convention on the Law of the Sea,1982
UKHO	Hydrographic Office of United Kingdom of Great Britain and Northern Ireland
VMAS	Voluntary IMO Member State Audit Scheme
NMFT	No More Favorable Treatment
RO	Recognized Organizations

## **Chapter 1**

### **Introduction**

#### ***1.1 Background Information***

International Maritime Organization (referred to as "IMO") is a specialized agency of the United Nations for the safety, security and environmental performance of international shipping headquartered in London (IMO, 2017). It has developed a series of Conventions, Protocols, Codes and Recommendations such as the SOLAS Convention, the STCW Convention and the MARPOL Convention, in order to promote safety of navigation and marine environmental protection in the global waters (Qin, Z., Yu & Y. D., 2010). These IMO instruments are the crystallization of IMO collective wisdom, which is of great significance for ensuring safety of navigation and protecting the marine environment.

Hydrographic surveying and mapping is the basis of safety of navigation and the protection of marine environment (Cao, Y., Zhou, P., 2009). China Hydrographic Office (referred to as "CHO" ) is a part of China Maritime Safety Administration (referred to as "China MSA" ). The implementation of IMO instruments is not only the obligations of CHO, but also an important way to improve the Chinese capacity and level of hydrographic service.

#### ***1.2 Purpose and Objectives of Research***

The purpose of this paper is to improve Chinese ability and level of compliance with IMO instruments and further standardize and improve the management and service level of CHO.

a) To analyze the content and development process of compliance with IMO instruments;

- b) To clarify the content of IMO instruments required to be implemented by CHO;
- c) To analyze the Chinese status and achievements of compliance with IMO instruments;
- d) To find shortcomings of CHO in the implementation of IMO instruments through a comparative study with the provision of IMO instruments and the experience of compliance of developed hydrographic nations.
- e) To explore the measures and methods of improving the implementation of IMO instruments by CHO.

### ***1.3 Methodology***

- a) Documentation method. Chapter 2 will analyze and sum up the content and development process of compliance with IMO instruments by studying IMO instruments and papers related to compliance and member state audit scheme. Chapter 3 will summarize the content of IMO instruments required to be implemented by CHO through studying IMO instruments including conventions.
- b) Data analysis method. Chapter 4 will analyze the Chinese status and achievements of compliance with IMO instruments through the collection and analysis of data.
- c) Comparative study. Chapter 5 will find shortcomings of CHO in the implementation of IMO instruments through a comparative study with the provision of IMO instruments and the experience of compliance of developed hydrographic nations.
- d) Experience summarization method. Chapter 6 will propose measures and suggestions of improving the implementation of IMO instruments by CHO, based on previous research results and the author's professional experience for many years in CHO.

#### ***1.4 Structure of the Research Paper***

Chapter 1 gives a brief description of the background, purposes, objectives and methods of the research, and the structure of the paper.

Chapter 2 analyzes the content and development process of compliance with IMO instruments, and lay the foundation for further research.

Chapter 3 focuses on the analysis of the content of IMO instruments required to be implemented by CHO.

Chapter 4 analyzes the Chinese status and achievements of compliance with IMO instruments.

Chapter 5 finds shortcomings of CHO in the implementation of IMO instruments through a comparative study with the provision of IMO instruments and the experience of compliance of developed hydrographic nations.

Chapter 6 explores the measures and methods of improving the implementation of IMO instruments by CHO.

On the basis of the above research, the conclusions summarizes this study, and points out the limitations and the further research proposals.

The structure diagram of the paper is shown in Figure 1.1.

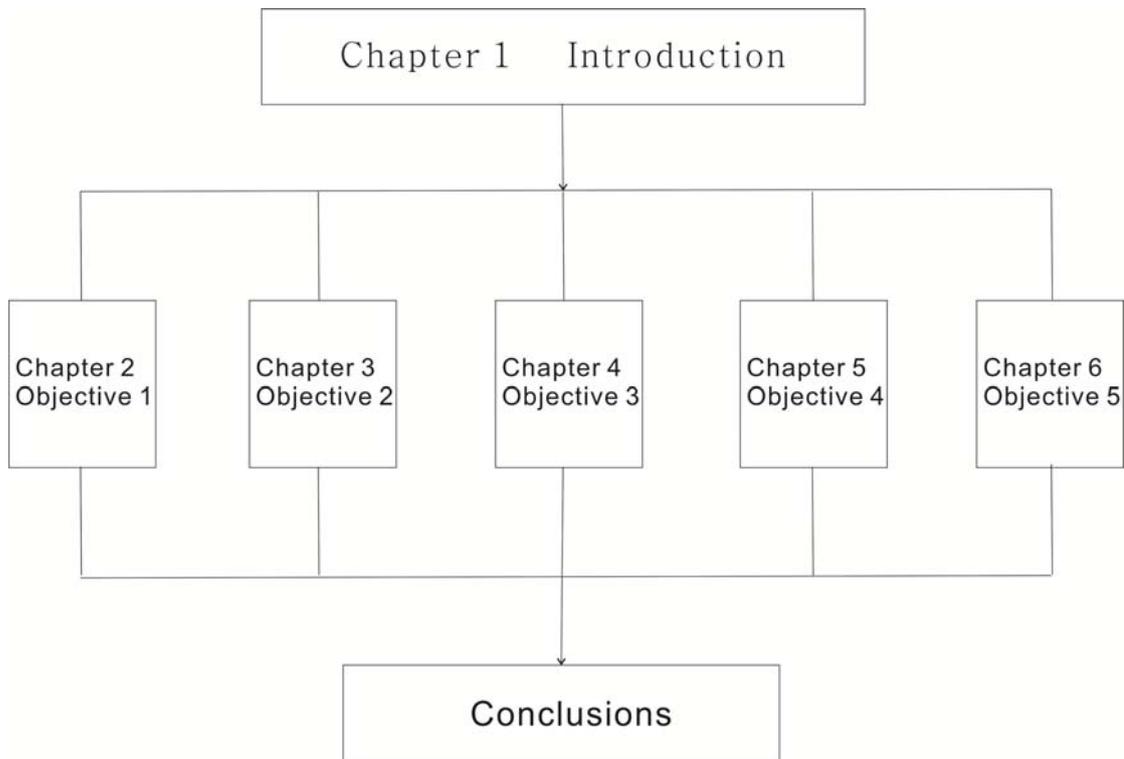


Figure 1.1 - The Structure Diagram of the Paper

Source: Wu Ling-zhi, 2017

### ***1.5 Chapter Summary***

These IMO instruments are the crystallization of IMO collective wisdom, which is of great significance for ensuring the safety of navigation and protecting the marine environment. The implementation of IMO instruments is not only the obligations of CHO, but also an important way to improve the Chinese capacity and level of hydrographic service. This research analyzes the Chinese status and shortcomings of compliance with IMO instruments by making use of several methods such as documentation method, data analysis and comparative study, and propose measures and gives suggestions of improving the implementation of IMO instruments by CHO, in order to improve the Chinese capacity and level of hydrographic service.

## Chapter 2

### **The Content and Development Process of Compliance with IMO Instruments**

#### ***2.1 The Content of the Implementation of IMO Instruments***

IMO has developed more than 40 conventions and protocols as well as more than 800 codes and recommendations on maritime safety, prevention of marine pollution and other related matters since its establishment (Yu, H. B., 2011). Generally speaking, all of these are IMO instruments which shall be implemented by member states. In particular, according to Code for the Implementation of Mandatory IMO Instruments adopted by Resolution A.973 (24), the main and key content of the implementation of IMO instruments are the obligations and responsibilities of contracting states stipulated by 10 IMO instruments including 6 conventions. These 10 IMO instruments are as follows (IMO, 2005a):

- a) the International Convention for the Safety of Life at Sea, 1974, as amended (SOLAS 1974);
- b) the Protocol of 1978 relating to the International Convention for the Safety of Life at Sea, 1974, as amended (SOLAS PROT 1978);
- c) the Protocol of 1988 relating to the International Convention for the Safety of Life at Sea, 1974, as amended (SOLAS PROT 1988);
- d) the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto, as amended (MARPOL 73/78);
- e) the Protocol of 1997 to amend the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL PROT 1997);

f) the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended (STCW 1978);

g) the International Convention on Load Lines, 1966 (LL 66);

h) the Protocol of 1988 relating to the International Convention on Load Lines, 1966 (LL PROT 1988);

i) the International Convention on Tonnage Measurement of Ships, 1969 (TONNAGE 1969); and

j) the Convention on the International Regulations for Preventing Collisions at Sea, 1972, as amended (COLREG 1972).

The status of Chinese accession to these 10 IMO instruments is shown in the following table 2.1.

Table 2.1 - Relation between the 10 IMO Instruments and China

<b>Name</b>	<b>Date of entry into force</b>	<b>Date of Ratification or Accession by china</b>	<b>Date of entry into force for china</b>
SOLAS 1974	1980.5.25	1980.1.7	1980.5.25
SOLAS PROT 1978	1981.5.1	1982.12.17	1983.3.17
SOLAS PROT 1988	2000.2.3	1995.2.3	2000.2.3

MARPOL 73/78	1983.10.2	1983.7.1	1983.10.2
MARPOL PROT 1997	2005.5.19	2006.3.15	2006.8.23
STCW 1978	1984.4.28	1981.6.8	1984.4.28
LL 66	1968.7.21	1973.10.5	1974.1.5
LL PROT 1988	2000.2.3	1995.2.3	2000.2.3
TONNAGE 1969	1982.7.18	1980.4.8	1982.7.18
COLREG 1972	1977.7.15	1980.1.7	1980.1.7

Source: Wei, J. T., Ma, Y. L. (2009). IMO's 60 years for regulating and serving the international shipping -A review of IMO's history of 60 years. *China Maritime Safety*, (10), 58–62.

## ***2.2 The Development Process of the Implementation System of IMO Instruments***

### ***2.2.1 Unsatisfactory Implementation of IMO Instruments before Audit Scheme***

Before the introduction of the member state audit scheme, IMO has taken a series of measures such as PSC, STCW, ISM, and SAF and so on, to strengthen and supervise the implementation of IMO instruments by member states, but the results are still unsatisfactory.

First of all, the PSC officers of port states cannot always effectively fulfill their responsibilities, though IMO has made guidelines for PSC inspection. The existence of plenty of problems such as lack of training of PSC officers and unified procedures

lead to the lack of unified standards of port state control. Take the accident of Tanker "prestige" for example, the PSC inspection which is nearest to the accident time failed to detect the serious structural defects of the tank (Zhao, Y. B., Yang, Y. L., 2009).

In the second place, there are also some problems in the implementation of STCW convention by member states. The existence of forged STCW certificates of competency seriously damaged the benefits resulting from STCW 95. According to statistics, no less than 12635 forged certificates are used (ICONS, 2001). In addition, the quality control of STCW convention only involves the seafarer training, but not involve the whole implementation of IMO instruments by flag state. Finally, under the STCW convention, IMO will not conduct an on-site audit to member states but make an audit to the written materials submitted by them.

Thirdly, there is a gap between the implementation of the ISM code and the requirements of the code. The only purpose of some shipping companies is to obtain the certificate; therefore they tend to implement the code by making plenty of documents. However, all the contents recorded in these documents may not actually be implemented. In addition, this paper work imposes a heavy workload on the crew.

At the end, the implementation of the flag state performance self assessment form (referred to as "SAF" ) is unsatisfactory. Only 54 member states and associate members submitted SAF to IMO by March 2004 (Li, Z. & Qiu J. W., 2007). Besides, as an internal assessment manner, SAF cannot really exert equal pressure on all member states. Finally, it is difficult to collect enough and accurate information through SAF because deadlines for reporting and correction of reports are not stipulated in SAF.

These problems above indicate that it is necessary to introduce an external mechanism for the supervision of the implementation of IMO instruments by member states.

### ***2.2.2 The Introduction of Voluntary IMO Member States Audit Scheme***

Voluntary IMO Member States Audit Scheme (referred to as “VMAS” ) means that IMO conducts a audit on a voluntary basis to determine to what extent member states are implementing and enforcing all the IMO conventions they joined, especially the management work of the maritime authority of member states (IMO, 2005b). The purpose of VMAS is to find out the deficiencies in the performance of IMO member states and put forward reasonable suggestions and opinions by VMAS, boost the exchange of successful and failure experience in the performance of IMO member states, and promote global maritime safety, protection of the marine environment and the improvement of administrative management of maritime authorities on a global scale (Wang, B. J., 2008).

International Commission on Shipping (referred to as “ICONS” ) is the first one to suggest the independent audit of the performance of flag states, which took place in the first Cooperation Meeting of Ministers of Transport in January 2002 (ICONS, 2001).

In May 15, 2002, the United Kingdom of Great Britain and Northern Ireland (referred to as “UK” ) and other 19 member states proposed to IMO to establish and develop a demonstrative audit scheme of member states on a voluntary basis to ensure that standards of maritime safety and environmental protection stipulated in IMO instruments will be implemented in a correct manner (IMO Secretariat, 2002).

On November 7, 2003, IMO adopted voluntary IMO member state audit scheme by resolution A.946 (23) (IMO, 2004). In order to ensure that all of the IMO instruments are effectively implemented, the scope of VMAS is not limited to flag states, but extends to coastal states and port states.

From September to November in 2004, IMO conducted two groups of experimental audit to obtain the audit experience. The first group consisted of UK, Cyprus and Marshall Islands, and the second group included Singapore, Iran and France. The content of two audits covered all of the mandatory IMO instruments joined by these member states except security regulations (Li, Z., Qiu J. W., 2007).

On December 1, 2005, IMO adopted framework and procedures for the voluntary IMO member state audit scheme through Resolution A.974 (24), which indicated that the implementation of VMAS on a global scale is officially on the agenda (IMO, 2005b).

In 2006, VMAS was officially implemented (Kuang, X. Y. & Xu, H.2008).

