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Research on collision avoidance and safety measures of drilling platform towing group

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RESEARCH ON COLLISION AVOIDANCE AND SAFETY MEASURES OF DRILLING PLATFORM TOWING GROUP

By

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DECLARATION

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

Signature: ……..

Date: ……..

Supervised by: ……..

Supervisor's affiliation: ……..

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Last but not the least, I want to say thank you to my family. Thank you for always be there for me and everything you have done for me. Because of that, I have the motivation to continue to study, especially my wife Yvna Niu, who shared almost all the family work during my study. You are the source of my happiness and the pride of my life.

ABSTRACT

Title of Dissertation: **Research on collision avoidance and safety measures of drilling platform towing group**

Degree: **Master of Science**

In recent years, with the rapid development of drilling oil fields in Bohai Sea, China, the offshore towing business of drilling platforms has become frequent. The drilling platform is a large-scale facility. During offshore towing operation, the length of towing group can reach 500-700 meters. The maneuverability of the towing group is greatly limited, and the speed is slow, so there is a great risk in the towing process. Once the operation is improper, it is easy to cause safety accidents, endanger the safety of itself and the surrounding ships, and even cause pollution to the water area. Taking the towing drilling platform as an example, through literature research, data quantitative analysis and expert experience summary, this paper combs the natural conditions of the towing fleet's navigation waters, ship's customary routes, ship traffic flow and fishing areas, and analyzes the risks existing in the towing operation of the drilling platform, In order to provide reference for towing operation of drilling platform in this water area, the precautions for collision avoidance and safety measures are put forward.

KEY WORDS: Platform towing group, Collision avoidance, Safety measures

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1: Introduction

1.1 Research content and significance

Bohai oilfield is the largest offshore oilfield in China and the second largest crude oil production base in China. The Bohai Sea covers an area of 73000 square kilometers, of which about 43000 square kilometers can be explored. By the end of 2010, Bohai oilfield has discovered nearly 5 billion cubic meters of grade III oil geological reserves, and discovered Penglai 19-3, Suizhong 36-1, Qinhuangdao 32-6, Bozhong 25-1, Jinxian 1-1, Jinzhou 25-1 and other 100 million ton oil fields, forming four production oil areas and eight production units, with more than 50 production fields and more than 100 production platforms. In February 2021, CNOOC announced that Bozhong 13-2 oilfield in Bohai Sea has geological reserves of 100 million tons.

The vigorous development of Bohai oilfield has brought the rapid increase of towing operation of drilling platform. Offshore oil drilling platform and oil acquisition and production platform are places with high risk of production environment. The cost of platform itself is expensive. Once an accident occurs, it may cause huge loss of life and property, and seriously harm the marine environment.

The drilling platform has the characteristics of large scale and large inertia, so there are great navigation safety risks in the process of offshore towing operation. This paper focuses on the safety of towing operation of drilling platform in Bohai Sea. Through literature research, data quantitative analysis and expert experience summary, this paper combs the natural conditions of the towing fleet's navigation waters, the ship's customary routes, the ship's traffic flow and fishing areas, analyzes the risks existing in the towing operation of drilling platforms, and puts forward the precautions and safety measures for collision avoidance during the offshore towing operation of drilling platforms.

In order to make a better quantitative analysis, this paper chooses the typical Bohai Sea towing route from Caofeidian wharf to Penglai oilfield to study. The geographical location of the route is shown in Figure 1-1-1.

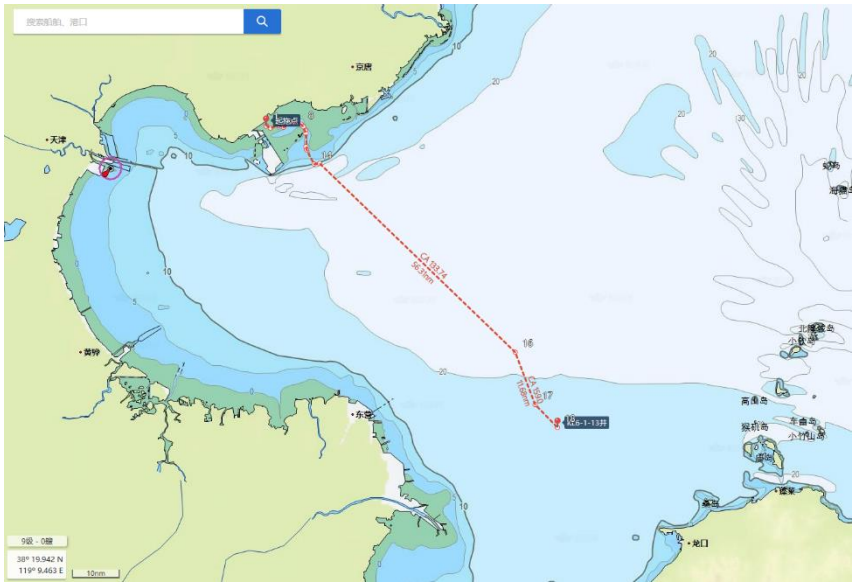

Figure 1-1-1 Schematic diagram of navigation seaa

1.2 Research status

Many scholars have carried out relevant research on the navigation safety of towing operation of large-scale offshore facilities.

According to his case study on towing large offshore ships and drilling platforms, Wang Zhenya combed the general steps of towing, summarized the navigation experience of towing operation, and put forward the matters needing attention in actual operation (Wang, 2019).

Wang Yanjie summarized and combed the general requirements of towing operation of drilling platform, and combined with the navigation experience and the problems that may be encountered in the towing process, put forward the corresponding navigation

safety guarantee measures (Wang, 2020).

Qian Jing studied the stability of the drilling platform in towing operation. Taking the operation stability as the breakthrough point, the calculation method of the extreme value of the lateral stability of the offshore vessel in towing state was analyzed (Qian, 2020).

Ni Minggui studied the industry standards and requirements for towing, as well as the mainstream and high-precision estimation methods of towing resistance and speed, and put forward suggestions on reasonable selection of towing tugs and proper allocation of towing rigging (Ni, 2020).

Li Yongye and his co-workers selected typical offshore drilling platforms, respectively adopted the code for general design of seaports commonly used in domestic navigation safety assessment, empirical algorithm and channel design guidelines of the United States and Canada to calculate and analyze the towing channel width, and put forward suggestions on the channel width required for the towing operation of drilling platforms (Li Yongye, Zheng Shuxi, & Bao Xingxian. 2016).

This paper analyzes the force of the towing system during navigation, establishes the mathematical model of the towing system, and uses MATLAB simulation software to simulate the motion of the towing system, and studies the influence of the loading condition of the towed ship on the yaw degree of the towing system (Hong Biguang, Li Qiang, Gao xiaori, & LV Weiwei., 2009).

At present, the research on offshore towing of drilling platform mainly focuses on towing technology and towing experience. In addition, the comprehensive navigation risk analysis and emergency plan are not detailed and specific enough. Combined with typical cases, this paper makes a systematic navigation risk analysis on the towing

operation of drilling platform, and puts forward preventive measures on this basis.

Chapter 2: Analysis of the navigation environment in the navigation waters

The navigation area of the towing group is located in the central waters of the Bohai Sea. The analysis of the navigation environment should mainly consider the natural environment of the waters and factors affecting the safety of the towing group's navigation, such as vessel traffic flow and customary routes. In order to make the analysis data more objective, the data of 2019 before the epidemic were selected to analyzed.

2.1 The natural environment of the navigation waters

2.1.1 Wind

The Bohai Sea area has obvious monsoon characteristics. The winter monsoon prevails from October to March of next year. The prevailing period is about 6 months, mainly northerly winds, of which the northwesterly winds are dominant, with stable wind direction and strong wind. The summer monsoon prevailing period is from May to August, and July and August are the peak periods of summer monsoon. The wind direction is southerly, mainly southeast wind, with less stable winds and weaker winds. Due to geographical conditions, the characteristics of the southeast monsoon are not obvious. There is a transition period between the winter and summer monsoon periods, with the transition from winter to summer being slightly longer and the change from summer to winter being faster.

The wind in the Bohai Sea is stronger in the northern part of the sea than in the southern part, and stronger in the distant sea than in the near shore, which is caused by the difference between the pressure gradient and the friction between sea and land. In terms of seasonal distribution, the wind is the strongest in winter, especially in January. The

monthly average wind reaches level 5, followed by spring, the smallest in summer, and it gradually increases in autumn. From the geographical distribution point of view, the wind in the Bohai Strait is relatively high, while the western coast is relatively small. The average wind force in Liaodong Bay is the largest in spring throughout the year, but the annual maximum occurs in November. The monthly average wind force is 4 to 5. The average wind force in summer is small, with an average wind force of 3 in August. The average wind force on the west coast of the Bohai Sea is highest in spring, especially in April, generally at level 3 to 4, followed by winter, and the smallest in summer in August, with an average wind force of level 3. The average wind force on Changxing Island and the Bohai Strait is the largest in late autumn and winter, and the monthly average wind is generally 4 to 5, followed by spring and the smallest in summer, with an average wind of 2 to 3. Statistics from meteorological stations show that the normal wind direction in the waters near Caofeidian Port is SSW with an occurrence frequency of 10.0%, while the secondary wind direction is ENE and SSE with a frequency of 9.0%. The strong wind direction is the ENE direction, the maximum wind speed is 25m/s; the second strong wind direction is the NE direction, the maximum wind speed is 21m/s. The frequency of winds of magnitude ≥7 in all directions is 4.9% throughout the year.

2.1.2 Fog

Sea fog is the main factor affecting visibility in this area. Fog days occur throughout the year. The fog season is from March to July, with the most in June and July. The average annual fog days in this area are 20-24 days.

There are 45 fog days with visibility below 1km in the waters around Caofeidian Port (measured in 2008), occurring from June to July and from November to February of the following year, with the longest continuous fog days being 3.0 days.

2.1.3 Flow

(1) Tidal currents

Due to the shallow water and weak ocean currents in the Bohai Sea, the role of tidal currents is very important. Generally, near shores and narrow places such as straits, waterways, and harbors are mostly reciprocating currents due to topographical restrictions. The outer sea, on the other hand, is mostly gyratory currents. The flow velocity is generally about 1-2kn, and the maximum flow velocity near the Laotieshan Channel can reach 6.25kn near the shore.

The nature of the tidal current in the Caofeidian waters is irregular semi-daily currents, and its movement form is basically a reciprocating current, and its flow direction is closely related to the seabed topography. On the outer side of the shallows is basically the same as the shoreline. The flow direction at high tide is slightly north to the west and slightly south to the west on the west side of Caofeidian head, while the flow direction at low tide is the opposite, flowing slightly south-east to the east on the west side of the head and slightly north-east to the east on the east side of the head.

(2) Ocean currents

In the Bohai Sea, in addition to wind-driven currents on the surface layer due to the influence of wind, there are also circulations composed of two systems: coastal currents and warm currents. The wind-driven currents have an average velocity of 2.5% of the wind speed, strong in winter and weak in summer, and the flow direction is 15°-20° to the right of the direction where the wind blows. The depth of wind influence is generally 10m, and the maximum is 20-30m. Under stable conditions in the Bohai Strait, there is a circulation from north to south all year round, and the flow velocity is strong in summer and weak in winter. After entering the Bohai Sea, due to the influence of the topography, it is divided into two tributaries. One turns right into the Liaodong Bay, forming the Liaodong Bay Circulation. And the other turns left into the Bohai Bay,

forming the Bohai Circulation. Among them, the circulation in the Liaodong Bay is unstable, and its trend changes with the monsoon and river flow. The Bohai Circulation is relatively stable and forms the southern Bohai circulation with the southern coastal circulation of the Bohai Sea.