In June 2008, in order to protect the interests of Chinese shipping industry and demonstrate to the world the good image of Chinese government, China MSA submitted its application of VMAS to the IMO Secretary-General (Wang, S. Y., 2009). In November 2009, China successfully passed the audit implemented by IMO audit team (Ma, Y. L. & Song, W., 2010). However, the audit also discovered some shortcomings of Chinese compliance management such as the lack of systematicness, inadequate national legislation of international conventions and so on (Wang, F., 2012).

### ***2.2.3 Transition from Voluntary Audit scheme to Compulsory Audit scheme***

On 4 December 2013, the twenty-eighth regular session of the IMO Assembly adopted transition from the voluntary IMO member state audit scheme to the IMO

member state audit scheme by Resolution A.1068 (28) (IMO, 2014). Currently, the chapter VIII of SOLAS has made mandatory from 1 January 2016 the IMO Member State Audit Scheme (Bao, J. Z., 2016), and each member state would be implemented a periodic audit every 3 years (Sha, Z. R., 2010). China is scheduled to be audited in 2021(IMO Secretary-General., 2016).

In theory, VMAS have plenty of disadvantages due to their voluntary nature. Firstly, some member states may avoid implementation of IMO instruments if they do not apply for the audit; secondly, the VMAS may be not translated into action but stay on the paper just like the implementation of ISM code; thirdly, VMAS may not able to impose an equal pressure on all member states and push member states to implement mandatory IMO instruments in a consistent manner.

The mandatory audit scheme has many advantages. Firstly, it will strengthen the connections among flag states, port states, coastal States and even recognized organizations (referred to as "RO" ) on a world-wide scale. Secondly, it will impose an equal pressure on all member states, and this pressure will force member states that have a poor level of performance to make an improvement before the audit. Thirdly, maritime safety and environmental protection can only be effectively improved through the mandatory audit scheme. The international nature of the marine environment requires all member states to implement international conventions uniformly, otherwise member states with a good level of performance will suffer the threat of maritime safety and pollution resulted from ships of member states that have a poor level of performance. Finally, the mandatory audit scheme will help IMO quell down criticism of its ability to control the implementation of IMO instruments from other organizations such as ICONS (Zhao, Y. B., Yang, Y. L., 2009).In general, the advantage of mandatory audits is that it will force member

states to accept audit just like the “No more favorable treatment (referred to as “NMFT” )” provision in some conventions (Song, S., 2016).

### ***2.3 Chapter Summary***

The introduction of IMO audit mechanism is a great progress in the implementation of IMO instruments, especially 10 main instruments including 6 conventions such as SOLAS 74, by member states from the perspective of flag states, coastal states and port states, respectively. This progress promotes the global maritime safety and marine environment protection. The transition from the voluntary IMO member state audit scheme to the IMO member state audit scheme has put forward higher requirements for the compliance ability and level of maritime authorities of member states. Compliance is no longer what you can do or not to do, but an important matter related to the international image of maritime authorities and even governments of member states. Therefore, implementation of IMO instruments by China Hydrographic Office is not only forced by the trend, but also the need for maintaining and promoting the international image and influence of China MSA.

## Chapter 3

### **Analysis of the Content of IMO Instruments Required to be Implemented by China Hydrographic Office**

#### ***3.1 The Content of IMO Instruments Related to the Provisions of Hydrographic Service***

##### ***3.1.1 The Content of SOLAS Related to the Hydrographic Service***

The Content of IMO Instruments related to the Provisions of Hydrographic Service is concentrated on Chapter V of SOLAS (hereinafter referred to as "SOLAS ").

a) The Regulation 2 (2) of Chapter V of SOLAS Convention International Convention for the Safety of Life at Sea (1974) stipulates:

" 2 Nautical chart or nautical publication is a special-purpose map or book, or a specially compiled database from which such a map or book is derived, that is issued officially by or on the authority of a Government, authorized Hydrographic Office or other relevant government institution and is designed to meet the requirements of marine navigation\*

\* Refer to appropriate resolutions and recommendations of the International Hydrographic Organization concerning the authority and responsibilities of coastal States in the provision of charting in accordance with regulation 9."

b) Regulation 9 "Hydrographic services" of Chapter V of International Convention for the Safety of Life at Sea (1974) stipulates:

" 1 Contracting Governments undertake to arrange for the collection and compilation of hydrographic data and the publication, dissemination and keeping up to date of all nautical information necessary for safe navigation.

2 In particular, Contracting Governments undertake to co-operate in carrying out, as far as possible, the following nautical and hydrographic services, in the manner most suitable for the purpose of aiding navigation:

.1 to ensure that hydrographic surveying is carried out, as far as possible, adequate to the requirements of safe navigation;

.2 to prepare and issue nautical charts, sailing directions, lists of lights, tide tables and other nautical publications, where applicable, satisfying the needs of safe navigation;

.3 to promulgate notices to mariners in order that nautical charts and publications are kept, as far as possible, up to date; and

.4 to provide data management arrangements to support these services.

3 Contracting Governments undertake to ensure the greatest possible uniformity in charts and nautical publications and to take into account, whenever possible, relevant international resolutions and recommendations.\*

\* Refer to the appropriate resolutions and recommendations adopted by the International Hydrographic Organization.

4 Contracting Governments undertake to co-ordinate their activities to the greatest possible degree in order to ensure that hydrographic and nautical information is made available on a world-wide scale as timely, reliably, and unambiguously as possible. "

c) Regulation 18 (4) of Chapter V of International Convention for the Safety of Life at Sea (1974) stipulates:

" 4 Systems and equipment installed prior to the adoption of performance standards by the Organization may subsequently be exempted from full compliance with such standards at the discretion of the Administration, having due regard to the recommended criteria adopted by the Organization. However, for an electronic chart display and information system (ECDIS) to be accepted as satisfying the chart carriage requirement of regulation 19.2.1.4, that system shall conform to the relevant performance standards not inferior to those adopted by the Organization in effect on the date of installation, or, for systems installed before 1 January 1999, not inferior to the performance standards adopted by the Organization on 23 November 1995 \*.

\* Refer to the Recommendation on performance standards for shipborne simplified voyage data recorders (SVDRs) (resolution MSC.163(78)), as amended by resolution MSC.214(81), annexes 1 and 2, Revised performance standards for electronic chart display and information systems (ECDIS) (resolution A.817(19)), as amended, and Revised performance standards and functional requirements for the long-range identification and tracking of ships (resolution MSC.263(84)). "

d) Regulation 19 (2.1, 2.10 and 2.11) of Chapter V of International Convention for the Safety of Life at Sea (1974) stipulates:

"2.1 All ships irrespective of size shall have:

... ..

.4 nautical charts and nautical publications to plan and display the ship's route for the intended voyage and to plot and monitor positions throughout the voyage. An electronic chart display and information system (ECDIS) is also accepted as meeting the chart carriage requirements of this subparagraph. Ships to which

paragraph 2.10 applies shall comply with the carriage requirements for ECDIS detailed therein; ( Replaced by Res.MSC.282(86)).

... ..

2.10 Ships engaged on international voyages shall be fitted with an Electronic Chart Display and Information System (ECDIS) as follows:

.1 passenger ships of 500 gross tonnage and upwards constructed on or after 1 July 2012;

.2 tankers of 3,000 gross tonnage and upwards constructed on or after 1 July 2012;

.3 cargo ships, other than tankers, of 10,000 gross tonnage and upwards constructed on or after 1 July 2013;

.4 cargo ships, other than tankers, of 3,000 gross tonnage and upwards but less than 10,000 gross tonnage constructed on or after 1 July 2014;

.5 passenger ships of 500 gross tonnage and upwards constructed before 1 July 2012, not later than the first survey\* on or after 1 July 2014;

.6 tankers of 3,000 gross tonnage and upwards constructed before 1 July 2012, not later than the first survey\* on or after 1 July 2015;

.7 cargo ships, other than tankers, of 50,000 gross tonnage and upwards constructed before 1 July 2013, not later than the first survey\* on or after 1 July 2016;

.8 cargo ships, other than tankers, of 20,000 gross tonnage and upwards but less than 50,000 gross tonnage constructed before 1 July 2013, not later than the first survey\* on or after 1 July 2017; and

.9 cargo ships, other than tankers, of 10,000 gross tonnage and upwards but less than 20,000 gross tonnage constructed before 1 July 2013, not later than the first survey\* on or after 1 July 2018.

\* Refer to the Unified interpretation of the term "first survey" referred to in SOLAS regulations (MSC.1/Circ.1290).

2.11 Administrations may exempt ships from the application of the requirements of paragraph 2.10 when such ships will be taken permanently out of service within two years after the implementation date specified in subparagraphs .5 to .9 of paragraph 2.10. "

e) Regulation 27 "Nautical charts and nautical publications" of Chapter V of International Convention for the Safety of Life at Sea (1974) stipulates:

"Nautical charts and nautical publications, such as sailing directions, lists of lights, notices to mariners, tide tables and all other nautical publications necessary for the intended voyage, shall be adequate and up to date."

f) Regulation 34(1) of Chapter V of International Convention for the Safety of Life at Sea (1974) stipulates:

"1 Prior to proceeding to sea, the master shall ensure that the intended voyage has been planned using the appropriate nautical charts and nautical publications for the area concerned, taking into account the guidelines and recommendations developed by the Organization\* .

\* Refer to the Guidelines for Voyage Planning, adopted by the Organization by resolution A.893 (21). "

### ***3.1.2 Technical Standards Related to Hydrographic Service Developed by IHO***

As mentioned in above provisions of SOLAS convention, International Hydrographic Organization (referred to as “IHO”) is always responsible for international coordination and development of hydrographic technical standards.

International Hydrographic Organization is an intergovernmental consultative and technical organization that was established in 1921 and headquartered in Monaco, to support safety of navigation and the protection of the marine environment (IHO, 2017a). IHO has 87 member states (IHO, 2017b), and China is one of the 18 founders (Zhai, G. J., Huang, M. T., Ouyang, Y. Z., Lu, X. P., 2012). For a long time, IHO makes effort to promote the development of global hydrographic surveying and mapping, and has played an important role in the coordination and the greatest possible uniformity of hydrographic technical standards, improvement of the world technology and management level of hydrographic surveying and mapping, and enhancement of global hydrographic surveying and mapping ability, and has made an important contribution to the safety of navigation and protection of marine environment (Yuan, J. S., Wu, L. L., 2016).

In accordance with IHO Resolution A2.15 “Nautical Publications and the SOLAS Convention”, “It is resolved that nautical publications produced in compliance with these Technical Resolutions and Recommendations shall be deemed to satisfy the relevant carriage requirements for nautical charts and nautical publications in accordance with the International Safety of Life at Sea (SOLAS) Convention Chapter V, particularly regulations 2.2 and 9 (IHO, 2017C).” “Technical Resolutions and Recommendations ” in this resolution refers to the 51 technical standards and manuals divided into 5 class and known as IHO publications, as shown in Table 3.1 below.

Table3.1 : IHO Publications

	<b>Class</b>	<b>Name</b>
1	Bathymetric Publications	B-1: General Bathymetric Chart of the Oceans (GEBCO)
2		B-4: Information Concerning Recent Bathymetric Data
3		B-6: Standardization of Undersea Feature Names (Guidelines, Proposal Form Terminology)
4		B-7: GEBCO Guidelines
5		B-8: Gazetteer of Geographical Names of Undersea Features
6		B-9: GEBCO Digital Atlas
7		B-10: The History of GEBCO
8		B-11: IHO-IOC GEBCO Cook Book
9	Capacity Publications	C-6: Reference Texts for Training in Hydrography
10		C-13: Manual on Hydrography
11		C-16: National Hydrographic Regulations
12		C-17: Spatial Data Infrastructures: “The Marine Dimension” - Guidance for Hydrographic Offices
13		C-33: Reference book about tide theory and practice
14		C-47: Training Courses in Hydrography and Nautical Cartography
15		C-51: Manual on Technical Aspects of the UN Convention on the Law of the Sea
16		C-55: Status of Hydrographic Surveying and Nautical Charting Worldwide
17	Miscellaneous Publications	M-1: Basic Documents of the IHO
18		M-2: National Maritime Policies and Hydrographic Services
19		M-3: Resolutions of the IHO
20		M-7: Staff Regulations
21		M-10: The History of the IHO
22	Periodical	P-1: International Hydrographic Review

23	Publications	P-5:IHO Yearbook
24		P-6: Conference Proceedings
28		P-7: IHO Annual Report
29	Standards and Specifications	S-4: Chart Specifications of the IHO and Regulations for International (INT) Charts
30		S-5: Standards of Competence for Hydrographic Surveyors
31		S-8: Standards of Competence for Nautical Cartographers
32		S-11:Guidance for the Preparation and Maintenance of International Chart Schemes and Catalogue of International (INT) Charts
33		S-12: Standardization of List of Lights and Fog Signals
34		S-23: Limits of Oceans and Seas (1953)
35		S-32: Hydrographic Dictionary
36		S-44: IHO Standards for Hydrographic Surveys
37		S-49: Standardization of Mariners' Routeing Guides
38		S-52: Specifications for Chart Content and Display Aspects of ECDIS
39		S-53: Joint IMO/IHO/WMO Manual on Maritime Safety Information
40		S-57: IHO Transfer Standard for Digital Hydrographic Data
41		S-58: Recommended ENC Validation Checks
42		S-60: User's Handbook on Datum Transformations involving WGS 84
43		S-61: Product Specifications for Raster Navigational Charts (RNC)
44		S-62: ENC Producer Codes
45		S-63:IHO Data Protection Scheme
46		S-64: Test Data Sets for ECDIS
47		S-65: ENC Production Guidance

48	S-66 : Facts about Electronic Charts and Carriage Requirements
49	S-99: Operational Procedures for the Organization and Management of the S-100 Geospatial Information Registry
50	S-100: IHO Universal Hydrographic Data Model
51	S-102: Bathymetric Surface Product Specification

Source : IHO. (2017d). *IHO - Publications*. Retrieved June 22, 2017 from the International Hydrographic Organization Web: [https://www.iho.int/iho\\_pubs/IHO\\_Download.htm](https://www.iho.int/iho_pubs/IHO_Download.htm)

### ***3.2 The Content of IMO Instruments Related to the Management of Hydrographic Survey Ship***

Three major IMO conventions including the SOLAS Convention, the MARPOL Convention and the STCW Convention, are aimed at improving the management of safety of ship, protection of environment and quality of crew respectively. Although they are mainly applicable to commercial ships, it should be included in the scope of the performance of CHO because they are also essential to improve the operational safety of hydrographic survey ships.