2.1.4 Wave

The waves in the Bohai Sea are mainly controlled by the monsoon, which is larger in winter and smaller in summer. The waves produced by winds are dominant, followed by swells. The wavelength and period of waves are shorter. January was dominated by northwest waves, with a wave direction frequency of about 30%, which is also the month when the frequency of large waves has the highest value throughout the year, at about 25%. In April, the number of southerly waves increased, and the frequency of large waves was below 25%. In July, the southeast waves were the main ones, and the frequency of large waves was less than 5% in the western Bohai Sea. In October, 30-40% of northerly waves appeared, and the frequency of large waves increased to more than 20%. Large waves above level 5 are mostly caused by cold waves in winter, typhoons in summer, and cyclones in spring.

The waves in the sea area of Caofeidian are dominated by the waves produced by winds, and the frequency of waves' accounts for more than 80%. The normal wave direction in this sea area is the S direction with a frequency of 10.87%, and the second normal wave direction is the SW direction with a frequency of 7.48%. The strong wave is in the ENE direction, the frequency of H4%≥1.5m is 1.63%, and the second strong wave is in the NE direction, the frequency of H4%≥1.5m is 0.97%. The wave height is slightly smaller in summer and larger in winter and spring.

2.1.5 Sea ice

The Bohai Sea and the northern part of the Yellow Sea in China have different sea ice conditions every winter. The ice period is about 2-4 months, usually from January to upper middle February. The ice conditions are more serious, which is the so-called severe ice period.

From December to February of the following year in Caofeidian Port area is the freezing period of the local coastal area. The thickness of the ice layer is 0.2～0.9m. In general years, the width of fixed ice in the shoals of Caofeidian Sea Area during the glacial period is 3～5km, and the thickness of drift ice is average. It is 10~20cm, and the thickness of overlapping ice can reach 30~40cm.

2.2 The route conditions of the navigation waters

2.2.1 The customary routes of the Bohai Bay

The main customary routes of the Bohai Bay are as follows (Figure 2-2-1):

(1) The customary route from Laotieshan to Qinhuangdao.

(2) The customary route from Laotieshan to Liaodong Bay.

(3) The customary route from Laotieshan to Jingtang Port.

(4) The customary route from Qinhuangdao to Tianjin.

(5) The customary route from Laotieshan to Tianjin.

(6) The customary route from Changshan Waterway to Tianjin.

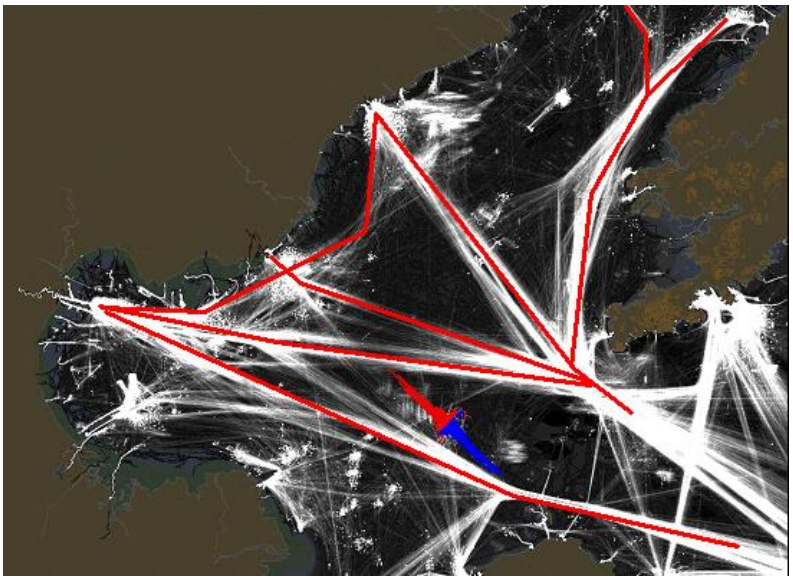

Figure 2-2-1 The customary routes of the Bohai Bay

2.2.2 Planned routes of the Bohai Bay

The issuance and implementation of the "National Coastal Vessel Routing System Master Plan" and the "National Coastal Vessel Route Master Plan" have clarified that China's coastal shipping routes take the main north-south waterway as the main route and sea-going routes of the important coastal waters and major ports as the branch routes. In the system, the width of the main two-way route is 6n mile, the width of the branch two-way route is 3n mile, and the width of the deep-water route is 1000m.

The route planning for the Bohai Sea and the waters to the east has clarified two deep-water routes: the route from Laotieshan Waterway to Tianjin Newport and the routefrom Laotieshan Waterway to the Xianren Island, and 8 recommended routes for main routes, with a width of 3-6n mile and recommended routes for branch routes.

The planned route of the Bohai Bay waters is shown in Figure 2-2-2.

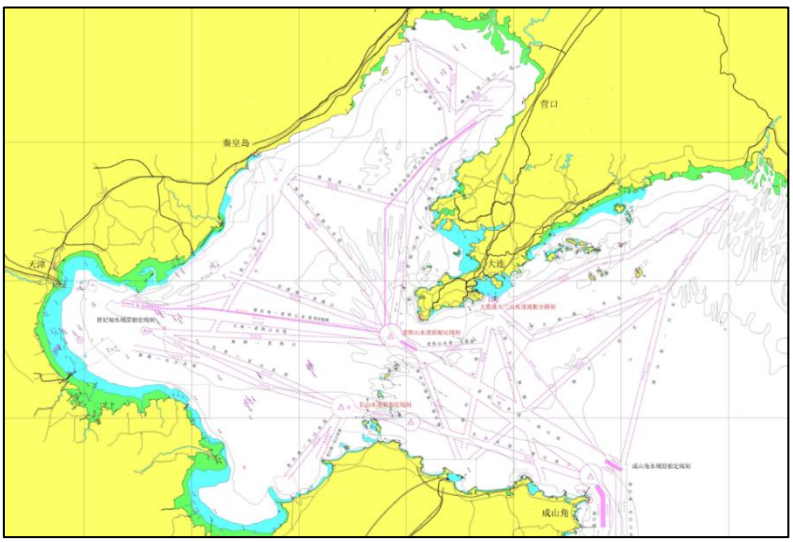

Figure 2-2-2 Schematic diagram of the planned routes of the Bohai Bay

2.3 Traffic flow of the navigation waters

2.3.1 Main traffic flows

The main traffic flows of the towing group's navigation waters are as follows (Figure 2-3-1):

1) The customary route from Qinhuangdao to Tianjin Port.
2) Traffic flow on the customary route from Laotieshan Waterway to Tianjin Port.
3) The customary route traffic flows from Changshan Waterway to Tianjin Port/Caofeidian/Huanghua direction.
4) The customary route traffic flows from.Changshan Waterway to Binzhou Port direction.

Caofeidian inbound and outbound traffic flow, Laotieshan Waterway to Tianjin Port customary route traffic flow, Changshan Waterway to Tianjin Port direction customary route traffic flow, Changshan Waterway to Binzhou Port customary route ship track distribution (AIS trajectory) and the statistics of door lines of traffic flow are shown in Figure 2-3-2 to Figure 2-3-9.

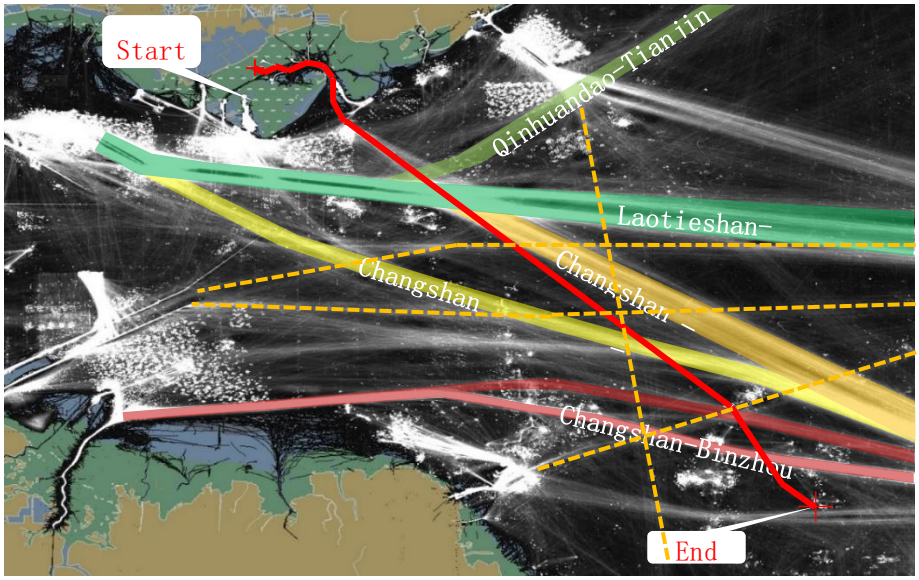

Figure 2-3-1 Distribution of customary routes near the project

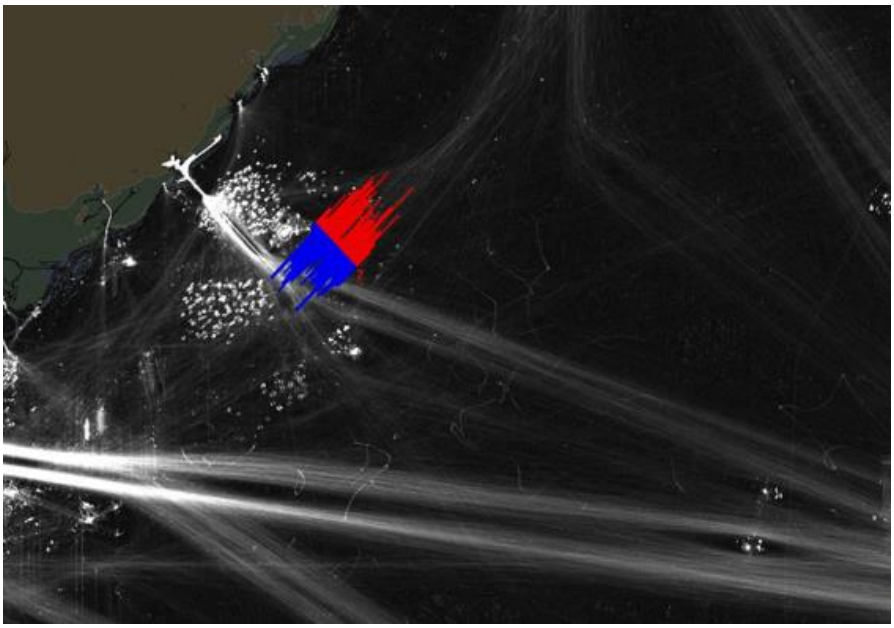

Figure 2-3-2 Traffic flow track distribution from Qinhuangdao to Tianjin Port (First Quarter of 2019)

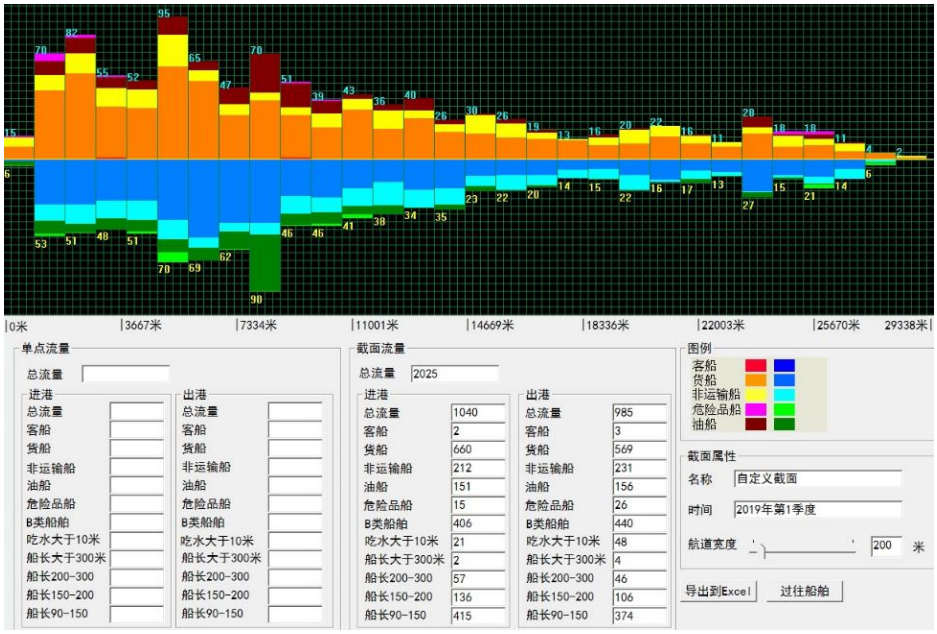

Figure 2-3-3 The door lines of traffic flow from Qinhuangdao to Tianjin Port (First Quarter of 2019)

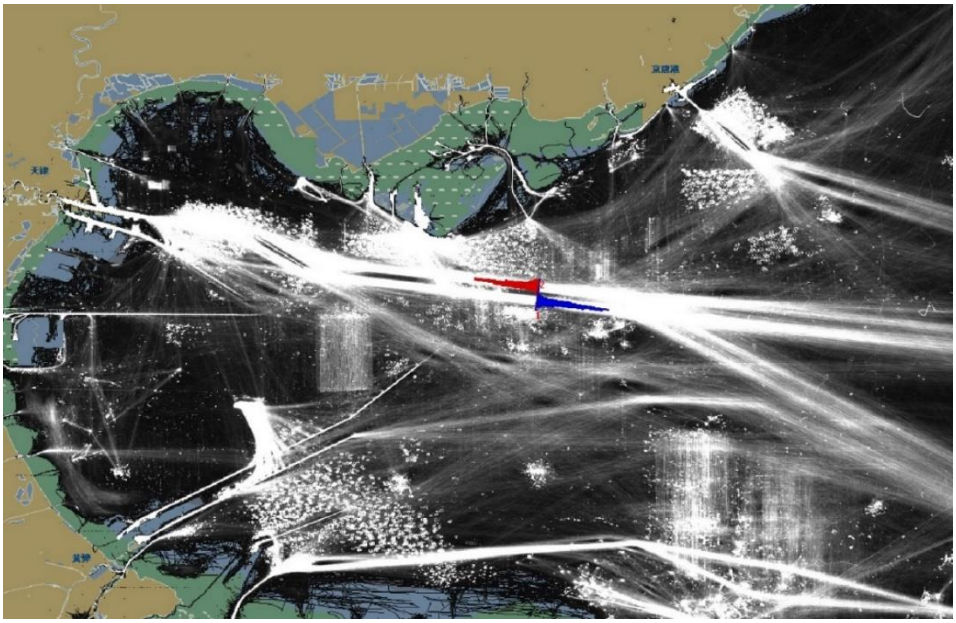

Figure 2-3-4 Distribution of route from Laotieshan to Tianjin Port (First quarter of 2019)

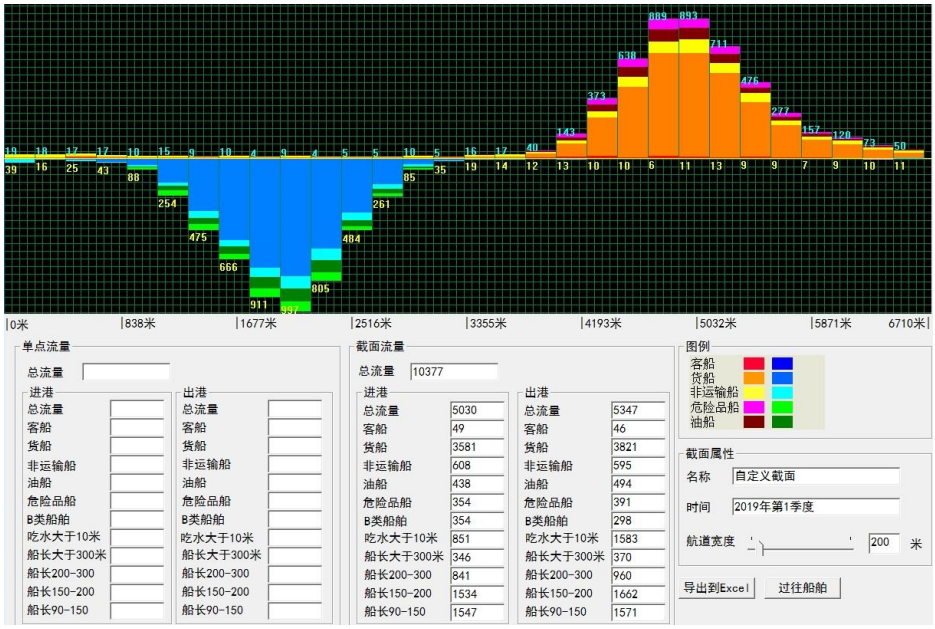

Figure 2-3-5 Statistics of traffic flow from Laotieshan to Tianjin Port (First quarter of 2019)

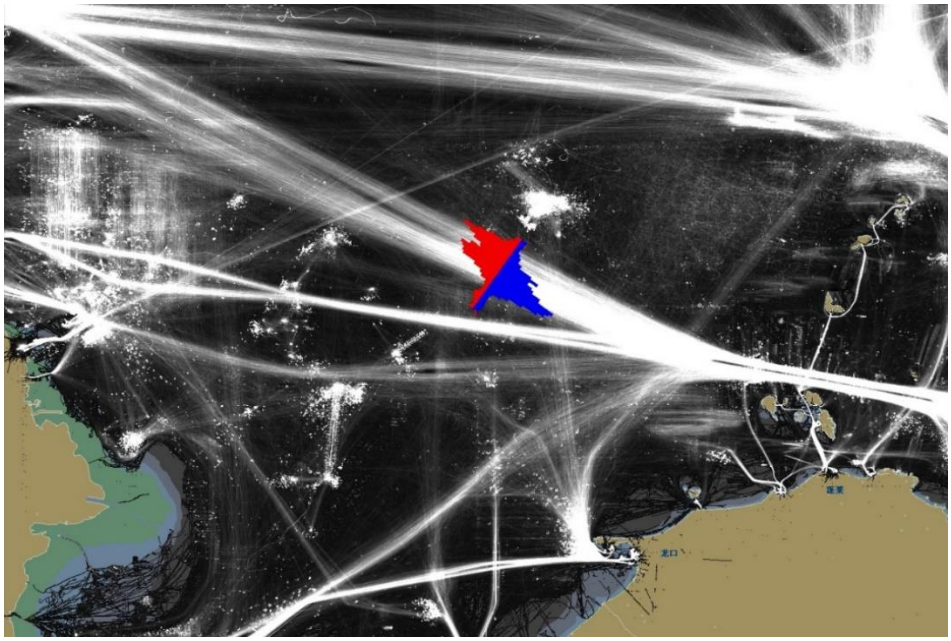

Figure 2-3-6 Distribution of route from Changshan Waterway to Tianjin Port (First quarter of 2019)

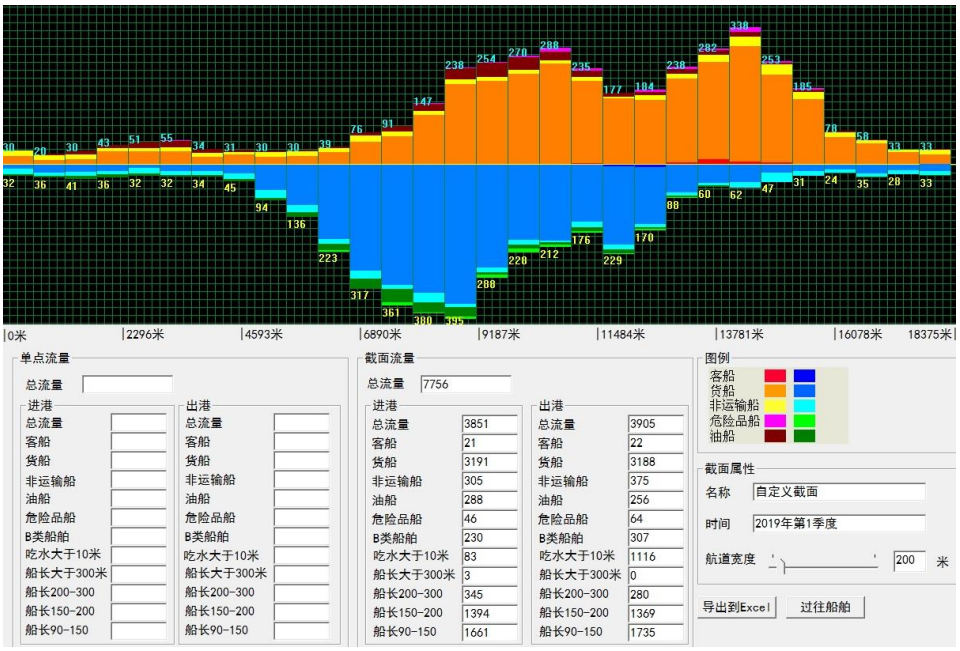

Figure 2-3-7 Statistics of traffic flow door lines from Changshan Waterway to Tianjin Port direction (First quarter of 2019)

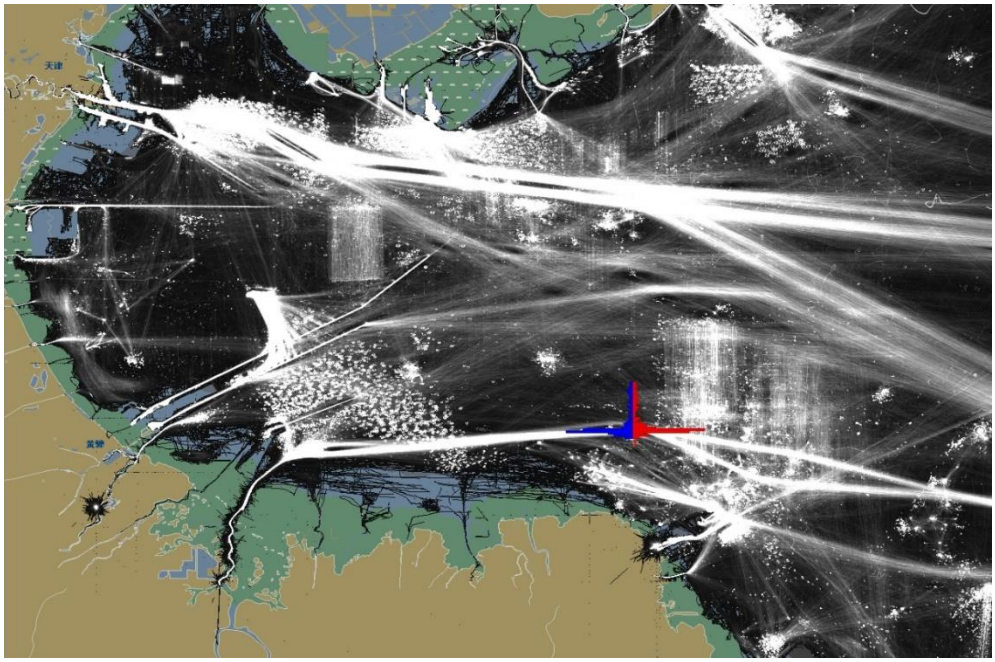

Figure 2-3-8 Distribution of the customary route track from Changshan Waterway to Binzhou Port (First Quarter of 2019)