#### ***3.2 .1 SOLAS***

The SOLAS convention consists of Articles of the international convention for the safety life at sea, 1974, protocol of 1988 relating to the international convention for the safety of life at sea, 1974, and annex to the 1974 SOLAS Convention and the 1988 Protocol relating thereto. The 14 chapters of the annex and their scope of application are as follows:

Table 3.2 - Chapters of the Annex of SOLAS

<b>Chapter No.</b>	<b>Names of chapters</b>	<b>Notes</b>
I	General provisions	
II-1	Construction - subdivision and stability, machinery and electrical installations	
II-2	Construction - Fire protection, fire detection and fire extinction	
III	Life-saving appliances	
IV	Radiotelegraphy and radiotelephony	
V	Safety of navigation	International Convention for the Safety of Life at Sea (1974) stipulates:  "...other ships owned or operated by a Contracting Government and used only on government non-commercial service are encouraged to act in a manner consistent, so far as reasonable and practicable, with this chapter."
VI	Carriage of cargoes and Oil fuels	The research doesn't involve the chapter.
VII	Carriage of dangerous goods	The research doesn't involve the chapter.

VIII	Nuclear ships	The research doesn't involve the chapter.
IX	Management for the Safe Operation of Ships	International Convention for the Safety of Life at Sea (1974) stipulates:  "This chapter does not apply to government-operated ships used for non-commercial purposes."
X	Safety measures for high-speed craft	The research doesn't involve the chapter.
XI-1	Special Measures to Enhance Maritime Safety	The research doesn't involve the chapter.
XI-2	Special measures to enhance maritime security	International Convention for the Safety of Life at Sea (1974) stipulates:  "This chapter does not apply to warships, naval auxiliaries or other ships owned or operated by a Contracting Government and used only on Government non-commercial service."
XII	Additional safety measures for bulk carriers	The research doesn't involve the chapter.
XIII	Verification of compliance	The chapter makes mandatory from 1 January 2016 the IMO Member State Audit Scheme
XIV	Safety measures for ships operating in polar waters	The research doesn't involve the chapter.

Source: Bao, J. Z. (2016). *Maritime Safety Standards*. Unpublished lecture handout, World Maritime University, Malmö, Sweden.

It can be seen from the above table 3.2 that China Hydrographic Office may refer to and implement Chapter II-1, II-2, III, IV and V of the SOLAS Convention in order to improve the management and safety of hydrographic survey ships. Especially, Chapter V of International Convention for the Safety of Life at Sea (1974) stipulates:

"...other ships owned or operated by a Contracting Government and used only on government non-commercial service are encouraged to act in a manner consistent, so far as reasonable and practicable, with this chapter. "

Chapter V mainly involves the carriage requirement of equipments.

### **3.2 .2 MARPOL**

The International Convention for Prevention of Pollution from Ships (referred to as 'MARPOL') is regarded as the most important international treaty on marine environment and enters into force on 2 October, 1983. The objective of the MARPOL Convention is to prevent marine pollution from ships including both accidental (through structural requirements) and operational (through equipment requirements and best operational practices) marine pollution (Du, D. C., 2016).

The MARPOL Convention also contains 6 technical Annexes. Each of them stipulates requirements to prevent one kind of pollution from ships respectively. The contents and time of entry into force of these Annexes are shown in Table 3.3 below:

Table3.3 - Relation between the Annexes of the MARPOL Convention and China

<b>Annexes</b>	<b>Date of entry into force</b>	<b>Date of Ratification or Accession by china</b>	<b>Date of entry into force for china</b>
Annex I - Regulations for the Prevention of Pollution by Oil	1983.10.2	1983.7.1	1983.10.2
Annex II - Regulations for the control of pollution by noxious liquid Substances	1987.4.6	1983.7.1	1987.4.6
Annex III - Regulations for the Prevention of Pollution by harmful substances carried by sea in packaged form	1992.7.1	1994.9.13	1994.12.13
Annex IV - Regulations for the Prevention of Pollution by sewage from ships	2003.9.27	2006.11.2	2007.2.2
Annex V - Regulations for the Prevention of Pollution by Garbage from Ships	1988.12.31	1988.11.21	1989.2.21
Annex VI - Regulations for the Prevention of Air Pollution from ships	2005.5.19	2006.5.23	2006.8.23

Source: Liu, Z. J. (2011). *Ship Safety Management*. Dalian: Dalian Maritime University press.

Article 3(3) of International Convention for the Prevention of Pollution from Ships (1973) stipulates:

" (the MARPOL Convention) shall not apply to any warship, naval auxiliary or other ship owned or operated by a State and used, for the time being, only on government non-commercial service. However, each Party shall ensure by the adoption of appropriate measures not impairing the operations or operational capabilities of such ships owned or operated by it, that such ships act in a manner consistent, so far as reasonable and practicable, with the present Convention."

As for hydrographic survey ships, it is necessary for China Hydrographic Office to take appropriate measures to ensure that these ships comply with the MARPOL Convention and its annexes I, IV, V and VI, in order to prevent the marine pollution from these ships and show the image of responsible government to the public.

### **3.2 .3 STCW**

As one of the most important convention developed by IMO, the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended (referred to as "STCW" ) highlights the human factor at the first time, and provides a generally acceptable and minimum standards for Training, Certification and Watchkeeping for Seafarers. The present STCW convention consists of 17Articles and 1 Annex including 8 chapters which are shown in the following table 3.4:

Table 3.4 –Annex of the Present STCW Convention

<b>Chapter No.</b>	<b>Name</b>	<b>Number of Regulations</b>
I	General provisions	15
II	Master and deck department	5
III	Engine department	7
IV	Radio communication and radio operators	2
V	Special training requirements for personnel on certain types of ships	2
VI	Emergency, occupational safety, medical care, and survival functions	6
VII	Alternative certification	3
VIII	Watchkeeping	2

Source: International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (1978)

It is noted that codes of Annex consist of part A (mandatory standards) and part B (Recommended guidance).

Article III of International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (1978) stipulates:

” (the present STCW shall not apply to) warships, naval auxiliaries or other ships owned or operated by a State and engaged only on governmental non-commercial service. However, each Party shall ensure by the adoption of appropriate measures not impairing the operations or operational capabilities of such ships owned or

operated by it, that the persons serving on board such ships meet the requirements of convention so far as is reasonable and practicable.”

Hydrographic survey ship, as a kind of government official ships, should be made appropriate arrangements to implement the STCW convention, especially regulations related to training, manning and watchkeeping, in order to ensure the operational safety of itself.

### ***3.3 Chapter Summary***

Requirements of IMO instruments for China Hydrographic Office are mainly embodied in two aspects. One is the mandatory requirement of Provisions of Hydrographic Service concentrated in Chapter V of SOLAS. The core of this kind of requirements is to produce and timely update nautical charts and nautical publications, in accordance with technical standards developed by IHO. The other is the non-mandatory requirement of management of hydrographic survey ships involving SOLAS, MARPOL and STCW. The core of this kind of requirements is that hydrographic survey ship, as a kind of government official ships, should be made appropriate arrangements to implement the content of the SOLAS convention related to ship structure and the safety of navigation, of the MARPOL Convention and its annex related to prevention of pollution from these ships, and of the STCW Convention related to training, manning and watchkeeping, in order to ensure the operational safety of itself.

## **Chapter 4**

### **Analysis of the Chinese Status and Achievements of Compliance with IMO Instruments**

#### ***4.1 Organizational Structure and Management Mode of China Hydrographic Office***

As a part of China MSA, the main responsibility of China Hydrographic Office is to manage and carry out hydrographic surveying task in Chinese coastal waters, and produce and update nautical charts and nautical publications, in order to provide the basic geographic information data for the safety of navigation and marine development (Xu, Y., 2015). China Hydrographic Office consists of administrative branch and technological branch. The administrative branch is responsible for administrative management of hydrographic surveying and mapping in Chinese waters and comprises of three MSA respectively located in Tianjin, Shanghai and Guangdong, while the technological branch is responsible for carrying out technical task of hydrographic surveying and mapping and includes Navigation Guarantee Center of North China Sea, Navigation Guarantee Center of East China Sea and Navigation Guarantee Center of South China Sea (China Hydrographic Office., 2016). The details are shown in figure 4.1 as follows:

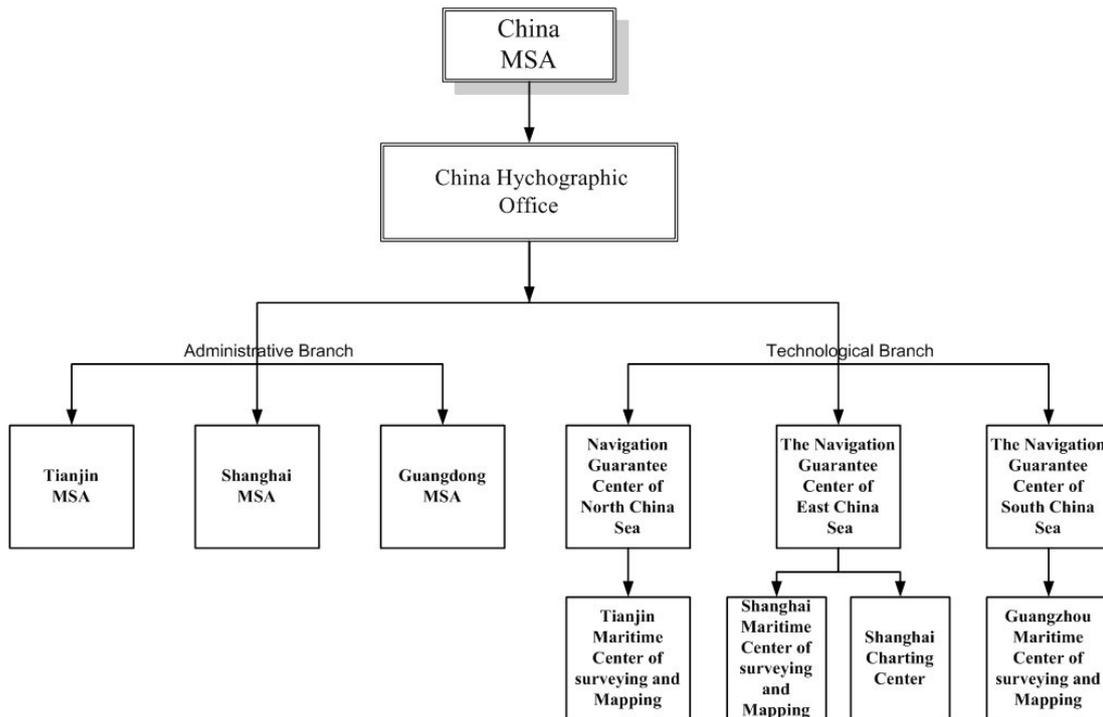


Figure 4.1- The Structure Chart of China Hydrographic Office

Source: China Hydrographic Office. (2016). *Chinese 13<sup>th</sup> 5-year Planning of Hydrographic Surveying and Mapping*. Beijing: Author.

At present, the three Maritime centers of surveying and mapping located in Tianjin, Shanghai and Guangzhou are respectively responsible for the acquisition and preprocess of hydrographic data in the Yellow Sea and the Bohai Sea, the East China Sea and the South China Sea. And then, all of the data will be transferred to Shanghai charting center for producing and updating nautical charts and nautical publications through hydrographic production database (referred to as "HPD" ).

After the rapid development of the past six decades, particularly the past three decades or more since Chinese reform and opening-up, China Hydrographic Office has established a more perfect and reasonable management structure, cultivated a large number of technical experts and senior managers who are rich in hydrographic

experience (Wang, Z., Liu, S. L., 2012, Wang, H. C., 2005). At present, China Hydrographic Office has reached world-class level, whether in equipments and technology, or in management and service (Wang, R. L., 2011), which lay a solid foundation for the implementation of chapter V of the SOLAS convention related to the provision of hydrographic products and service necessary for safe navigation.

## ***4.2 Provision of High-Quality Hydrographic Services***

### ***4.2.1 Hydrographic Surveying***

China Hydrographic Office always tries its best to implement Article 9(2(a)) of Chapter V of the SOLAS Convention, and carries out hydrographic surveying in accordance with the requirements of safe navigation. China Hydrographic Office makes a reasonable arrangement of the range, order and cycle of survey of Chinese coastal waters, conducted periodic measurements of all coastal ports and important waterways, in accordance with IHO standards for hydrographic surveys (S-44), on the basis of actual existing hydrographic capacity, the natural geographical feature of sea area, port, channel and sea lane and navigational habits of ships. Hydrographic surveying is usually divided into basic measurement which means surveying all lands and waters within the range of measurement and inspection measurement that means only surveying the important water areas within the range of measurement (China MSA., 2016). The hydrographic period of waters varies from 3 months to 8 years according to the degree of importance and the degree of variability of navigation environment of sea waters (China MSA., 2016). In general, open ports and important waterways have a shorter hydrographic period, while the coastal routes have a longer hydrographic period. For instance, the mouth of the Yangtze River is quarterly conducted an inspection measurement. Multi-beam measurement and single-beam measurement, which refer to measure depths by multi-beam echo sounder and single-beam echo sounder respectively, are two main bathymetric

methods used by China Hydrographic Office. Generally speaking, Multi-beam measurement is used in waters of special order such as berth, channel and anchorage, while single-beam measurement is used in other waters (China Hydrographic Office., 2011). In addition, obstruction detection is necessary for waters of special order. The method of obstruction detection is the union of multi-beam measurement and the combination of single-beam measurement and side scan sonar measurement. Under special circumstances, divers will also be required to dive to the bottom of the sea to confirm what exactly the obstruction is (China Hydrographic Office., 2011).