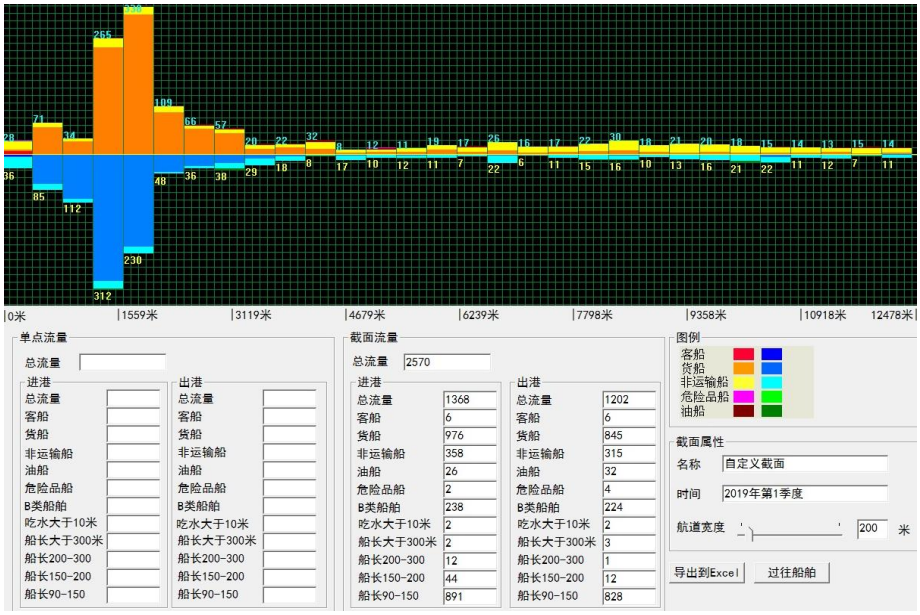

Figure 2-3-9 Statistics of traffic flow door lines of the customary route from Changshan Waterway to Binzhou Port (First quarter of 2019)

2.3.2 The Customary Route from Qinhuangdao to Tianjin Port

(1) Traffic volume

The customary route from Qinhuangdao to Tianjin Port in the first quarter of 2019, the total number of ships entering and leaving the port was 2025, with an average of 22.5 daily. Among them, the number of ships entering and leaving the port were 1,040 and 985, respectively, with an average daily rate of 11.6 and 10.9, respectively.

(2) Distribution of ship types

In the first quarter of 2019, the passenger ships, cargo ships, non-transport ships, oil tankers and dangerous goods ships in and out of the port of the customary route from Qinhuangdao to Tianjin Port were 5 times, 1229 times, 443 times, 307 times and 41 times, respectively, accounting for 0.2%, 60.7%, 21.9%, 15.2% and 2.04% of the total number of ships (Figure 2-3-10).

The traffic flow of the customary route from Qinhuangdao to Tianjin Port is dominated

by cargo ships, accounting for about 60.7% of the total number of ships entering and leaving the port; followed by non-transport ships, accounting for about 22%. Oil tankers and dangerous goods ships together account for the total number of ships entering and leaving the port 17.2%.

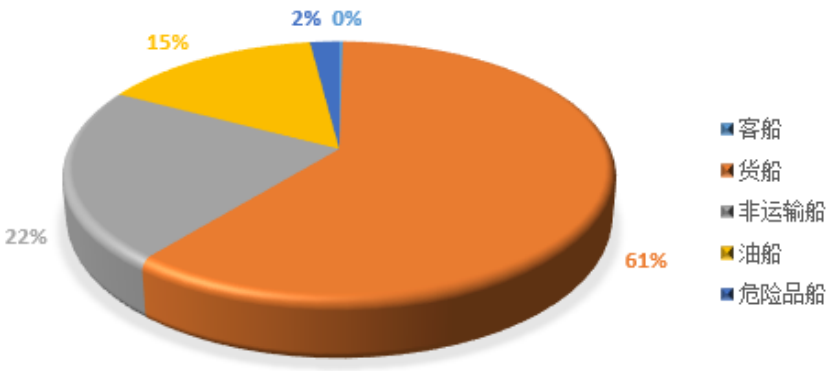

Figure 2-3-10 Distribution of types of ships entering and leaving the port on the route from Qinhuangdao to Tianjin Port

(3) Distribution of length

As shown in Table 2-3-1, in the first quarter of 2019, the total number of ships entering and leaving the port on the route from Qinhuangdao to Tianjin Port was 2025, with an average of 22.5 per day. Among them, the total number of ships entering and leaving the port with a length of less than 90m, 90-150m, 150-200m, 200-300m and more than 300m are 885, 789, 242, 103, and 6 ships, respectively, with an average daily number was 9.8, 8.8, 2.7, 1.1 and 0.1 respectively, accounting for 43.7%, 39.0%, 11.9%, 5.1% and 0.3% of the total number of ships entering and leaving the port (Figure 2-3-11) .

Table 2-3-1 The distribution of length of ships entering and leaving the port of the route from Qinhuangdao to Tianjin Port

length (m)	Inbound (Ship	Outbound (Ship number)	In and out of port	Daily average	Remarks

	number)		(Ship number)	(Ship number)	
≥300	2	4	6	0.07	
200~300	57	46	103	1.14	
150~200	136	106	242	2.69	
90~150	415	374	789	8.77	
<90	430	455	885	9.83	
Total	1040	985	2025	22.50	

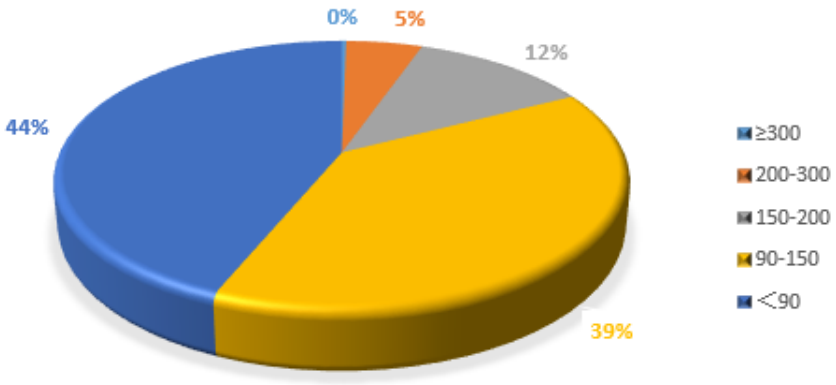

Figure 2-3-11 Distribution of length of ships entering and leaving the port on the route from Qinhuangdao to Tianjin Port

2.3.3 The Customary Route from Laotieshan to Tianjin Port

(1) Traffic volume

The total number of ships entering and leaving the port of the customary route from Laotieshan Waterway to Tianjin Port in the first quarter of 2019 was 10,377, with an average of 115.3 per day. Among them, the number of ships entering and leaving the port were 5,030 and 5,347 respectively, with an average of 55.9 and 59.4 per day.

(2) Distribution of ship types

In the first quarter of 2019, the number of passenger ships, cargo ships, non-transport ships, oil tankers, and dangerous goods ships on the customary route from Laotieshan Waterway to Tianjin Port was 95, 7402, 1203, 932 and 745, respectively. They accounted for 0.9%, 71.3%, 11.6%, 9.0% and 7.2% of the total number of ships entering and leaving the channel (Figure 2-3-12).

The traffic flow on the customary route from Laotieshan Waterway to Tianjin Port is dominated by cargo ships, accounting for 71.3% of the total number of ships entering and leaving the port on the customary route; oil tankers and dangerous goods ships together accounted for 16.2% of the total number of ships entering and leaving the port.

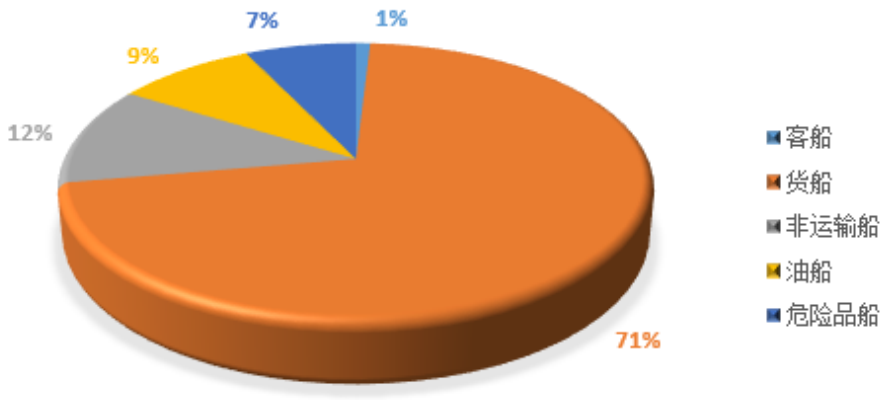

Figure 2-3-12 Distribution of types of ships entering and leaving the port on the route from Laotieshan Waterway to Tianjin Port

（3）Distribution of length

As shown in Table 2-3-2, in the first quarter of 2019, the total number of ships entering and leaving the port on the route from Laotieshan Waterway to Tianjin Port was 10,377, with an average of 115.3 per day. Among them, the total number of ships entering and

leaving the port with a length of less than 90m, 90-150m, 150-200m, 200-300m and over 300m is 1586, 3118, 3156, 1801, and 716, respectively, with an average daily number was 17.6, 34.6, 35.1, 20.0 and 8.0, respectively, accounting for 15.3%, 30.0%, 30.4%, 17.4% and 6.9% of the total (Figure 2-3-13).

Table 2-3-2 Distribution list of length of ships entering and leaving the port on the route from Laotieshan Waterway to Tianjin Port

length (m)	Inbound (Ship number)	Outbound (Ship number)	In and out of port (Ship number)	Daily average (Ship number)	Remarks
≥300	346	370	716	7.96	
200~300	841	960	1801	20.01	
150~200	1534	1622	3156	35.07	
90~150	1547	1571	3118	34.64	
<90	762	824	1586	17.62	
Total	5030	5347	10377	115.30	

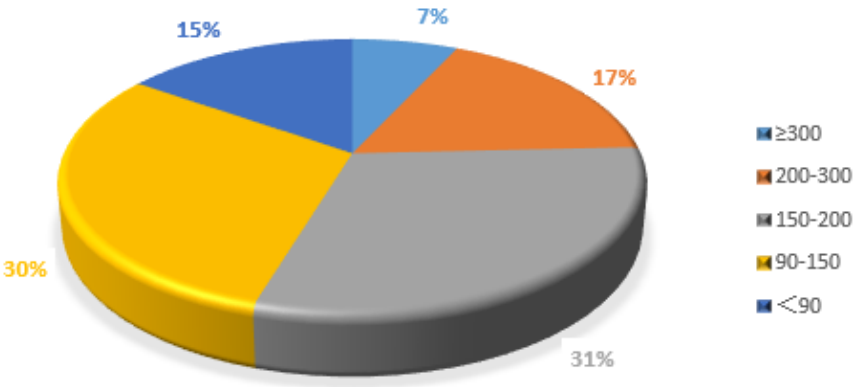

Figure 2-3-13 Distribution of length of ships entering and leaving the port on the route from Laotieshan Waterway to Tianjin Port

2.3.4 The customary route from Changshan Waterway to Tianjin Port/Caofeidian/Huanghua direction.

(1) Traffic volume

In the first quarter of 2019, the number of ships entering and leaving the port on the customary route from Changshan Waterway to Tianjin Port was 7756, with an average of 86.2 per day. Among them, the number of ships entering and leaving the port were 3851 and 3905 respectively, with an average of 42.8 and 43.4 per day.

(2) Distribution of ship types

In the first quarter of 2019, the number of passenger ships, cargo ships, non-transport ships, oil tankers, and dangerous goods ships on the customary route from Changshan Waterway to Tianjin Port were 43, 6,379, 680, 544, and 110, respectively. They accounted for 0.6%, 82.2%, 8.8%, 7.0% and 1.4% of the total number of ships entering and leaving the port (Figure 2-3-14).