Also, in order to improve the accuracy and efficiency of hydrographic surveying, China Hydrographic Office also established a national coastal Differential Global Positioning System (referred to as "DGPS" ) comprising 22 Global Positioning System (referred to as "GPS" ) satellite observation stations, a national coastal GPS control network including hundreds of sites, and a national coastal tidal observation network containing more than one hundred hydrological observation stations, and provided Internet hydrological information service in important waters such as the Pearl River Estuary, the Yangtze River Estuary, the Bohai Bay and so on (Yang, Y., Lv, Y. X., 2008).

#### ***4.2.2 Production of Nautical Charts and Nautical Publications***

##### ***4.2.2.1 Production of Paper Charts and Electronic Navigational Charts***

China Hydrographic Office makes every effort to comply with the requirements of Article 9 (1 and 2) of chapter V of the SOLAS convention by producing and updating a series of paper charts and electronic navigational charts (referred to as "ENC" ) covering the main Chinese coastal waters in a timely manner.

At the beginning, China Hydrographic Office has planned, compiled and published 499 paper charts covering all of the 150 China coastal ports and main routes, based on the full consultation with users and scientific evaluation of Chinese hydrographic service capacity and demand (China MSA., 2012). Details could be found in the following table 4.1 and table 4.2.

Table 4.1 - Comparison Table of Chart Categories between IHO Standard and Chinese National Standard

No.	Chart Category (Usage Band)		Scale Range	Navigational Purposes (China)	Recommended Compilation Scales (China)
	IHO Standard	Chinese National Standard			
1	Overview	General chart of the sea around China	$\leq 1:4,000,000$	Complete display of sea area around China.	1:4,000,000
2	General	Ocean navigational chart	Between 1:4,000,000 and 1:1,500,000	Display of the coastal areas of china such as the Bohai sea, the Yellow sea, the East China sea and the South China sea.	1:1,500,000
		Offshore	Between 1:	Used to develop	1:750,000

		navigational chart	1,500,000 and 1:750,000	navigational plans.	
3	Coastal	Offshore navigational chart	Between 1:750,000 and 1:300,000	Used for offshore navigation.	1:300,000
		Coastal navigational chart	Between 1:180,000 and 1:100,000	Used for coastal navigation.	1:180,000, 1:150,000, 1:120,000 and 1:100,000
4	Approach	Harbour chart	Between 1:80,000 and 1:30,000	Used of ships to navigate near ports, main waterways, or complex congested waters.	1:80,000, 1:75,000, 1:50,000, 1:40,000, 1:35,000, and 1:30,000
5	Harbour		Between 1:30,000 and 1:5,000	Used for entering and leaving ports and navigating within ports, anchorages, harbors and rivers connected with sea.	1:25,000, 1:15,000, and 1:10,000

6	Berthing		$\geq 1:4,000$	Display of details of berthing.	
---	----------	--	----------------	---------------------------------	--

Source: China Hydrographic Office. (2016). *Chinese 13<sup>th</sup> 5-year Planning of Hydrographic Surveying and Mapping*. Beijing: Author, IHO. (2007). *The Present Status of Small Scale ENC Coverage with Respect to the Allocation of Cells to Usage Bands 1 (Overview) and 2 (General)* (CHRIS19-06.1E). Monaco: Author.

Table 4.2 - Number of Charts of China by Sea Area (Unit: sheet)

Sea area		Total	North Sea Area	East Sea Area	South Sea Area
Categories					
General chart of the sea around China (1:4,000,000)		1	-	-	-
Ocean navigational chart (1:1,500,000)		4	-	-	-
Offshore navigational chart	1:750,000	5	-	-	-
	1:300,000	17	6	6	5
Coastal navigational chart (1:180,000 - 1:100,000)		52	18	19	15
Harbour chart (1:80,000-1:5,000)		420	106	170	144
Total		499	130	195	164

Source: China MSA. (2012). *Planned Catalogue of Chinese Coastal Port and Fairway Charts (2012)*. Beijing: China Communications press.

In the second place, China Hydrographic Office has compiled and timely updated more than 400 cells of ENC in accordance with related IHO technical standards such as IHO Transfer Standard For Digital Hydrographic Data (S-57), Recommended Enc Validation Checks (S-58), IHO Data Protection Scheme (S-63), Electronic Navigational Charts (ENCs) “Production, Maintenance And Distribution Guidance” (S-65) and so on (China Hydrographic office., 2011).

Finally, China Hydrographic Office regularly edits and publishes 3 issues of Notices to Mariners and some update files of ENC each month to respectively correct paper charts and ENCs, which ensures the timely updating of paper charts and ENCs, in order to meet the requirements of the safe navigation of ships in Chinese coastal seas (China Hydrographic Office., 2012b).

#### ***4.2.2.2 Nautical Publications***

China Hydrographic Office does its best to implement Article 9 (1 and 2) of chapter V of the SOLAS convention, and has compiled and published plenty of nautical publications including Sailing Directions, Tide Tables, Pilot Atlas, and Thesis charts which are well received by mariners and bring enormous safety benefits and social benefits due to its short updating cycle, high quality, fast production and publication, and good currency.

#### ***4.2.3 Distribution of Nautical Charts and Nautical Publications***

China Hydrographic Office has established a multi-level distribution network of nautical charts and nautical publications, to ensure the timely and reliable provision of hydrographic and nautical information, in order to comply with the requirements of Article 9 (4) of chapter V of the SOLAS convention. First of all, the basic distribution network as shown in Figure 4.2 below has been set up in the main Chinese coastal ports so as to provide distribution service of nautical charts and

nautical publications to mariners navigating in Chinese coastal waters; Secondly, based on the cooperation with the UKHO and Norway Hydrographic Service, China Hydrographic Office always provides Chinese hydrographic and nautical information to global mariners by using the two partners' global distribution network (China Hydrographic office., 2012b). Finally, China Hydrographic Office has established a special official distribution website to provide users with online shopping and updating service. At present, the annual circulation of nautical charts of Chinese Hydrographic Office has reached more than 200,000 sheets and is expected to increase year by year (China Hydrographic Office., 2016).

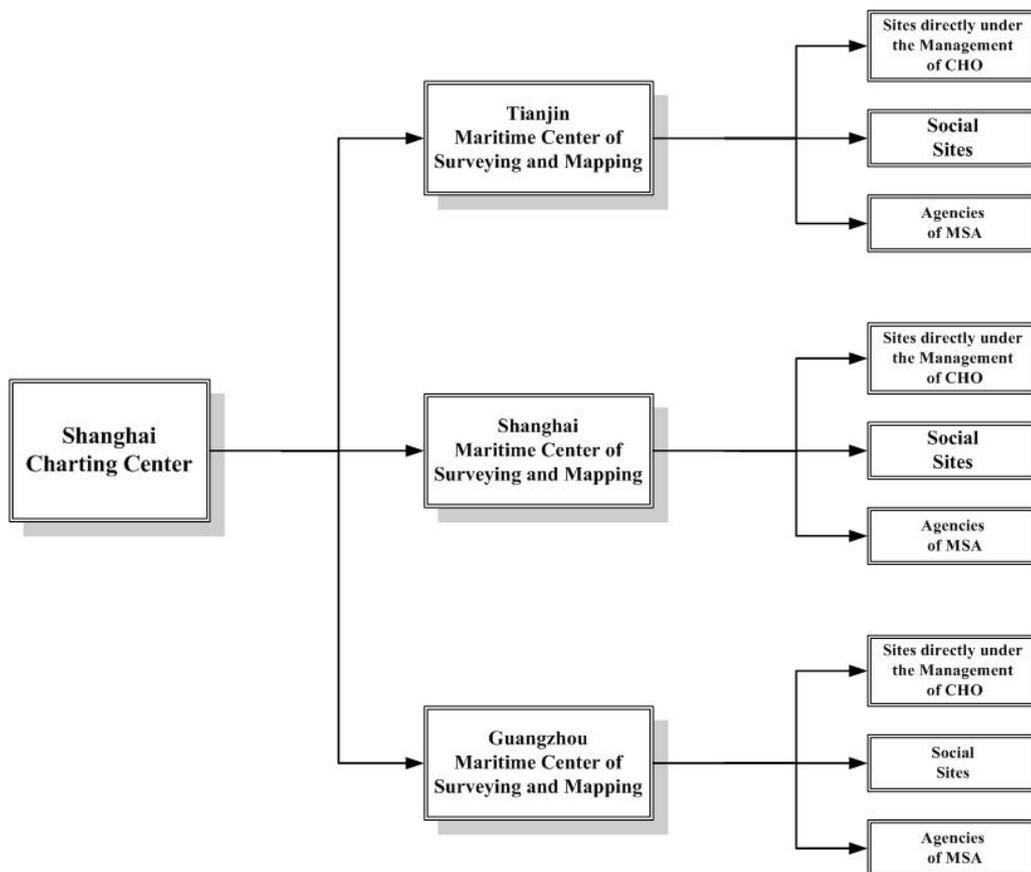


Figure 4.2 - The Structure Chart of Chinese Distribution Network of Nautical Charts and Nautical Publications

Source: China Hydrographic office. (2012a). *Research Reports on Product Sequence of Chinese Civil Nautical Charts and Nautical Publications*. Beijing: Author.

Table 4.3 - Statistics of Distribution Sites of Nautical Charts and Nautical Publications

<b>Categories Sea Area</b>	<b>Total</b>	<b>Sites directly under the Management of CHO</b>	<b>Agencies of MSA</b>	<b>Social Sites</b>
North Sea Area	16	1	9	6
East Sea Area	23	2	16	5
South Sea Area	13	1	5	7
Total	52	4	30	18

Source: China Hydrographic Office. (2012a). *Research Reports on Product Sequence of Chinese Civil Nautical Charts and Nautical Publications*. Beijing: Author.

#### ***4.2.4 Promoting the Uniformity in Charts and Nautical Publications***

China Hydrographic Office always implements Article 9 (4) of chapter V of the SOLAS convention, and makes its due contribution to the greatest possible worldwide uniformity in charts and nautical publications through international, regional and domestic levels of efforts. Firstly, at the international level, CHO actively participates in the technical work of IHO committees and working groups, and the development, application and promotion of the IHO technical standards and policies, to promote the uniformity in technical standards of nautical charts and nautical publications and the application of ENC, ECDIS and other advanced technologies around the world. Secondly, at the regional level, CHO always promotes the improvement of ability and uniformity of hydrographic surveying and mapping in East Asia region under framework of the East Asia hydrographic

Commission (referred to as “EAHC”), through technical exchanges and cooperation. At the end, at the national level, CHO actively boosts the transformation from international standards to national standards and always provides nautical products and services complied with international standards, in order to ensure that all of the ships sailing in the Chinese coastal waters and flying different flags can conveniently obtain and use products and services of CHO.

#### ***4.2.5 Supporting the Carriage of ECDIS***

Article 18 and Article 19 of chapter V of the SOLAS convention stipulate the requirements of carriage time and performance of electronic chart display and information systems (referred to as “ECDIS” ). In order to ensure that ships flying Chinese flag and sailing in international waters will not suffer the detention resulted from no installation of ECDIS, CHO has done a lot of work to encourage and promote the carriage of ECDIS in line with the requirements of the Convention. Firstly, the carriage requirements of ECDIS and the great advantages of electronic navigation are actively and widely propagated to guide ships flying Chinese flag to install ECDIS as soon as possible; Secondly, in order to promote the reduction of installation cost of ECDIS, CHO also actively encourage Chinese companies to develop ECDIS equipment by providing them with technical support and free ENC data to help them pass the type approval as soon as possible. Thirdly, CHO also actively help IHO improve ENC standards through submitting the feedback of problems found in the test on ships in which ENC complying with IHO standards are displayed in the ECDIS. Finally, CHO tries its best to accelerate the production of ENC and Inland Electronic Navigational Chart (referred to as “IENC” ) so as to cover Chinese coastal and inland navigable waters and lay a solid data foundation for the promotion of ECDIS and inland ECS.

#### ***4.2.6 Supporting the PSC and FSC Inspection of Carriage of Nautical Charts and Their Equivalents***

In accordance with Article 27 and 34 of chapter V of the SOLAS convention, ships must be equipped with adequate, accurate and timely updated official paper charts or their equivalent - ENC to ensure the safety of navigation. Therefore, CHO actively provides technical support to the PSC officers and FSC officers, in order to focus the inspection on whether or not ships sailing in Chinese coastal waters are equipped with official nautical charts which means official paper charts and ENCs produced by CHO and published by China MSA or other authorized organization, and ensure that these requirements of the SOLAS convention are fully implemented by these ships.

#### ***4.3 Management of Hydrographic Survey Ships***

##### ***4.3.1 The Construction and Survey of Hydrographic Survey Ships***

China MSA is responsible for the unified organization of construction of hydrographic survey ships based on the demand submitted by CHO. At present, there are 4 standard ship types for hydrographic survey ships including 100 meters for assignment inter-areas, 60 meters for assignment within sea area, 40 meters for measurement of harbors and channels, and 25 meters for measurement of berthing (China Hydrographic Office., 2011). All of the four standard ship types are designed by first-class ship design institutes with corresponding qualifications such as 701 according to the relevant provisions of the SOLAS convention, and passed the approval of expert group organized by China MSA. The expert group consists of ship structure experts from CCS and other organizations responsible for audit of safety performance of ships and hydrographic experts responsible for audit of the performance standard of hydrographic equipments installed on these ships. In

addition, the construction of ship and installation of hydrographic equipment has also been supervised by another expert team composed of experts from CCS and CHO.

The survey and certification of hydrographic survey ships are implemented by China classification society (referred to as "CCS" ) according to the Technical Regulations for Statutory survey of Domestic Seagoing Ships which is based on the related IMO instruments.

#### ***4.3.2 Operation of Hydrographic Survey Ships***

Maritime centers of survey and mapping are responsible for the operational management of their hydrographic survey ships in accordance with a series of management system based on the related IMO instruments and made by Navigation Guarantee Centers under the supervision and guidance of CHO. The management system consists of internal management system related to watchkeeping, maintenance etc., management system of certificates and technical documents, operating procedures of equipment, regulations for safety navigation and operation of ship, emergency plan of ship etc.

China MSA is responsible for recruiting the crew of hydrographic survey ships mainly from masters, chief engineers and seafarers who have related certificates of qualification and years of navigation experience in international or Chinese coastal waters.

Navigation Guarantee Centers are responsible for the training of crew in accordance with the related requirements of the STCW Convention under the supervision and guidance of CHO. The training usually focuses on main contents of STCW and new requirements of amendments.

#### ***4.3.3 To Prevent Marine Pollution from Hydrographic Survey Ships***

In order to prevent marine pollution from hydrographic survey ships, CHO has developed regulations for prevention of marine pollution from hydrographic survey ships based on the MARPOL Convention and its annex requirements, focusing on the prevention of pollution by sewage, kitchen waste and oil. The navigation guarantee centers are responsible for drawing up the detailed rules for implementation and organizing regular inspection of hydrographic survey ships.

#### ***4.4 Chapter Summary***

Compliance with IMO instruments has very important significance to enhance the management level of hydrographic survey ships, promoting maritime navigation safety and environmental protection, and showing the image of responsible government to the public. Therefore, over the years, CHO has always strictly complied with the requirements of IMO instrument, and made a positive contribution to the safety of navigation and protection of marine environment in Chinese coastal waters by the provision of high quality hydrographic products and services and good management of hydrographic survey ships.

## Chapter 5

### Shortcomings of CHO in the Implementation of IMO Instruments

#### *5.1 National Legislation of the Requirements of IMO Instruments*

National legislation of the requirements of IMO instruments is the most important measures of the implementation of these IMO Instruments, and is also one of the key points of the audit (Sha, Z. R., 2016). However, Constitution of the People's Republic of China does not explicitly define the domestic application of international law, and Law of the People's Republic of China on the Procedure for Concluding Treaties also does not specify the legislation and implementation requirements after contracting, but only stipulates the procedures for ratification, accession and recognition of conventions, which lead to slow progress in national legislation of the requirements of IMO instruments(Wang, L., 2015). Therefore, IMO instruments included in the scope of the audit are now directly quoted in accordance with Law of the People's Republic of China on the Procedure for Concluding Treaties, which leads to the lack of legal logic and imposes a negative effect on the effectiveness of the implementation, especially the lack of compulsory measures for violations of these requirements (Ben, J. H., 2011, Qu, Y. N., 2013).

Take CHO for example, the relevant requirements of the SOLAS convention related to the provision of hydrographic services by member states have always not been included in the Surveying and Mapping Law in People's Republic of China. As a result, it is difficult for CHO to exercise the function of official hydrographic organization and comply with the requirements of the SOLAS convention because of the lack of legal support, especially in the administrative management of hydrographic surveying industry.

Firstly, there is a serious overlap problem in the functions of the production of nautical charts and nautical publications between CHO and the hydrographic branch of Chinese navy. The hydrographic branch of Chinese navy began to enter the civil markets of nautical charts and nautical publications for the purpose of taking profits to make up for the inadequate budget some years ago, which leads to the overlap of functions

Secondly, it is difficult for CHO to implement the administrative management of hydrographic surveying industry. Since the opening of marine engineering surveying market to surveying and mapping companies promoted by the National Administration of Surveying, Mapping and Geoinformation, plenty of land surveying and mapping enterprises have expanded their business into the hydrographic surveying industry. Driven by economic interests, some bad surveying and mapping enterprises conspire with dredging enterprises and practice fraud in the bathymetry of dredging project, which brings serious safety risks to the ships entering and leaving the port (Yang, Y., Lv, Y. X., 2008). However, CHO is incapable of action without adequate legal support in the administrative management of hydrographic surveying industry, and has to check the reliability of these data by costly repeated measurement, in order to ensure the safety of navigation.

## ***5.2 Provision of Hydrographic Service***

### ***5.2.1 Hydrographic Capacity Building***

In recent years, with the development of The Belt and Road Initiative and the transformation of the focus of national economic development from land to sea, the demand of hydrographic service increases sharply because the construction of ports ushers in a new wave of climax, which makes the trend of relative lack of hydrographic capacity more and more obvious and brings a huge challenge and

pressure to the implementation of Article 9 ( 2 ( 1 ) ) of chapter V of the SOLAS convention. The relative lack of hydrographic capacity mainly includes the following four aspects:

First of all, the number of hydrographic service is inadequate. In the past 10 years, the number of Chinese charts increased significantly while quantity of organizations, staff, hydrographic surveying ships and hydrographic equipments are almost the same, which leads to the extension of the cycle of hydrographic surveying in some waters and a slower update speed of some charts.

Table 5.1 - Comparison Table of Planned Charts in 2006, 2009 and 2012

<b>Categories</b>		<b>Years</b>		
		<b>2006</b>	<b>2009</b>	<b>2012</b>
General chart of the sea around China ( 1:4,000,000 )		0	0	1
Ocean navigational chart ( 1:1,500,000 )		0	0	4
Offshore navigational chart	1:750,000	0	0	5
	1:300,000	17	0	17
Coastal navigational chart ( 1:180,000 - 1:100,000 )		51	21	52
Harbour chart ( 1:80,000- 1:5,000 )		238	404	420
<b>Total</b>		<b>306</b>	<b>425</b>	<b>499</b>

Source: China MSA. (2006). *Planned Catalogue of Chinese Coastal Port and Fairway Charts (2006)*. Beijing: China Communications press, China MSA. (2009).

*Planned Catalogue of Chinese Coastal Port and Fairway Charts (2009)*. Beijing: China Communications press, China MSA. (2012). *Planned Catalogue of Chinese Coastal Port and Fairway Charts (2012)*. Beijing: China Communications press.

Secondly, the coverage of hydrographic surveying needs to be further broadened. With the development of marine economy, exploration of offshore oil, the ship traffic in offshore and deep water is increasing. According to the SOLAS convention, the Hydrographic Department has the responsibility to expand the scope of hydrographic surveying to cover these busy waters, in order to ensure the safety of navigation in these waters (China Hydrographic Office., 2016).

Thirdly, the hydrographic service capacity of CHO has weakness. Firstly, with the extension of the coverage of hydrographic surveying from port waters to offshore waterway and even the islands waters of South China Sea, the lack of deepwater measurement capacity is gradually exposed and becomes a bottleneck restricting the improvement of hydrographic service (Wang, F. Z., Li, Q. R., Wang, S., Zhao, J. Y., 2015). Secondly, along with the development of large-scale ships, the need for large vessels to take the opportunity of the high tide to entry and exit ports has become increasingly frequent, which requires higher real-time hydrologic forecasting capacity, so the problems such as insufficient hydrological stations, imperfect layout, insufficient accuracy and weak service capacity of hydrological forecast, and lack of high precision marine navigation and positioning service are becoming increasingly apparent. Thirdly, in recent years, although considerable progress has been made in bathymetric capacity building due to the increase of investment in bathymetric equipments, the ability of control survey such as geodetic survey and topographic survey has experienced a drop because of relatively insufficient investment.

Finally, idea of development of hydrographic surveying urgently needs to be changed. This relates to the transformation of three aspects. Firstly, the objective of

hydrographic surveying shall be transferred from meeting the needs of compilation of charts to improving the currency (update speed) of charts as far as possible. Secondly, the organizational model of hydrographic surveying shall be transferred from the traditional measurement of charts which means to carry out periodic measurement of charts one by one, to measurement of grids which means to carry out periodic measurement of grids one by one and is beneficial to the collection of geographic information fully covering the whole sea area. Thirdly, the development direction of hydrographic technology shall be transferred from only focusing on the improvement of accuracy to achieving large-range, full-coverage and rapid measurement. The purpose of this change is to create the conditions for the production of large-coverage, seamless-connection, high-currency and fast updating ENC to replace the traditional paper chart, and lay a solid foundation for the implementation of Article 19 of chapter V of the SOLAS convention on mandatory carriage of ECDIS, which will further enhance the ability to ensure the safety and efficiency of navigation in Chinese coastal waters.

### ***5.2.2 Production of Nautical Charts and Nautical Publication***

Compared with the nautical charts and nautical publications produced by the UK Hydrographic Bureau (referred to as "UKHO" ) such as rich variety, complete system and global coverage, the disadvantages of nautical charts and nautical publications produced by CHO such as rare variety and limited coverage is very prominent. At present, UKHO publishes more than 220 nautical publications covering global waters (Wang, H., Zhang, M. J., Xi, L., Ren, X. W., 2015), while CHO only publishes a few kinds of nautical publications which are not even fully covering Chinese coastal waters such as Catalogue of Chinese Coastal Port and Fairway Charts, Notice to Mariners, List of Lights, Tide Tables, Sailing Direction and so on. As a result, some mariners prefer to use products of UKHO while

knowing that products of CHO have a better currency than that of UKHO, which brings risks to the safety of navigation in Chinese coastal waters (Yang, Y., Lv, Y. X., 2008).

Table 5.2 - Main List of Nautical Charts and Nautical Publications Produced by the UKHO

<b>No. of Publications</b>	<b>Name of Publications</b>
NP100	The Mariner's Handbook
NP131	Catalogue of Admiralty Charts and other Hydrographic Publications
NP136	Ocean Passages for the World
NP1-72 NP1S-72S	Sailing Direction & Supplements
NP201	ATT Vol 1-United Kingdom & Ireland (Including European Channel Ports)
NP202	ATT Vol 2 -Europe(excluding UK & Ireland),Mediterranea Sea & Atlantic Ocean
NP203	ATT Vol 3-Indian Ocean & South China Sea (including Tidal Stream Tables)
NP204	ATT Vol 4-Pacific Ocean (including Tidal Stream Tables)
NP234A	Cumulative List to Admiralty Notices to Mariners A
NP234B	Cumulative List to Admiralty Notices to Mariners B
NP281(1)	ALRS Vol 1 Part 1- Maritime Radio Stations, Europe, Africa & Asia (excluding the Far East)
NP281(2)	ALRS Vol 1 Part 2-Maritime Radio Stations, The Americas, Far

	East & Oceania
NP282	ALRS Vol 2-Radio Aids Nav/Satellite Nav Sys/Legal Time/Radio Time Signals & Electronic Position Fixing Sys
NP283(1)	ALRS Vol 3 Part 1-Maritime Safety Information Services,Europe/Africa/Asia(exclude Far East)
NP283(2)	ALRS Vol 3 Part 2-Maritime Safety Information Services, The Americas, Far East & Oceania
NP284	ALRS Vol 4-Meteorological Observation Stations
NP285	ALRS Vol 5, Global Maritime Distress & Safety System(GMDSS)
NP286(1)	ALRS Vol 6 Part 1- Pilot,Vsl Traffic & Port Operations(UK/Ireland)
NP286(2)	ALRS Vol 6 Part 2- Pilot,Vsl Traffic & Port Operations(Europe)
NP286(3)	ALRS Vol 6 Part 3- Pilot,Vsl Traffic & Port Operations(Med/Africa/Persian Gulf)
NP286(4)	ALRS Vol 6 Part 4- Pilot,Vsl Traffic & Port Operations(Indian sub-continent, South East Asia and Australasia)
NP286(5)	ALRS Vol 6 Part 5- Pilot,Vsl Traffic & Port Operations(Americas/Antarctica)
NP286(6)	ALRS Vol 6 Part 6- Pilot,Vsl Traffic & Port Operations(North East Asia)
NP350(1)	Distance Tables Vol 1-Atlantic Ocean
NP350(1)S	Supplement to Admiralty Distance Tables-Atlantic Ocean
NP350(2)	Distance Tables Vol 2-Indian Ocean
NP350(3)	Distance Tables Vol 3-Pacific Ocean
NP401(1)	Sight Reduction Tables for Marine Navigation Vol 1-LAT 00-15
NP401(2)	Sight Reduction Tables for Marine Navigation Vol 2-LAT 15-30

NP401(3)	Sight Reduction Tables for Marine Navigation Vol 3-LAT 30-45
NP401(4)	Sight Reduction Tables for Marine Navigation Vol 4-LAT 45-60
NP401(5)	Sight Reduction Tables for Marine Navigation Vol 5-LAT 60-75
NP401(6)	Sight Reduction Tables for Marine Navigation Vol 6-LAT 75-90
NP5011	Symbols and Abbreviations used on Admiralty Paper Charts
NP727	Ships Boat Charts
NP735	Maritime Buoyage System
NP74-84	List of lights and fog signals
NP247	Annual Summary of Admiralty Notices to Mariners
NP5006	The world-time zone chart
	Admiralty Notices To Mariners
1-4999	British Admiralty Navigational chart

Source: UKHO. (2013). *Catalogue of Admiralty Charts and other Hydrographic publications* (NP131). Taunton: Author.

### ***5.2.3 Distribution of Nautical Charts and Nautical Publications***

First of all, it is necessary to improve the internal management system of distribution of nautical charts and nautical publications. There still are some defects in the existing service policy or management system of distribution, which results in no unified supply and service system. Especially, there is no unified circulation statistics and sales revenue sharing system and a matching unified distribution system, which easily leads to vicious internal competition.