The traffic flow of on the customary route from Changshan Waterway to Tianjin Port is dominated by cargo ships, accounting for about 82.2% of the total number of ships entering and leaving the port; followed by non-transport ships, accounting for about 8.8% of the total number of ships entering and leaving the port; oil tankers and dangerous goods ships accounting for both in and out 8.4% of the total number of ships.

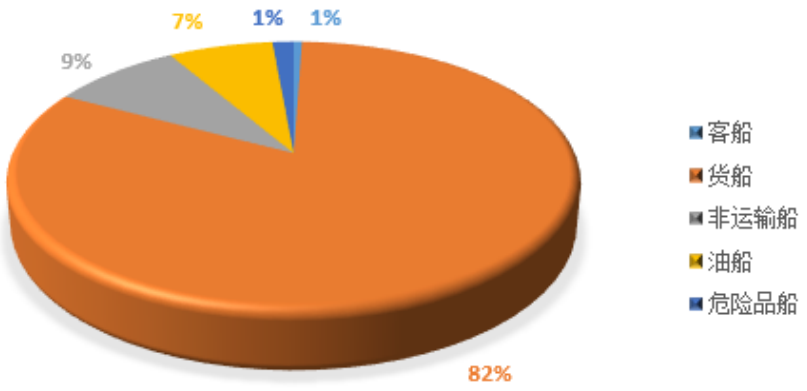

Figure 2-3-14 Distribution of types of ships entering and leaving the port on the customary route from Changshan Waterway to Tianjin Port

(3) Distribution of length

As shown in Table 2-3-3, in the first quarter of 2019, the total number of ships entering and leaving the port on the route from Changshan Waterway to Tianjin Port was 7756, with an average of 86.2 per day. Among them, the total number of ships entering and leaving the port with lengths of less than 90m, 90-150m, 150-200m, 200-300m and over 300m are 969, 3396, 2763, 625, and 3 ships, respectively, with an average daily number was 10.8, 37.7, 30.7, 7.0 and 0.0 respectively, accounting for 20.7%, 46.2%, 22.7%, 9.4% and 1.2% of the total number of ships entering and leaving the port (Figure 2-3-15).

Table 2-3-3 Distribution list of length of ships entering and leaving the port on the route from Changshan Waterway to Tianjin Port

length (m)	Inbound (Ship number)	Outbound (Ship number)	In and out of port (Ship number)	Daily average (Ship number)	Remarks
≥300	3	0	3	0.03	
200~300	345	280	625	6.94	

150~200	1394	1369	2763	30.70	
90~150	1661	1735	3396	37.73	
<90	448	521	969	10.77	
Total	3851	3905	7756	86.18	

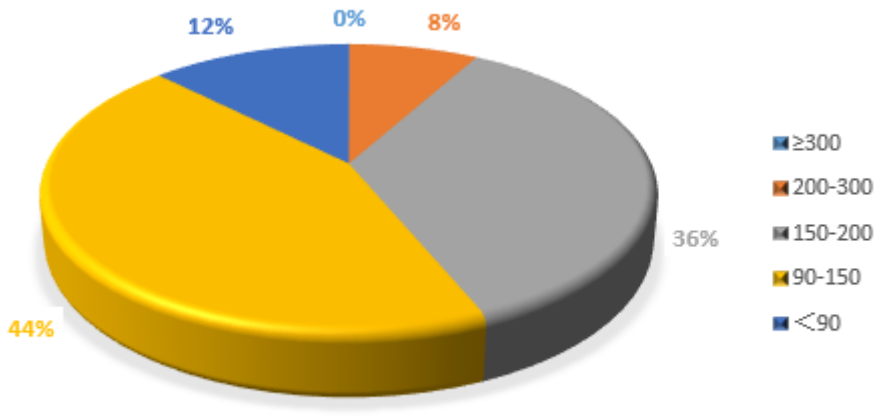

Figure 2-3-15 Distribution of length of ships entering and leaving the port on the route from Changshan Waterway to Tianjin Port

2.3.5 The Customary Route from Changshan Waterway to Binzhou Port

(1) Traffic volume

In the first quarter of 2019, the route from Changshan Waterway to Binzhou Port had a total of 2570 vessels entering and leaving the port, with an average of 28.6 vessels per day. Among them, the number of ships entering and leaving the port were 1,368 and 1,202, respectively, with an average daily rate of 15.2 and 13.4.

(2) Distribution of ship types

In the first quarter of 2019, the number of passenger ships, cargo ships, non-transport ships, oil tankers and dangerous goods ships on the route from Changshan Waterway to

Binzhou Port in and out of the port traffic was 12 times, 1821 times, 673 times, 58 times and 6 times. The number of vessels, respectively, accounted for 0.5%, 70.9%, 26.2%, 2.3% and 0.2% of the total number of ships entering and leaving the port (Figure 2-3-16).

The traffic flow of the route from Changshan Waterway to Binzhou Port is dominated by cargo ships and non-transport ships, accounting for 70.9% and 26.2% of the total number of ships entering and leaving the port respectively; oil tankers and dangerous goods ships together accounted for 2.5% of the total number of ships entering and leaving the port.

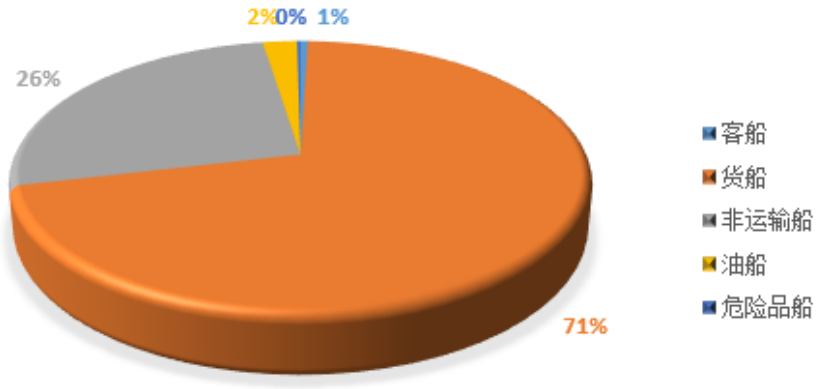

Figure 2-3-16 Distribution of types of ships entering and leaving the port on the route from Changshan Waterway to Binzhou Port

(3) Distribution of length

As shown in Table 2-3-4, in the first quarter of 2019, the route from Changshan Waterway to Binzhou Port had a total of 2570 vessels entering and leaving the port, with an average of 28.6 vessels per day. Among them, the total number of ships entering and leaving the port with lengths of less than 90m, 90-150m, 150-200m, 200-300m and over 300m are 777, 1719, 56, 13 and 5 vessels, respectively, with an average daily

number was 8.6, 19.1, 0.6, 0.2 and 0.1 respectively, accounting for 30.29%, 66.7%, 27.2%, 0.5% and 0.2% of the total number of ships entering and leaving the port (Figure 2-3-17).

Table 2-3-4 Distribution of length of ships entering and leaving the port on the route from Changshan Waterway to Binzhou Port

length (m)	Inbound (Ship number)	Outbound (Ship number)	In and out of port (Ship number)	Daily average (Ship number)	Remarks
≥300	2	3	5	0.06	
200~300	12	1	13	0.14	
150~200	44	12	56	0.62	
90~150	891	828	1719	19.10	
<90	419	358	777	8.63	
Total	1368	1202	2570	28.56	

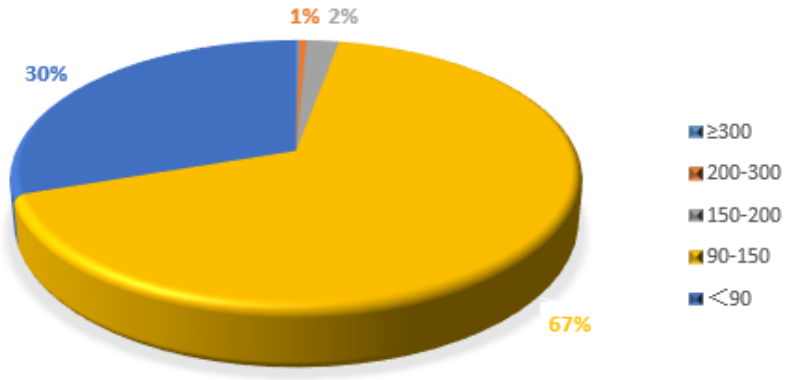

Figure 2-3-17 Distribution of length of ships entering and leaving the port on the route from Changshan Waterway to Binzhou Port

2.4 Statistics of traffic accidents

(1) Overview of the accident

According to the survey, the number of traffic accidents in the Caofeidian Maritime Safety Administration's jurisdiction in 2016, 2017 and 2018 were 8, 11 and 8, respectively. In the past 3 years, there were 27 water traffic accidents of various levels and types (Table 2-4- 1).

Table 2-4-1 List of traffic accidents in the jurisdiction of Caofeidian Maritime Safety Administration from 2016 to 2018

SERIAL NUMBER	TYPE OF ACCIDENT	NUMBER OF ACCIDENTS	ACCIDENT LEVEL			
			MINOR ACCIDENT	GENERAL ACCIDENT	MAJOR ACCIDENT	SEVERE ACCIDENT
1	Collisions	10	10			
2	Groundings	5	5			
3	Hit the rocks	0	0			
4	Touch accidents	3	3			
5	Wave damage	0	0			
6	Fire/explosion	1	1			
7	Wind disaster	0	0			
8	Self-sink	2	2			
9	Other	6	6			
Total		27	27			

(2) Accident level distribution

According to the "Measures for Statistics of Water Traffic Accidents" by the Ministry of Transport (Order No. 15, 2014 of the Ministry of Transport), marine accidents are counted as "extraordinary accidents, severe accidents, major accidents, general accidents, and minor accidents".

A total of 27 accidents occurred in the Caofeidian waters in the past three years, of which, minor accidents, general accidents, major accidents, severe accidents, and extraordinary accidents were 27, 0, 0, 0, and 0 respectively, each accounting for the total number of accidents. 100%, 6%, 0%, 0% and 0% (Figure 2-4-1).

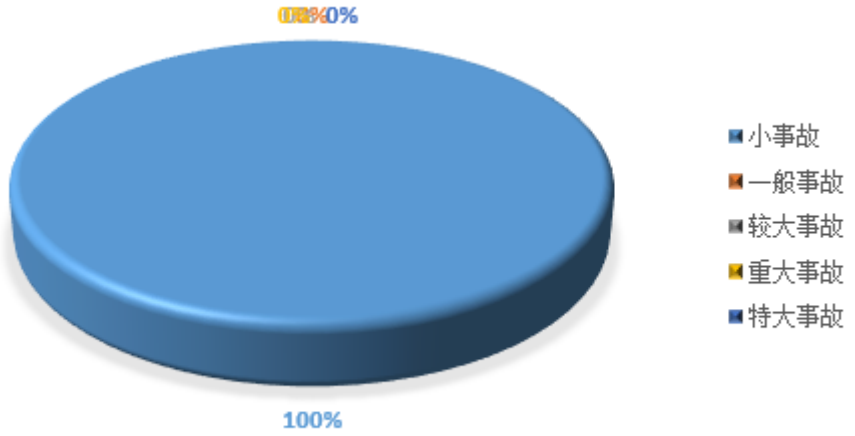

Figure 2-4-1 Caofeidian Water Area 2016~2018 Water Traffic Accident Level Statistics

It can be seen that all water traffic accidents in Caofeidian waters are minor accidents, accounting for 100% of the total number of accidents in these waters, and there have been no accidents of general or higher level in the past three years. The navigation safety of Caofeidian waters from 2016 to 2018 was good.

(3) Distribution of accident types

According to the "Measures for Statistics of Water Traffic Accidents" by the Ministry of Transport (Order No. 15 of 2014) and the actual traffic accidents in the Caofeidian port area, the marine accidents are based on "collisions, groundings, rocks, touch accident, wave damage, fire/explosion, wind disaster, self-sink and others" for statistics.