Secondly, the coverage of the existing distribution system is very limited. The existing distribution network only covers domestic market, and foreigner distribution service completely relies on the distribution networks of UKHO and PRIMAR, which imposes many adverse effects on CHO. First of all, the distribution of nautical

charts and nautical publications becomes a single sales behavior, which prevents the establishment of the communication and interaction between producers and users. In the second place, it imposes more or less negative impact on the updating of charts, which damages safety of navigation. Thirdly, it is not beneficial to the establishment of the brand image of CHO on a global scale. If things go on like this, CHO has the risk of subcontracting for UKHO and PRIMAR. The trend will be further strengthened especially in the era of ENC. Finally, it is not good for the protection of CHO's investment in hydrographic surveying. Unlike domestic distributors which only obtain the non-editable final products of CHO, UKHO and PRIMAR could get editable data files by data exchange in order to ensure that these data are able to be recompiled and integrated into their products. However, it also means that UKHO and PRIMAR could freely get the hydrographic data which are acquired based on the large investment of CHO.

Third, the service mode of distribution needs to keep pace with the times. Today is an era of e-commerce, so CHO shall not be stuck in the old and decayed traditional distribution model based on distributors, but actively use E-commerce platform such as taobao, Jingdong, Amazon and so on, to directly distribute its products to mariners, which is beneficial to the establishment of a direct link between CHO and its end users and the improvement of efficiency and user experience.

#### ***5.2.4 Promoting the Uniformity in Charts and Nautical Publications***

Firstly, at the international level, CHO has a weaker influence on international standards for nautical charts and nautical publications. Because of the lack of strength and depth of participation in IHO technical work, which is seriously inconsistent with the Chinese image of big shipping nation and Chinese huge financial contribution to the IHO (Yang, Y., Lv, Y. X., 2008). Among all of 87 IHO members, China has the third most total tonnages and pays the most contributions as much as

UK, Singapore, and Greece etc. However, Tides, Water Level and Currents Working Group is only one of the 11 IHO technical work groups that has delegate of CHO. In addition, CHO rarely submit the proposals or recommendations of high technology content to meetings of IHO Committees and the working groups. In a word, CHO is always a follower of IHO technical standards in the international hydrographic industry, and never deeply participants into the proposal, development revision of these standards.

Secondly, not enough has been done to promote the nationalization of international standards. The internationalization of hydrographic survey standards has already been an overwhelming reality, and also has complied with Article 9(3) of Chapter V of the Convention SOLAS. At present, all of Chinese national standards of hydrographic surveying and mapping are based on the relevant international standards. However, unlike the responding international standards which are frequently revised to include new technology and new process (Lu, Y., Xia, Q. B., Kong, H. Y., 2015), the development and revision of national standards are time-consuming, so some national standards cannot meet the needs of development of domestic hydrographic technology and practical work because of no timely revision (Yin, X. D., Chen, Y., Tang, J., Zhan, X. S., Xu, W. M., 2011). In addition, although the relevant ENC international standards have been widely used in the production and distribution of Chinese ENC, the nationalization of these international standards has not yet been put on the agenda. Therefore, in order to keep the level of Chinese hydrographic technology consistent with the international advanced level, it is necessary to speed up the policy research to pave the way for the nationalization of international standards.

#### ***5.2.5 Supporting the PSC and FSC Inspection of Carriage of Nautical Charts and Their Equivalents***

As mentioned above, PSC and FSC inspection of the carriage of nautical charts or their equivalent (i.e. ECDIS) is important to ensure that ships sailing Chinese coastal waters will be equipped with official products of CHO and guarantee the safety of navigation. Although CHO has provided some service and support for this purpose, there are still some weaknesses. Firstly, China MSA has made series of regulatory documents in terms of inspection of the carriage of nautical charts or their equivalent; However, due to the lack of national legislation and implementation rules, no unified management system has been established. Secondly, PSC officers and FSC officers don't know enough about the importance of requiring ships sailing in Chinese coastal waters to be equipped with official products made by CHO or other authorize organizations in terms of safety of navigation, so their executive willingness and level are barely satisfactory, and the standards of enforcement in each sea area are also uneven. Finally, CHO did not provide adequate technical support and lack specific and effective measures. Especially in terms of carriage of the equivalents (ECDIS), there are still many technical problems to be solved by CHO.

### ***5.3 Management of Rental Fishing Vessels Used for Hydrographic Surveying***

Every year, CHO has to rent a lot of fishing vessels to conduct hydrographic surveying task because of the lack of its own hydrographic survey ships. In general, the staffs of CHO are responsible for the operation of hydrographic equipments equipped on the fishing vessels, while the crews employed by ship owners are responsible for the operation of the fishing vessels. Objectively speaking, there is a large gap between these fishing vessels and the modern hydrographic survey ships owned and operated by CHO in the safety aspects such as structure, Fire protection, fire detection and fire extinction, life-saving appliances and arrangements, and equipments. In addition, CHO also has no strict requirements for and even has not developed detailed regulations for the qualifications, training and watchkeeping of

crew of the fishing boat for a long time. As for the prevention of pollution from these fishing vessels, it is never taken into account by CHO. However, considering these fishing vessels also flying the flag of CHO, its unsafe behavior will also impose a negative effect on the responsible image of CHO, so CHO should strengthen the management of these fishing vessels in accordance with the management mode of public service ship, so as to ensure the safety of navigation and prevent the pollution of the marine environment from these fishing vessels.

#### ***5.4 Chapter Summary***

CHO has made a lot of efforts in the performance of the IMO instruments, but there are also large gaps between the work of CHO and the requirements of IMO instruments in several aspects such as national legislation of the requirements of IMO instruments, provision of hydrographic service including hydrographic capacity building, production and distribution of nautical charts and nautical publication, Promoting the Uniformity in Charts and Nautical Publications and supporting the PSC and FSC inspection of carriage of nautical charts and its equivalent, and the management of rental fishing vessels used for hydrographic surveying. These problems shall be solved as soon as possible in the future.

## Chapter 6

### **The Measures of and Suggestions on Improving the Implementation of IMO Instruments by CHO**

#### ***6.1 Strengthening the Study of Countermeasures for IMO Member State Audit***

First of all, carry out the research on IMO member state audit scheme. On the one hand, it is necessary to clarify the requirements, characteristics and other issues of IMO audit by studying the relevant regulations, resolutions and recommendations of IMO on member state audit. On the other hand, it is also necessary to learn good practices and successful experiences on how to pass the IMO audit from other functional departments of China MSA and other countries through the study of IMO audit report of China MSA and other countries.

Secondly, find out the weaknesses of the implementation of IMO instruments by CHO. CHO shall make the requirements of IMO member state audit as the standard and goal of work, and carefully check the hydrographic work of CHO from two different viewpoints including how to successfully pass the IMO audit and how to perfectly comply with IMO instruments, in accordance with the principle of benchmarking management,. The focus of the check is to find out the weakness and problems of implementation of IMO instruments and deeply analyze the reasons for the problems and main difficulties to implement the requirements of IMO instruments

Thirdly, develop countermeasures for passing the IMO audit and improving the implementation of IMO instruments by CHO. It is suggested that CHO develop corresponding measures from the short-term and long-term perspectives respectively, to solve the main problems and difficulties restricting the enhancement of ability and level of performance, in order to lay a solid foundation for successfully passing the

imminent IMO mandatory audit and fundamentally improving Chinese ability and level of hydrographic service.

Finally, CHO should speed up the establishment of management mechanism of the implementation of IMO instruments based on ISO 9001 quality management system. Objectively speaking, IMO member state audit scheme did not force the establishment of quality management system by member states, but the establishment of management mechanism of the implementation of IMO instruments based on ISO 9001 quality management system, which is beneficial to form the closed loop of management of the implementation of IMO instruments, is the effective measure and an inevitable option to deal with the audit considering that the audit scheme is originally established based on the principle of quality management and the IMO auditors prefers to conduct the audit in accordance with the principle of quality management system (Bao, J. L., 2011, Wang, L., 2015, Zhou, Y., Sha, Z. R., 2011).

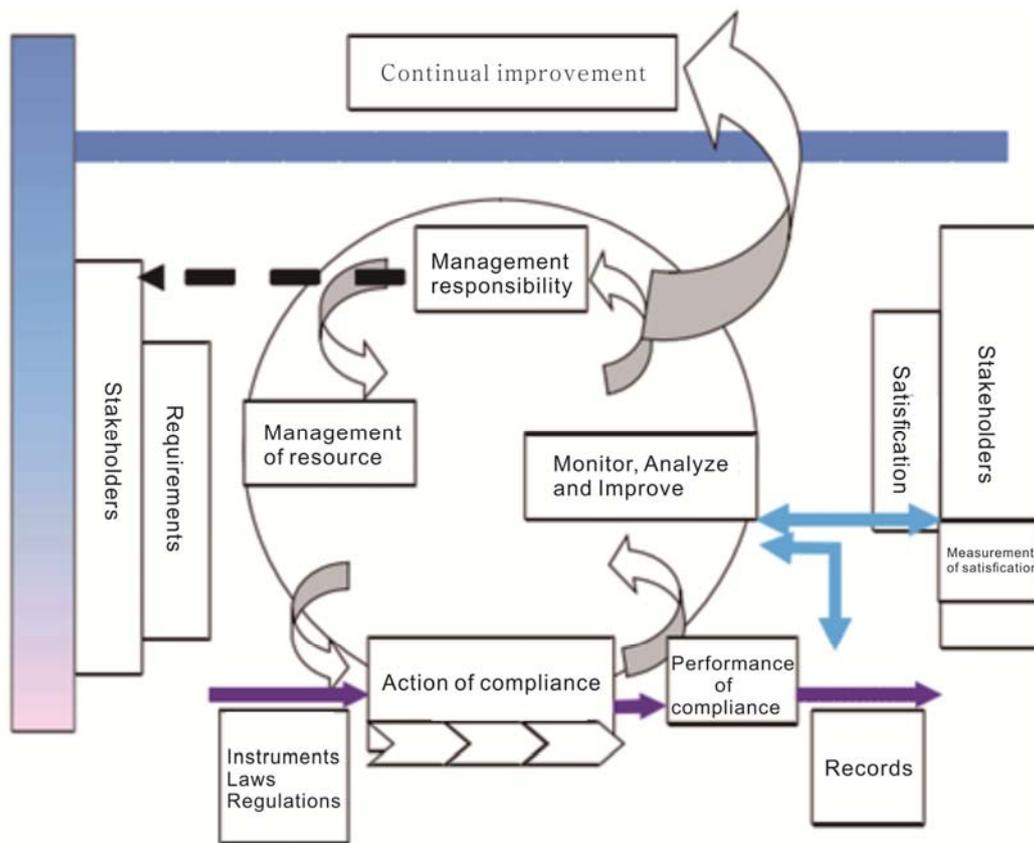


Figure 6.1 - Management Mechanism of the Implementation of IMO Instruments Based On ISO 9001 Quality Management System

Source: Yang, K. P. (2012). Consideration of the establishment of the Management Mechanism for Implementation of Maritime Conventions based on the quality control system. *China Maritime Safety*, (5), 31–33.

### **6.2 National Legislation of the Requirements of IMO Instruments**

Firstly, CHO must seize the opportunity that Chinese navy will withdraw from civil Surveying and Mapping markets, to boost the revision of Surveying and Mapping Law of the People’s Republic of China and Maritime Traffic Safety Law of the People’s Republic Of China, while integrating the requirements of the SOLAS Convention on the provision of hydrographic service into the two laws, which will

help to confirm CHO as the official position of the Hydrographic Organization, and eliminate the overlap of functions from the origin.

Secondly, promote Ministry of Transport of the People's Republic of China to develop Regulations for the administration of Hydrographic Surveying and mapping of Chinese coastal navigable waters which will further confirm the legal position of CHO as the official position of the Hydrographic Organization (He, K. Q., 2006). And then, CHO shall develop control regulations for the administration of Hydrographic Surveying and mapping of Chinese coastal navigable waters to lay the foundation for the specification and purification of marine engineering measurement market (Lu, Y. Q., 2013).

Thirdly, strengthen the administrative management of marine engineering measurement market. CHO shall expel the bad enterprises from the market through improving the system of access and exit mechanism and establishing a blacklist system. Also, CHO shall establish a system to provide and strengthen the audit bathymetry of navigable dimension of Chinese coastal waters in order to guarantee the safety of navigation.

### ***6.3 Improvement of the Capacity and Level of Hydrographic Service***

#### ***6.3.1 Capacity Building of Hydrographic Surveying***

First of all, CHO shall quickly solve the problem of lack of quantity and ability of hydrographic service by speeding up the establishment of sub-centers of hydrographic surveying and mapping, the construction of hydrographic survey ships and docks, and the purchase of advanced hydrographic equipments, in order to improve Chinese quality and level of the hydrographic service. As for the site selection of sub-centers of hydrographic surveying and mapping, CHO shall take into account the distance between the selected city and its major surrounding ports

and its radiation force to surrounding cities in order to improve working environment of staff at the production line, enhance their sense of belonging and happiness, and improve the efficiency of hydrographic surveying. As for the construction of the hydrographic ship, CHO should not only attach importance to solve the shortage problem, but also pay more attention to solve the problem of structural imbalance. That is to say, CHO shall not only invest more money to the construction of large hydrographic survey ships which is suitable to measure in ocean and deep waters, but also pay more for the construction of small hydrographic survey ships with a length of 25 meters which is suitable to measure in berthing waters instead of rental fishing vessels. In terms of the purchase of hydrographic equipments, CHO should not only pay more attention to the purchase of foreign advanced equipments, especially the deep-water bathymetric equipments so as to improve bathymetric ability of CHO in ocean and deep waters (Wang, F. Z., Li, Q. R., Wang, S., Zhao, J. Y., 2015), but also give more attention to replacement of foreign equipments by domestic equipments in order to improve the efficiency in the use of funds and create conditions to increase the number of hydrographic equipments as much as possible. In addition, as for the construction of hydrographic survey ships and the purchase of hydrographic equipments, CHO can explore how to make up for the lack of financial investment through making use of social funds, For instance, co-construction and sharing. That is to say, CHO is responsible for developing the technical performance requirements of these ships and equipments, and enterprises are responsible for investing money to construct hydrographic survey ships and purchase hydrographic equipments, and then CHO obtains the right to use these ships and equipments through long-term rental contract between CHO and enterprises with these ships and equipments.