From 2016 to 2018, there were 10, 5, 0, 3, 0, 1, and 0 collisions, groundings, rocks, touches, wave damage, fire/explosion, wind damage, self-sinking and other accidents in Caofeidian waters from 2016 to 2018. There were 37.0%, 18.5%, 0.0%, 11.1%, 0.0%, 3.7%, 0.0%, 7.4% and 22.2% of the total number of accidents, respectively (Figure 2-3-19).

A total of 27 water traffic accidents occurred in Caofeidian waters from 2015 to 2017, of which 10 were collision accidents, accounting for about 37.0% of the total number of accidents; the 27 water traffic accidents in the past three years were all minor accidents, and no accidents of general or above level occurred. It can be seen that the collision accident is the main factor affecting the navigation safety of this water area.

2.5 Special area

2.5.1 Anchorage

According to the "Approval for the Establishment of Outer Anchorages in the Caofeidian Port Area of Tangshan Port" by the Maritime Safety Administration of the People's Republic of China (Haitonghang [2011] No. 56), two anchorages are set up in the Caofeidian waters on the west side and the east side outer anchorage (Figure 2-5-1 and Table 2-5-1).

Table 2-5-1 Location of existing anchorages in Caofeidian Port Area

Name	Control	North latitude	East longitude	Depth (m)	The main purpos

	oint				
Anchorage outside th vest port		38°55′37.02"	18°18′08.77"	3～28	Anchorage fo coal, containe nd general carg hips
	2	38°54′47.79"	18°25′43.61"		
	3	38°53′25.80"	18°24′39.60"		
	4	38°53′37.20"	18°24′39.60"		
	5	38°52′21.60"	18°23′51.00"		
	6	38°52′53.69"	18°17′39.80"		
Anchorage outside th ast port		38°54′12.00"	18°33′24.00"	23～31	Oil tanker, larg bulk carrie nchorage
	2	38°57′00.00"	18°42′48.00"		
	3	38°50′10.89"	18°42′47.98"		
	4	38°51′17.08"	18°32′53.83"		

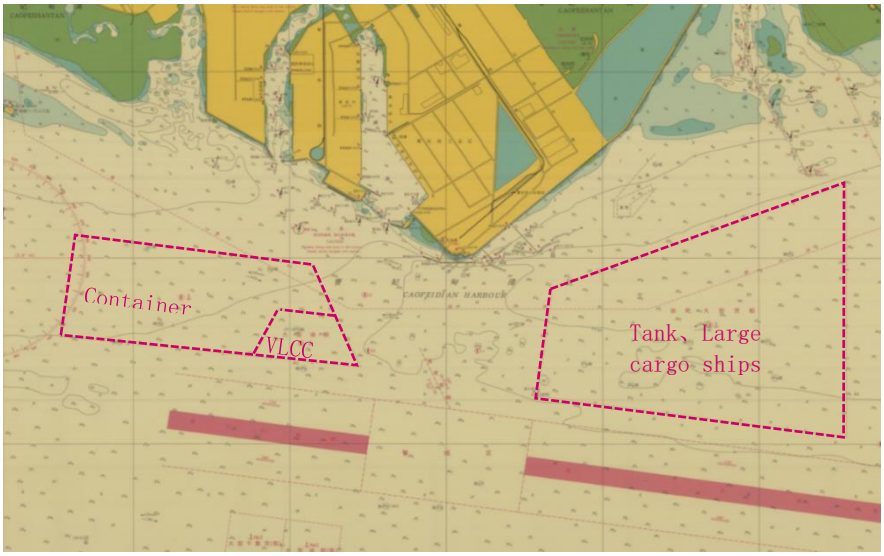

Figure 2-5-1 Anchorage layout outside Caofeidian Port Area of Tangshan Port

2.5.2 Fishing Port

From the north to the northeast coast of the east area of Caofeidian Port Area, there are 3 fishing ports, namely Gaoshangbao, Liuzan Town and Laoyujian Village from west to east (Figure 2-5-2).

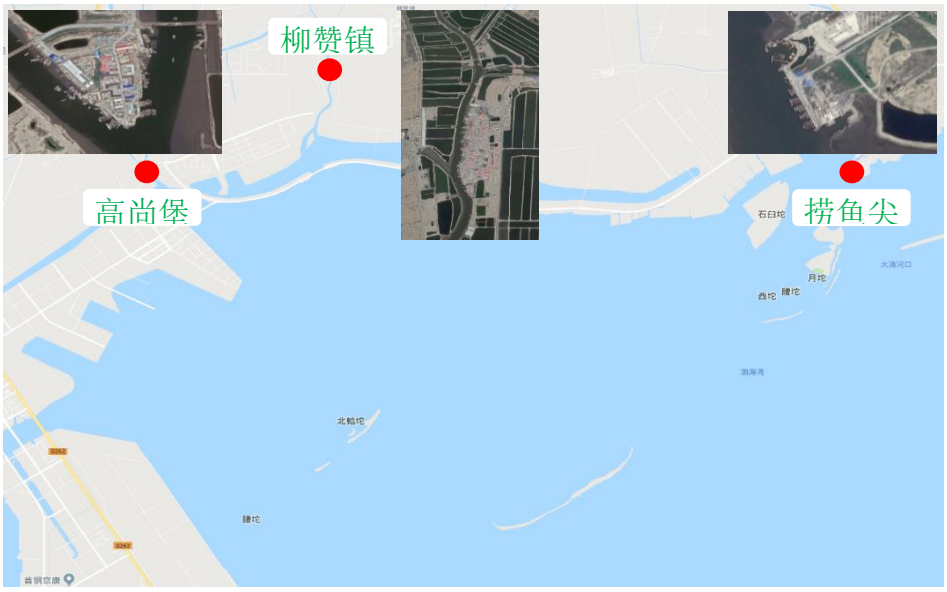

Figure 2-5-2 Distribution of fishing ports on the north side of the east area of Caofeidian Port Area

2.5.3 Offshore wind farm

As shown in Figure 2-5-3, the planned route of the towing group is about 1.5n mile away from the built Puti Island offshore wind farm.

Figure 2-5-3 Schematic figure of wind farms near the starting and towing section route

2.5.4 Oilfield operation area

As shown in Figure 2-5-4, the towing point of the planned route of the towing group is about 2.1n mile and 3.3n mile from the BZ35-2CEPA and BZ35-2WHPA platforms, respectively, and the nearest submarine pipeline to the west is about 0.75n mile. The planned route of the segment is about 1.5n mile and 2.5n mile from the BZ35-2CEPA platform and the BZ29-4 South WHPC platform, respectively.

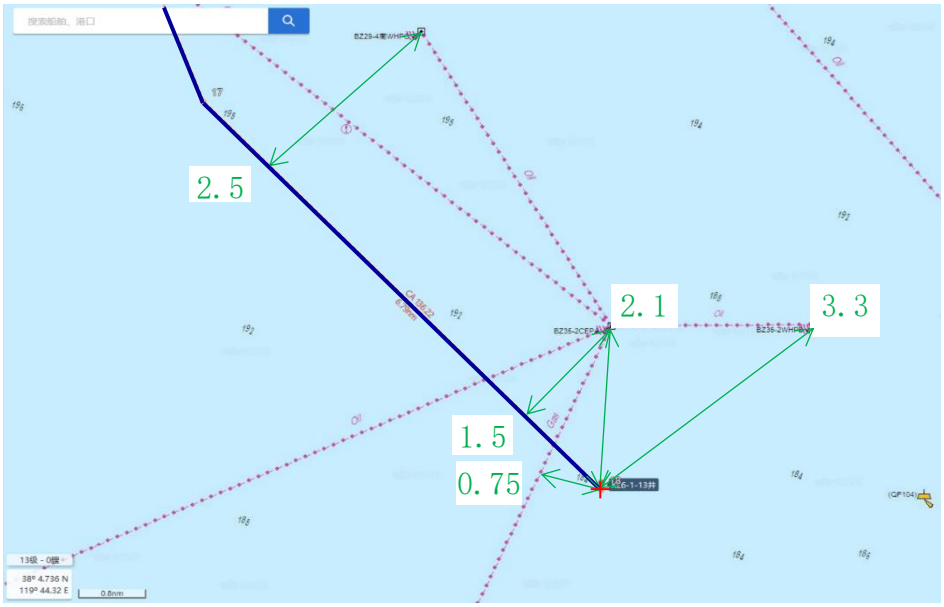

Figure 2-5-4 Schematic figure of the distribution of platforms and pipelines near the towing point

2.6 Safety guarantee conditions

2.6.1 Maritime Safety Management Agency

The sailing area of the towing group is located in the area under the jurisdiction of the Caofeidian Bureau, the tow-stop route is located in the jurisdiction of the Shandong Maritime Safety Administration, the middle course is mainly located in the jurisdiction of the Tianjin Maritime Safety Administration, and the middle voyage is about 4.5n

mile in the Tangshan Maritime Safety Administration (Figure 2-5-1) , Caofeidian Maritime Safety Administration and other relevant competent authorities are mainly responsible for the jurisdiction of the waters through which the towing operation of the starting and towing section passes.

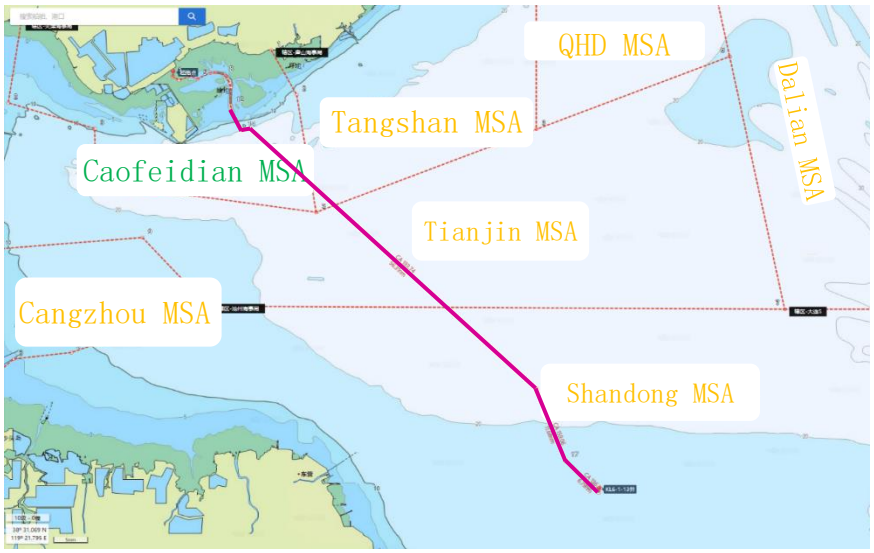

Figure 2-6-1 The distribution of the water area of the planned route

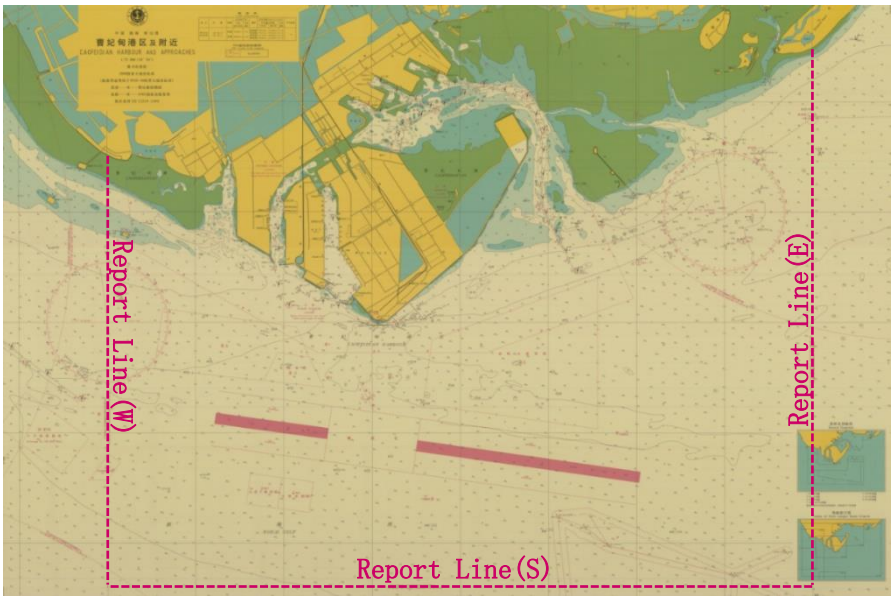

Figure 2-6-2 Schematic figure of VTS coverage in Caofeidian Port Area

2.6.2 Vessel Traffic Management System (VTS)

The Caofeidian VTS system consists of Caofeidian radar station (38°55′46″N, 118°31′11″E) and Caofeidian VTS center (38°55′23″N, 118°29′55″E). The traffic control center of the bureau is responsible for the management, and the duty room listens to the VHF 08 channel.

The Caofeidian VTS system can monitor the waters within 24n mile from the radar station and has the function of tracking and replaying. The VHF communication system has a range of 25n mile and has the multi-channel recording function. The ship data processing system has the function of processing more than 500 ships. The system displays weather data and historical query in real time around the clock. The coverage of VTS is shown in Figure 2-4-2.

2.6.3 Maritime search and rescue agencies

The Hebei Province Maritime Search and Rescue Center, the Tianjin Maritime Search and Rescue Center, the Shandong Province Maritime Search and Rescue Center and the Caofeidian Maritime Search and Rescue Center are responsible for the search and rescue of maritime hazards in the waters of their respective jurisdictions in the navigation waters of the towing group.

There are two offices under the Tangshan Maritime Search and Rescue Center. Among them, the Caofeidian Sea Area Search and Rescue Office is located in the Caofeidian Maritime Safety Administration. The search and rescue center daily VHF 08 channel distress monitoring, 24 hours to receive distress information through 0315-5076100.

The Caofeidian maritime search and rescue force includes the professional rescue assistance invested and constructed by government departments, the rescue assistance capacity of the army and the armed police, the official rescue assistance capacity of

government departments, other civil ships and aircrafts that can be used for rescue operations, enterprises, institutions, social organizations, individuals, and other social manpower. Material resources.

Chapter 3: Risk analysis of towing group

3.1 Risk Analysis of Fishing Boat Collision

The Bohai Sea fishing ground that the tow group sailed through is one of the four major fishing grounds in China. It is divided into four fishing grounds: Dongwan Fishing Ground, Luanhekou Fishing Ground, Bohai Bay Fishing Ground and Laizhou Bay Fishing Ground. There are more fishing boats engaged in fishing operations during the fishing season. There are many types of fishing boats and fishing tools along the coast of China. Since Chinese fishing boats do not specify a universal VHF channel, it is impossible to contact fishing boats on VHF16 channel; some individual fishing boat drivers do not master the international collision avoidance rules, or do not comply with them, turning a blind eye to the signals suspended by the towing group. In order to protect fishing gear, fishing boats will even approach the towing group to drive away. These situations all bring greater risks to the navigation safety of the towing group.

3.2 Risk analysis of anchored ship collision

The planned route of the mopping group is about 0.1n mile away from the northeast area of the outer anchorage on the west side of Caofeidian Port Area (Figure 3-2-1).

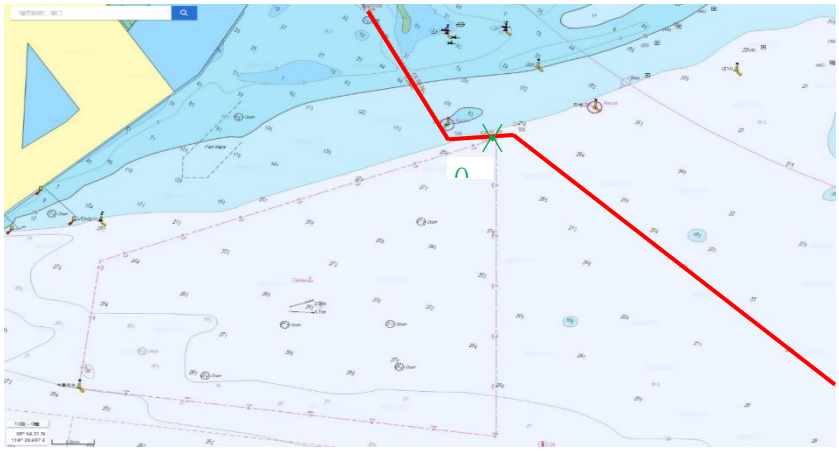

Figure 3-2-1 Distribution of anchorages in waters near the starting and towing

section of the route

According to the "General Design Specification for Seaports", the distance from the anchorage outside the port to the edge of the channel should not be less than 2 to 3 times the length of the ship, and the length of a 100,000-ton bulk carrier is about 250m, and the corresponding distance standard is 500-750m.

The planned route of the towing group is about 185m (0.1n mile) from the northwest end of the outer anchorage on the east side of the Caofeidian port area. Since this part of the anchorage is located near the entrance of the main channel in the east area of the Caofeidian port area, there are fewer anchored ships, and the west side of the route is navigable. The waters are wide, and during the towing operation, there is a lot of room for temporary adjustment of the route, and there is little mutual influence.

3.3 Collision risk analysis between ships entering and leaving the port.

The navigable width of the main channel, the branch B channel and the branch C channel in the east area of Tangshan Port Caofeidian Port Area is 150m. It is a one-way navigation channel. The towing group has slow towing speed, poor operation performance, and occupies a wide range of waters. During the towing group's departure, it will be with Caofeidian Port. The main channel, B branch channel and C branch channel of the eastern zone have a great influence on each other, and other ships need to be temporarily restricted from entering and leaving the eastern zone.

3.4 Collision risk analysis of navigable ships on the customary routes

The towing group has successively crossed the customary routes from Qinhuangdao to Tianjin Port, from Laotieshan Waterway to Tianjin Port, etc. The planned route also

crossed the customary routes from Huanghua Port to Laotieshan Waterway, from Jingtang Port to Weifang Port and other directions (Figure 3-4-1).

The towing group has slow towing speed, poor operation performance, and occupies a wide range of waters. The navigable ships in the navigable waters are denser and the traffic flow is more complicated. During the towing operation, the towing group and the navigable ships of the customary routes have a certain mutual relationship influence.

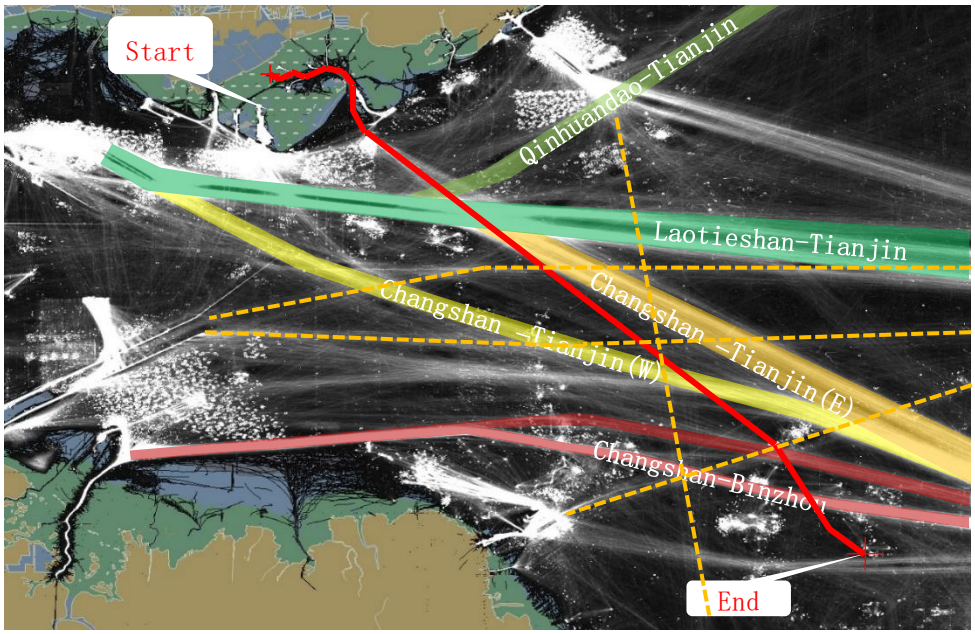

Figure 3-4-1 Schematic figure of the relationship between planned routes and the customary routes

3.5 Drilling platform pipeline collision risk analysis

As shown in Figure 3-5-1, the towing point of the towing group is about 2.1n mile and 3.3n mile from the BZ35-2CEPA and BZ35-2WHPA platforms, respectively, and the nearest submarine pipeline to the west is about 0.75n mile. The route distance is about 1.5n mile and 2.5n mile from BZ35-2CEPA platform and BZ29-4 South WHPC

platform, respectively. The towing speed of the towing group is slow before it approaches the towing stop. Due to the influence of uncertain factors such as short-term strong winds and the interference of passing ships around, the towing group is at risk of contact with the surrounding platforms.

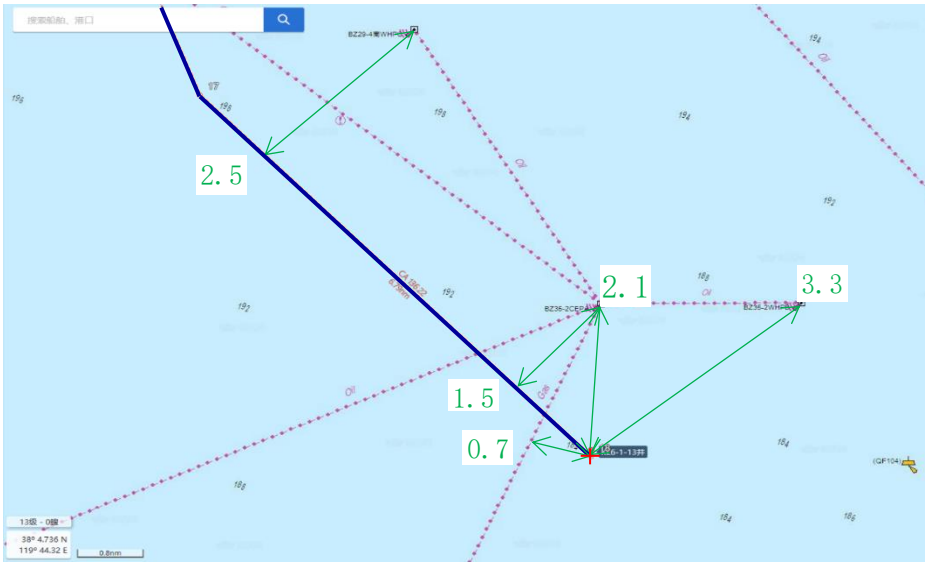

Figure 3-5-1 Schematic figure of the distribution of platforms and pipelines near the towing point

3.6 Impact of the natural environment on the navigation safety of the towing group

3.6.1 Analysis of the impact of wind

The Bohai Sea area has obvious monsoon characteristics. The winter monsoon prevails from October to March of the following year. The prevailing period is about 6 months. The wind direction is stable and strong. The summer monsoon prevails from May to August, and summer is from July to August. During the peak wind period, the wind direction is southerly, mainly southeast wind, the wind direction is not very stable, and the wind is weak. There is a transition period between the winter and summer monsoon periods. The transition period from winter to summer is slightly longer, and the change from summer to winter is faster.

Wind acts on the ship to deflect the bow while also causing the ship to drift downwind. Ship drift caused by wind power is mainly related to wind speed, wind side angle, ship speed, wind area of the ship and ship type.