Secondly, it is suggested that CHO improves the hydrological network by accelerating the construction of hydrological stations, and the ability and level of hydrological information services. CHO should develop the national development plan of coastal hydrological station network and promote the overall construction of the national hydrological stations for the purpose of the establishment of a national coastal hydrological station network possessing reasonable layout, sufficient quantity, advanced technology and comprehensive coverage, through the combination of self construction and joint construction, as soon as possible. The national coastal hydrological station network will lay a solid foundation for the establishment of a unified land and ocean vertical datum and meet the development needs of expanding the coverage of hydrographic surveying from port waters to offshore and deep waters. Also, CHO should accelerate the construction of hydrological information service system and provide the high-accuracy and real-time hydrological and depth services to the mariners as soon as possible, in order to meet the need for large vessels to take the opportunity of the high tide to entry and exit ports and promote the safety of navigation and the improvement of ports' economic efficiency.

Thirdly, CHO is supposed to strengthen the construction of human resources, in order to improve its capacity of sustainable development (Yang, Y. Y., 2016). First of all, CHO should recruit more university graduates majoring in geodesy, GIS, hydrology and meteorology, in order to solve the problems of aging and irrational knowledge structure of staff. Secondly, it is necessary to establish a reasonable income and promotion incentive mechanism to improve the attraction of posts at the production line to technicians. Thirdly, CHO should cultivate more technical experts and leading talents, in order to improve the ability of CHO to lead the development of hydrographic technology and standards and enhance the international influence

and right of speech of CHO. Finally, CHO should promote the steady improvement of geodesy and topographic surveying capabilities by training and update the knowledge of technicians.

Fourthly, CHO is proposed to strengthen technological innovation in order to improve the efficiency of hydrographic surveying. First of all, CHO should actively carry out the research on the application of remote sensing technique and UAV (Deng, Z. S., Shi H., Y., Cheng, S., L., 2017)) in hydrographic surveying in order to improve the capacity of wide range and fast topographic survey. Secondly, CHO should promote the application of Beidou Navigation Satellite System (referred to as "BDS" ) and Continuously Operating Reference Stations (referred to as "CORS" ) techniques in hydrographic surveying in order to improve the accuracy and quality of Bathymetric data and hydrological data (Wu, L. Z., Huang, Y. J., Lv, Y. J., 2010).

Finally, CHO is suggested to expand the coverage of the hydrographic surveying to covering all of Chinese coastal waters. First of all, CHO should complete as soon as possible the hydrographic surveying of all the nautical charts included in the Catalogue of Chinese planned Coastal Port and Fairway Charts, in order to meet the needs of the production of paper charts and ENC's. Secondly, CHO should complete as soon as possible the hydrographic surveying of all planned waters included in the general plan of Ships 'Routing System in Chinese Coastal waters, in order to meet the needs of safety of navigation and marine management. Thirdly, CHO should establish the plan of and regulations for hydrographic surveying in the territorial sea, contiguous zone and Exclusive Economic Zone (referred to as "EEZ" ) of China, in order to exercise the exclusive rights of hydrographic surveying in the territorial sea and contiguous zone and administrative rights of hydrographic surveying in EEZ

which are stipulated in the United Nations Convention on the Law of the Sea, 1982(referred to as “UNCLOS”).

### ***6.3.2 Production of Nautical Charts and Nautical Publications***

Firstly, CHO is suggested to strengthen top-level design of production of nautical charts and nautical publications. CHO should complete the compilation of the product sequence of Chinese civil nautical charts and nautical publications by strengthening the planning of productions and enriching and innovating types of production, considering the characteristics of modern navigation and making a reference from the catalogue of nautical charts and nautical publications produced by some developed hydrographic nations such as UK and the United States.

Secondly, CHO is supposed to make reasonable plan of implementation and accelerate the implementation of the product sequence of Chinese civil nautical charts and nautical publications. CHO should give priority to the enrichment of types of production and the achievement of fully covering Chinese coastal waters and put them in the same important position when making the plan of implementation. For example, CHO should make great efforts to expand the coverage of existing publications such as tide tables and sailing directions.

Finally, CHO is proposed to pay more attention to the transformation of the idea of development. ENC will be the future of paper nautical chart, and digitalization also will be the trend of the development of nautical publications just like that information service is the future of hydrographic service. Therefore, it is necessary to promote the transformation of products of CHO to these forms of products and services representing the future direction of development.

### ***6.3.3 Distribution of Nautical Charts and Nautical Publications***

First of all, CHO is supposed to regulate the management of the distribution of nautical charts and nautical publications. Firstly, CHO should set up a unified supply and service system for nautical charts and nautical publications as soon as possible, through improving the management system of distribution service to eliminate the mechanisms that easily lead to internal vicious competition and unify the price and standards of distribution services. Secondly, CHO should strive for the establishment of the Chinese civil nautical charts and nautical publications stress in Shanghai, to centralized management of distribution and supply of nautical charts and nautical publications. Finally, CHO should promote data exchanges and cooperation with major international service providers of nautical charts and nautical publications, to gradually realize the mutual distribution of each others' products between CHO and them.

Secondly, CHO is proposed to innovate the mode of distribution service and enrich channels of service distribution. Firstly, CHO should explore to provide distribution service through e-commerce websites, mobile APP platforms and other new media. Secondly, CHO shall innovate the idea of distribution service. For example, CHO should not only take the initiative to find and predict the needs of users, but also actively guide users to realize the self-discovery of their demand. Thirdly, CHO should establish the Print on Demand (referred to as "POD") service system of nautical charts and nautical publications, to provide more timely, convenient and efficient distribution services of paper charts.

Thirdly, CHO is suggested to strengthen the distribution service of ENC. CHO should provide users with more comprehensive, convenient, fast and effective purchasing and updating services of ENC. CHO should also further improve the cloud service platform and promote cloud service of ENC data, to provide data analysis service based ENC to the public.

Finally, it is suggested that CHO should carry out the information service. First of all, CHO should strengthen the study on Key techniques of E-Navigation, construction of information infrastructure and integration of various information in order to establish the integrated information system based on E-Navigation (Li, J. T., 2017, Wu, J. Y., Liang, C. L., Dou, T. F., 2016). At the end, CHO should promote the application of Cloud computing and big data techniques in distribution of information included in the nautical charts and nautical publications in order to improve the quality and satisfaction of hydrographic Service (Lin, S. Y., Zhong, T., 2015).

#### ***6.3.4 Promoting the Uniformity in Charts and Nautical Publications***

Firstly, CHO is suggested to improve the capacity and depth to participate in IHO technical work. The key is to work six aspects. 1. CHO should set up a systematic and comprehensive tracking mechanism of IHO technical work. 2. CHO should establish database of technical information on international hydrographic surveying and mapping, to provide information service of international hydrographic surveying and mapping. 3. CHO should strengthen English training of technicians, and pay more attention to the cultivation of technical experts who are able to participate in the international exchange. 4. CHO should establish the corresponding incentive mechanism to arouse the enthusiasm of technicians on participation in the International exchange. 5. CHO should encourage domestic manufacturers of hydrographic and ECDIS equipments to join the delegation of CHO and participate in the IHO technical work. 6. CHO should select and send outstanding technical experts to join the IHO headquarters and working groups.

Secondly, CHO is supposed to speed up nationalization of international standards (Li, H. M., 2016). CHO should revise and improve the existing the form of standards system for hydrographic surveying and mapping, and

accelerate the development of new national standards through the special standards project, to nationalize international standards (Lu, Y., Xia, Q. B., Kong, H. Y., 2015). Secondly, CHO should improve the existing amendment procedures of national standards, and speed up the revision of national standards, to include the amendments of IHO standards related to new technology and process as soon as possible. Finally, as for ENC which is a new product based on international standards around the world, CHO should set up a special procedure to directly nationalize these international standards in order to accelerate the production of this new product.

#### ***6.3.5 Supporting the PSC and FSC Inspection of Carriage of Nautical Charts and Their Equivalents***

First of all, CHO is supposed to give more technical support to PSC officers and FSC officers in carrying out inspections of nautical charts and their equivalent. Firstly, CHO should actively provide PSC officers and FSC officers with the knowledge of its products and updating information of versions through special training, WeChat APP software and electronic or paper manuals. Secondly, CHO should help PSC officers and FSC officers to carry out inspection through provision of technical softwares based on PAD and intelligent mobile phone platform made by CHO such as checking software of version information and inspection software of small correction of charts. These technical softwares will be a useful tool to reduce the complexity and difficulty of inspection and convenient to implement the inspection. Finally, CHO should improve the quality and updating speed of paper charts and ENCs, and provide good product reputation to support the inspection.

Secondly, CHO is proposed to promote the developments of laws and regulations, in order to provide a legal basis for the carriage requirement of official hydrographic products produced by CHO and authorize organizations (He, K. Q., 2006). Also,

CHO should suggest China MSA to develop regulations to unify the PSC and FSC inspection of carriage of nautical charts and their equivalent in order to improve effectiveness and efficiency of inspection and make sure ships sailing in Chinese coastal waters carriage the latest official hydrographic products to promote the safe of navigation.

#### ***6.4 Improving the Management of Hydrographic Survey Ships.***

First of all, CHO is proposed to improve the existing management system of hydrographic survey ships. CHO should re-examine the existing management system from the perspectives of the reference implementation of the SOLAS convention, STCW Convention and MARPOL convention, and take measures to ensure the effectiveness of the implementation of these IMO instruments, in order to effectively improve the level of standardized management of the existing hydrographic survey ship and enhance the safety of hydrographic survey ships and prevent the pollution of marine environment from hydrographic survey ships.

Secondly, CHO is supposed to focus on strengthening and improving the management of rental fishing vessels used for hydrographic surveying. Firstly, it is necessary to improve the selection system of fishing vessels used for hydrographic surveying in accordance to the requirements of the SOLAS Convention on the structure of ship, fire protection, fire detection and fire extinction, life-saving appliances and arrangements, and equipments, in order to fundamentally enhance the safety of these fishing vessels. Secondly, it is also essential to develop the system of watchkeeping and strengthen the competence training of crew according to the requirements of the STCW Convention, in order to improve the operational safety of these fishing vessels. Last but not least, CHO should develop rules and regulations for implementation of the MARPOL convention to focus on

strengthening the supervision of food waste, sewage and oil, in order to prevent the pollution of the marine environment from these fishing vessels.

Finally, CHO is supposed to enhance the awareness and ability of compliance of all crew and surveyors on the production posts. CHO should improve their awareness of safety of navigation and protection of marine environment through the training of knowledge of IMO instruments and periodical fire drill, lifeboat drill and pollution prevention drill so that each one understands that their behaviors will impose an influence on the image of China MSA and Chinese government.

### ***6.5 Chapter Summary***

CHO will be able to rapidly improve the level of compliance with IMO instruments in China through strengthening the study of countermeasures for IMO member state audit and making full use of good practices and successful experiences learned from other functional departments of China MSA and other countries on how to pass the IMO audit.

However, in order to fundamentally improve Chinese ability and level of hydrographic service, CHO has to solve the main problems and difficulties restricting the enhancement of ability and level of performance, through strengthening 5 aspects of hydrographic capacity building including organization, hydrographic survey ships, hydrographic equipments, hydrological network and human resources, establishment and development of the product sequence of Chinese civil nautical charts and nautical publications, improvement and innovation of the distribution system of nautical charts and nautical publications, making greater efforts to promote the uniformity in charts and nautical publications and support the PSC and FSC inspection of carriage of nautical charts and their equivalent, and improving the management of hydrographic survey ships.

## **Chapter 7**

### **Conclusions**

#### ***7.1 Summary***

This paper aims to further standardize and improve the management and service level of CHO, through reasonable suggestions to improve Chinese ability and level of compliance with IMO instruments based on the assessment of status and shortcomings of CHO in the implementation of IMO instruments.

At the beginning, this paper reviews the development history of the Implement System of IMO Instruments, and analyzes the content of IMO instruments required to be implemented by CHO. And then, based on the assessment of status of CHO in the implementation of IMO instruments, this research finds out shortcomings of CHO in the implementation of IMO instruments in National Legislation of the Requirements of IMO Instruments, provision of Hydrographic Service including hydrographic capacity, production and distribution of nautical charts and nautical publications, promoting the uniformity in charts and nautical publications and supporting the PSC and FSC inspection of carriage of nautical charts and their equivalent, and the management of hydrographic survey ships, through making an reference of the specific requirements of IMO instruments and advanced experience of UKHO in hydrographic service. Finally, On the basis of the analysis of cause, the paper puts forward 4 proposals to solve the main problems and difficulties, which laid a solid foundation for fundamentally improving Chinese ability and level of compliance with IMO instruments. The four proposals are as follows:

a) To rapidly improve the level of compliance with IMO instruments in China through strengthening the study of countermeasures for IMO member state audit and making full use of good practices and successful experiences learned from other

functional departments of China MSA and other countries on how to pass the IMO audit.

b) To confirm CHO as the official position of the Hydrographic Organization through national legislation of the requirements of IMO instruments, which will lay the foundation for improving and strengthening the administrative management of hydrographic industry.

c) To improve Chinese ability and level of hydrographic service through strengthening 5 aspects of hydrographic capacity building including organization, hydrographic survey ships, hydrographic equipments, hydrological network and human resources, establishment and development of the product sequence of Chinese civil nautical charts and nautical publications, improvement and innovation of the distribution system of nautical charts and nautical publications, and making greater efforts to promote the uniformity in charts and nautical publications and support the PSC and FSC inspection of carriage of nautical charts and their equivalent.

d) To promote the standardized management of hydrographic survey ships through the improvement of management system of hydrographic survey ships owned by CHO, strengthening and improving the management of rental fishing vessels used for hydrographic surveying, and enhance the awareness and ability of compliance of all crew and surveyors on the production posts.

## **7.2 Limitations**

Due to the limitation of time and materials, there are some limitations in this research as follow:

a) Some topics lack quantitative data analysis. For example, how much is the gap between hydrographic capacity (annual measurement area) of CHO and demand of

users or the requirements of the SOLAS Convention (annual demand area)? How many additional ships, equipments and staff need to be added in order to fill the gap?

b) Some topics need to be further studied and described. For instance, what kinds of nautical publications should be included in the product sequence of Chinese civil nautical charts and nautical publications? What specific measures need to be taken and what quantitative index need to be achieved in order to ensure the implementation of the MARPOL convention by hydrographic survey ships, especially fishing vessels used for hydrographic surveying?

c) The coverage of some topics needs to be further expanded. For example, the study of the product sequence of Chinese civil nautical charts and nautical publications could be extended to NOAA and PRIMAR.

d) Some proposals in this paper may be feasible in theory, and the practical implementation of them may require support from higher levels of Chinese government and more time. Take the national legislation of the requirements of IMO instruments for example. The withdraw of Chinese Navy from civil Surveying and Mapping markets really creates an opportunity to confirm CHO as the official position of the Hydrographic Organization, but the attention and support of Ministry of Transport and even higher levels of Chinese government and a long-time process may be necessary because these problems involve the division of functions among CHO, Chinese Navy, and National Administration Of Surveying, Mapping And Geoinformation.

### ***7.3 Implications for Further Research***

The following suggestions are put forward to solve the limitations mentioned above:

a) Strengthen quantitative analysis of some topics. These topics include but not limited to: the gap between hydrographic capacity (annual measurement area) of

CHO and demand of users or the requirements of the SOLAS Convention (annual demand area), the gap of hydrographic survey ships, hydrographic equipment and staff, cost benefit assessment of the establishment of global distribution system of nautical charts and nautical publications, the number and proportion of fishing vessels, reasonable emission standard of hydrographic survey ships etc..

b) To carry out special studies on some topics. These topics include but not limited to: the legislative system of Hydrographic Surveying and Mapping, layout and scheme of the establishment of sub-centers of hydrographic surveying and mapping, the configuration standards, selection of design and construction planning of hydrographic survey ships, the nationalization of advanced hydrographic equipments, the construction planning of hydrological network, hydrological information service system, the product sequence of Chinese civil nautical charts and nautical publications, the nationalization of international hydrographic standards, and the scheme of the implementation of the MARPOL Convention and its annexes by hydrographic survey ships etc..

c) To further expand the coverage of some topics, to enrich the content of this study.

d) To carry out the research on implementation rules of relevant countermeasures and suggestions, so as to improve the feasibility and efficiency of the implementation of them.

Word Count: 16,138

## REFERENCES

- Bao, J. L. (2011). On the construction of the control system for implementation of IMO mandatory instruments. *China Maritime Safety*, (10), 25–28.
- Bao, J. Z. (2016). *Maritime Safety Standards*. Unpublished lecture handout, World Maritime University, Malmö, Sweden.
- Ben, J. H. (2011). *Study on the competent authorities' application of maritime conventions in china*. Unpublished master's thesis, Dalian Maritime University, Dalian, China.
- Cao, Y., Zhou, P. (2009). The Role of Hydrographic Surveying and Mapping in Coastal Integrated Navigation Guarantee System. *China Water Transport*, 9(7), 24–25.
- China Hydrographic Office. (2012a). *Research Reports on Product Sequence of Chinese Civil Nautical Charts and Nautical Publications*. Beijing: Author.
- China Hydrographic Office. (2012b). *Annual Report on Hydrography in 2012*. Beijing: Author.
- China Hydrographic Office. (2011). *Chinese 12<sup>th</sup> 5-year Planning of Hydrographic Surveying and Mapping*. Beijing: Author.
- China Hydrographic Office. (2016). *Chinese 13<sup>th</sup> 5-year Planning of Hydrographic Surveying and Mapping*. Beijing: Author.

- China MSA. (2006). *Planned Catalogue of Chinese Coastal Port and Fairway Charts (2006)*. Beijing: China Communications press.
- China MSA. (2009). *Planned Catalogue of Chinese Coastal Port and Fairway Charts (2009)*. Beijing: China Communications press.
- China MSA. (2012). *Planned Catalogue of Chinese Coastal Port and Fairway Charts (2012)*. Beijing: China Communications press.
- China MSA. (2016). *Catalogue of Chinese Coastal Port and Fairway Charts (2016)*. Beijing: China Communications press.
- Deng, Z. S., Shi, H. Y., Cheng, S. L. (2017). Research on Application of UAV in navigation Guarantee. *China Water Transport*, 17(1), 24–25.
- Du, D. C. (2016). *Marine Environment Protection Standards*. Unpublished lecture handout, World Maritime University, Malmö, Sweden.
- He, K. Q. (2006). Discussion on improving the service capacity of nautical charts and nautical publications of CHO. *Pearl River Water Transport*, (7), 88–90.
- International Commission on Shipping (ICONS). (2001). *Ships, Slaves and competition*. Charlestown: Author.
- IHO. (2007). *The Present Status of Small Scale ENC Coverage with Respect to the Allocation of Cells to Usage Bands 1 (Overview) and 2 (General) (CHRIS19-06.1E)*. Monaco: Author.

- IHO. (2017a). *About the IHO*. Retrieved June 22, 2017 from the International Hydrographic Organization Web:  
[https://www.iho.int/srv1/index.php?option=com\\_content&view=article&id=298&Itemid=297&lang=en](https://www.iho.int/srv1/index.php?option=com_content&view=article&id=298&Itemid=297&lang=en)
- IHO. (2017b). *New IHO Member State - Republic Of Vanuatu* (Circular Letter 28/2017). Monaco: Author.
- IHO. (2017c). *Resolutions of the International Hydrographic Organization* (M-3). Monaco: Author.
- IHO. (2017d). *IHO - Publications*. Retrieved June 22, 2017 from the International Hydrographic Organization Web:  
[https://www.iho.int/iho\\_pubs/IHO\\_Download.htm](https://www.iho.int/iho_pubs/IHO_Download.htm)
- IMO. (2004). *Voluntary IMO Member State Audit Scheme* (A.946(23)). London: Author.
- IMO. (2005a). *Code for the Implementation of Mandatory IMO Instruments* (A.973(24)). London: Author.
- IMO. (2005b). *Framework and Procedures for the Voluntary IMO Member State Audit Scheme* (A.974(24)). London: Author.
- IMO. (2014). *Transition from the Voluntary IMO Member State Audit Scheme to the IMO Member State Audit Scheme* (A.1068 (28)). London: Author.

IMO. (2017). *Introduction to IMO*. Retrieved June 22, 2017 from the International Maritime Organization Web:

<http://www.imo.org/en/About/Pages/Default.aspx>

IMO Secretariat. (2002). *Outcome of C 88 (MEPC 48/10/4)*. London: Author.

IMO Secretary-General. (2016). *Progress report on the implementation of the Scheme (C 116/6)*. London: Author.

International Convention for the Safety of Life at Sea 1974, IMO, (1974).

International Convention for the Prevention of Pollution from Ships 1973, IMO, (1973).

International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978, IMO, (1978).

Kuang, X. Y., Xu, H. (2008). How to tackle the interim of IMO Voluntary Member States Audit Scheme. *World Shipping*, 31(1), 30–31.

Li, H. M. (2016). Study on the development of navigation safeguard standardization and international standardization. *China Maritime Safety*, (8), 49–52.

Li, J. T. (2017). Discussion on the informationization service system for navigation safeguard. *China Maritime Safety*, (1), 46–47.

Li, Z., Qiu J. W. (2007). On the status, challenge and developing trends of Voluntary

IMO Member States Audit Scheme. *World Shipping*, 30(1), 40–42.

Lin, S. Y., Zhong, T. (2015). Discussion on the reform of the administrative mode of navigation guarantee department in big data Era. *Technological Development of Enterprise*, 34(6), 131–132.

Liu, Z. J. (2011). *Ship Safety Management*. Dalian: Dalian Maritime University press.

Lu, Y. Q. (2013). Strategic thinking of coastal hydrographic industrial management. *China Maritime Safety*, (3), 52–54.

Lu, Y., Xia, Q. B., Kong, H. Y. (2015). Research Status about the Standard of International Hydrographic Organization. *Hydrographic Surveying and Charting*, 35(4), 52–56.

Ma, Y. L., Song, W. (2010). Effective and efficient implementation: a good image of a big maritime country - China successfully passes the IMO Voluntary Audit. *China Maritime Safety*, (1), 18–20.

Qin, Z., Yu, Y. D. (2010). Role of VMSAS on implementing international maritime standards. *Journal of Dalian Maritime University*, 36(6), 138–139.

Qu, Y. N. (2013). *Study on Legislative Transformation about International Maritime Conventions under IMO Audit Scheme in China*. Unpublished doctor's thesis, Dalian Maritime University, Dalian, China.

- Sha, Z. R. (2010). Cost-effective analysis by China MSA on IMO member state voluntary audit. *China Maritime Safety*, (1), 21–25.
- Sha, Z. R. (2016). Future development and associated countermeasures on the Convention implementation of China MSA. *China Maritime Safety*, (12), 60–62.
- Song, S. (2016). *Study on Legal Challenge and Countermeasure about Maritime Compliance of China under IMO Compulsory Audit Scheme*. Unpublished master's thesis, Shanghai University, Shanghai, China.
- UKHO. (2013). *Catalogue of Admiralty Charts and other Hydrographic publications* (NP131). Taunton: Author.
- Wang, B. J. (2008). Study on the Application of IMO Voluntary Audit to the Work of Aids to Navigation. *China Maritime Safety*, (2), 51–54.
- Wang, F. (2012). Discussion on the construction of performance system of Zhenjiang MSA. *Shipbuilding Science and Technology*, (4), 39–42.
- Wang, F. Z., Li, Q. R., Wang, S., Zhao, J. Y. (2015). Study on the navigation guarantee of San sha sea area. *China Water Transport*, 15(4), 16–18.
- Wang, H., Zhang, M. J., Xi, L., Ren, X. W. (2015). Research and Enlightenment of Foreign Navigation Support Systems. *Hydrographic Surveying and Charting*, 35(3), 57–59.
- Wang, H. C. (2005). Surveying all over the country – a review of China's marine

- survey and plotting for the past 50 years. *China Maritime Safety*, (3), 4–7.
- Wang, R. L. (2011). The explorer of the ocean - 56th anniversary of the development of maritime hydrography. *China Maritime Safety*, (11), 70–71.
- Wang, L. (2015). Suggestions on Preparing for the Transformation of IMO VMSAS into a Mandatory Scheme. *China Maritime Safety*, (8), 32–34.
- Wang, S. Y. (2009). On the application of Voluntary IMO Member State Audit Scheme in VTS management and measures to be taken. *China Maritime Safety*, (3), 47–49.
- Wang, Z., Liu, S. L. (2012). The several “Firsts” in the history of China’s maritime hydrological survey. *China Maritime Safety*, (6), 74–75.
- Wei, J. T., Ma, Y. L. (2009). IMO's 60 years for regulating and serving the international shipping -A review of IMO's history of 60 years. *China Maritime Safety*, (10), 58–62.
- Wu, L. Z., Huang, Y. J., Lv, Y. J. (2010). Discussion on key technologies of location selection for reference stations of marine BDS CORS. *Journal of Navigation and Positioning*, 5(1), 138–139.
- Wu, J. Y., Liang, C. L., Dou, T. F. (2016). General framework of the integrated information system for navigation support based on E-Navigation. *Port & Waterway Engineering*, (S1), 138–139.

- Xu, Y. (2015). *Study of National Hydrographic Management System Construction in the New Era*. Unpublished master's thesis, Tianjin Maritime University, Tianjin, China.
- Yang, K. P. (2012). Consideration of the establishment of the Management Mechanism for Implementation of Maritime Conventions based on the quality control system. *China Maritime Safety*, (5), 31–33.
- Yang, Y. Y. (2016). Discussion on issues confronted by the development of China navigation security system and associated countermeasures. *China Maritime Safety*, (9), 49–50.
- Yang, Y., Lv, Y. X. (2008). To strengthen the capabilities building on provision of hydrographic services under the guidance of the newest international conventions. *China Maritime Safety*, (3), 31–33.
- Yin, X. D., Chen, Y., Tang, J., Zhan, X. S., Xu, W. M. (2011). A Comparison of International Standards for Hydrographic Surveys. *Hydrographic Surveying and Charting*, 31(4), 35–38.
- Yu, H. B. (2011). Refereeing Audit Findings from IMO When Fulfilling International Conventions in China. *World Shipping*, 34(7), 48–49.
- Yuan, J. S., Wu, L. L. (2016). Progress of International Hydrographic Service and Technical Standards. *Hydrographic Surveying and Charting*, 36(6), 65–69.
- Zhai, G. J., Huang, M. T., Ouyang, Y. Z., Lu, X. P. (2012). On the Definition of

Hydrographic Survey and Marine Survey. *Hydrographic Surveying and Charting*, 32(3), 65–72.

Zhao, Y. B., Yang, Y. L. (2009). Study on the application of IMO Voluntary Audit Scheme in the Control Work of China MSA. *China Maritime Safety*, (9), 39–42.

Zhou, Y., Sha, Z. R. (2011). Thoughts on IMO Audit and construction of the management system of performance. *China Water Transport*, (7), 14–15.