If the towing group navigates during the prevailing winter monsoon in the Bohai Sea, there will be mainly northerly winds during this period, and the northwest wind is the dominant wind. The wind direction is stable, and the wind is strong. The wind will have a greater impact on the navigation safety of the towing group.

3.6.2 Analysis of the fog

The waters through which the towing group sails are foggy areas along the coast of China. Fog days occur throughout the year. The fog season is from March to July, with the most in June and July. The average annual fog days are 20-24 days.

The Bohai Sea is greatly affected by radiation fog in winter, early spring, and late autumn, and it mainly occurs at night or morning when it is sunny, breezy, near the ground, and with plenty of water vapor. It is mostly in autumn and winter, mostly from the second half of the night to the early morning, when the concentration is strongest around sunrise, and the radiation temperature rises gradually during the day.

Fog is the main factor leading to poor visibility at sea. The direct impact on the towing operation is to increase the difficulty of the operation, that is, increase the difficulty of navigation of the towing group itself and the difficulty of avoiding each other between the towing group and the surrounding ships.

3.6.3 Analysis of the flow

Due to the shallow water and weak currents in the Bohai Sea, the role of tidal currents is very important. Generally, near shores and narrow places such as straits, waterways, and harbors are mostly reciprocating currents due to topographical restrictions. It is 1-2kn.

The effect of water current causes the ship's speed to change, and at the same time causes the ship to deviate from the planned route or cause yaw, drift, etc. The effect of the wind and current in the same direction makes it easier for the sailing ship to deflect, drift and deviate from the course.

The towing speed of the platform is slow, the operation performance of the towing group is poor, and the current has a certain influence on the navigation of the towing group. During the towing operation, the platform should be properly controlled when the platform is lifted and in place, and the lifting and in-position operations should be avoided during the 2-3 hours before and after the high tide when the tide speed is the highest; during the towing process, attention should be paid to setting up reasonable air flow. The pressure difference, the tugboat controls the towing angle, and keeps the towed platform towed on the planned route.

Chapter 4: Safety measures for towing group to avoid collision at sea

4.1 Safety measures for collision avoidance of fishing boats

Towing group is a restricted ship, and the corresponding signal type shall be displayed according to regulations when sailing. When there is a collision danger between towing group and fishing boat, if fishing boat is not engaged in fishing operation, fishing boat should avoid towing group as a motor boat according to International Regulations for Preventing Collision at Sea 1972; if fishing boats are engaged in fishing operations, according to Article 18 of the International Rules for Preventing Collisions at Sea 1972, fishing boats should also give way to restricted boats, single trawlers should be responsible for avoiding them. This is a division from the avoidance responsibility. It should be noted that the towing group should display the signal type of the restricted ship in strict accordance with the regulations.

However, in view of the fact that many fishing boats in the waters where the towing group navigates do not comply with the rules, the towing group should take the following safety measures when navigating in the waters where the fishing boats are dense.

(1) Collect information through VTS and other channels in advance, intensify visual observation and radar observation to know and understand the dynamics of fishing boats in the navigating waters ahead as early as possible.

(2) Pay attention to observation, not only to observe the fishing boats, but also the distribution of fishing gear such as fishing nets near the fishing boats, so as to set aside a redundant distance in advance and pass safely.

(3) The towing group shall be equipped with escort boats in areas where fishing boats

are dense, and the escort boats shall keep uninterrupted cruising at an appropriate distance in front of the towing group.

(4) If there is any doubt about the incoming ship's dynamics, which may affect the towing operation safety, immediately contact the ship by all effective means such as VHF, lights and sound signals, and send warning information in time to remind the incoming ship to take necessary avoidance actions as soon as possible, so as to keep clear of the towing group.

(5) If you cannot get in touch with the incoming ship in time, the escort ship shall sail to the incoming ship in time, and attract the attention of the ship through lights and sound signals at close distance, and try to get in touch with the ship as soon as possible.

(6) Remind the passing fishing boats in time to avoid crossing the towing group between the main tugboat and the towed platform.

(7) When necessary, the escort ship will go to the incoming ship to intercept or drive away.

If the towing group is an overtaking ship, at this time it should be a giving way ship, and take obvious avoidance as soon as possible to ensure that the two ships pass at a safe distance until they pass by and keep clear.

4.2 Safety Measures for Collision Avoidance of Ships at Customary Route/Lane

Because the towing group is longer in length and the speed is slower, it will be more difficult to perform coordinate avoidance than ordinary ships. In order to ensure navigation safety, the towing group should take the following safety measures when passing through the crowded area of ship traffic flow:

(1) Know and master the distribution of ships in navigable areas in advance, reasonably select the towing time, and try to control crossing the customary routes and navigable areas during the day.

(2) Before passing through the customary route, inform the tug captain to board the bridge in advance.

(3) Before passing through the customary route, shorten the length of the main streamer properly to facilitate the operation.

(4) The main tugboat, the auxiliary tugboat and the platform side should intensify their duty, keep visual observation, radar observation and AIS observation, and know the status and dynamics of navigable ships in the customary route and crowded navigable area in advance.

(5) According to the actual situation of navigable ships in the customary route, adjust the course appropriately, crossing at right angles to the general direction of actual traffic flow in the customary route as much as possible, shorten the time of crossing the customary route, and reduce the mutual influence with navigable ships in the customary route.

(6) continuously inform the surrounding ships about the towing group dynamics through VHF16 channel, etc.

(7) Escort ships should be on guard at an appropriate distance in front of the towing group, know and master the dynamic of navigation ships ahead of the route in advance, intensify communication and coordination among them, and promptly remind passing ships to stay away from the towing group.

(8) Strengthen the monitoring of small ships such as fishing boats between the main tugboat and the towed platform, promptly remind small ships such as passing fishing boats, and avoid crossing the towing group between the main tugboat and the towed platform.

(9) If there is any doubt about the incoming ship's dynamics, which may affect the towing operation safety, the main and auxiliary tugboats shall make full use of all available means such as VHF, lights and audio signals to communicate and contact the incoming ship in time, and send warning information to remind the incoming ship to take necessary avoidance actions as soon as possible, so as to clear the towing group.

(10) If you cannot get in touch with the incoming ship in time, the escort ship shall sail to the ship in time, attract the attention of the incoming ship through lights and sound signals at close distance, and try to get in touch as soon as possible; intercept the ship or drive away it if necessary.

(11) During the towing operation, the towing group shall hang the signal lights and shapes according to the Regulations, and if the visibility is poor, the sounding signal shall be sounded according to the regulations.

(12) Turn on the signal lights at night according to regulations, and make full use of the platform and main tug lighting equipment to indicate the towing cable position, so as to remind passing ships to avoid crossing the towing group between the main tug and the towed platform.

(13) If crossing the customary route at night, the main tugboat shall take measures such as shortening the towing cable, getting on the bridge by the captain himself, increasing the broadcasting frequency of towing navigation police, and strengthening the

observation of the main and auxiliary tugboats and the platform to ensure navigation safety.

4.3 Safety measures for poor visibility

(1) conventional measures

① strengthen the lookout, let sailors to lookout at bow;

② the captain shall commands on the bridge;

③ turn on the navigation lights during the day and change the autopilot to manual steering;

④ turn on radar, make full use of radar to assist navigation, and take effective avoidance measures in time;

⑤ use VHF to issue navigation warnings, listen carefully to VHF information, and carefully check AIS arrival information, etc;

⑥ Sound the fog release signal according to regulations (the tugboat sounds one long and two short sound signals, and the platform sounds one long and three short sound signals immediately after the tugboat sounds the signal);

⑦ The bridge informs the engine room of the fog situation, keeps close contact, prepares vehicles and drives at a safe speed;

⑧ VHF shall keep normally open, and contact with nearby ships or VTS center at any time to coordinate avoidance actions.

(2) Strengthen vigilance and monitoring

① The main tugboat and the auxiliary tugboat strengthen radar monitoring, pay attention to the effective combination of long-range and short-range radar scanning, and understand and master the surrounding ship dynamics;

② The auxiliary tugboat keeps cruising alert at a proper distance in front of the route;

③ If it is found that the surrounding ships and towing group will meet, it is necessary to get in touch with the incoming ship in time by VHF and other effective means to

remind the incoming ship to stay away from the towing group as far as possible.

④ When meeting, both sides should strengthen communication and coordinate avoidance actions to avoid uncoordinated avoidance actions.

⑤ If there is a collision risk between the incoming ship and the towing group, and effective contact cannot be obtained, while the towing group continues to try to contact, the auxiliary tugboat will sail to and from the ship in time, using sound signals, light signals and all means to contact, and it is necessary to intercept and drive away.

⑥ During the meeting, perform the duty of keeping the direction and speed of the direct ship as much as possible. If the steering action must be taken, notify the incoming ship in advance, so as to prevent the incoming ship from making wrong judgment and taking wrong avoidance actions.

(3) Collision avoidance actions

When visibility is poor and ships are not seeing each other, both ships with collision risk will take collision avoidance actions, that is, the towing group will also take collision avoidance actions as early as possible and greatly, and pay attention to:

① in addition to being chased over the ship, turn to the right before the ship;

② The incoming ship near and behind the right cross, turn on the back of the incoming ship.

(4) Drive carefully

When you hear the fog signal before you know whether there is collision danger with the incoming ship, or when you can't avoid the urgent situation before you come to the ship in the right direction, reduce the speed to the minimum speed that can maintain the course, stop the ship if necessary, avoid blind steering before you know the collision dynamics, and drive carefully until the collision danger passes.

4.4 Security measures for severe weather such as cold wave and strong wind

During towing operation, once affected by bad weather such as cold wave and strong wind, the following navigation safety measures shall be taken in time:

(1) Timely report the weather, sea conditions and towing group status at that time to emergency command center and VTS center.

(2) When encountering sudden severe weather and sea conditions, adjust the course to the course of stopping the ship against the wind in advance. When sailing along the wind and waves, pay special attention to the restricted water area in front of the route, strengthen the observation duty of the bridge, strengthen the cruise alert around the auxiliary tugboat, and at the same time, make preparations for emergency assistance towing.

(3) Reduces the speed of the towing group, and the main tugboat should adjusts the length of the towing cable and controls the tension of the towing cable to prevent cable breakage.

(4) In case of sudden bad weather, the towing group can take a detour properly, or slow down at low speed, or even sail backwards at low speed, so as to ensure the safety of the towing cable system of the towing group and the navigation safety of the whole towing group while avoiding collision and stranding.

(5) The main tugboat discharges some materials that can be adjusted, such as fresh water, ash and mud.

(6) When the water depth is appropriate, the towed platform should properly lower the pile legs by 3~9m, lower the height of the center of gravity and reduce the wind load.

(7) Strengthen communication with emergency command center and VTS center, and obey the command.

(8) In case of any emergency, such as cable breakage and personnel falling into water, the relevant emergency plan should be started immediately, and the emergency command center and VTS center should be reported in time.

(9) If necessary, apply for additional tugboats to assist in wind resistance, etc.

(10) Strengthen the monitoring and contact of the surrounding ships, and remind the surrounding ships to stay away from the towing group as far as possible.

Chapter 5: Emergency plan for maritime navigation safety of towing group

There may be many accidents when towing group is sailing at sea, such as broken towing cable, ship out of control, bad weather, man overboard, fire, serious injury (illness), hull damage, oil spill, ship abandonment, collision, etc. When the tugboat and the tugboat encounter emergency and special circumstances, the personnel on duty shall immediately report to the captain, who shall report to the company and relevant authorities while organizing relevant measures to obtain shore-based support. When the ship can no longer be towed according to the conditions specified for towing, the captain shall take some measures corresponding to the special environment after considering the situation with experience. To ensure the safety of personnel and ships as much as possible and reduce losses.

5.1 Emergency Measures for Maritime Navigation Emergency of Towing Group

5.1.1 Emergency safeguard measures for streamer breakage

(1) In case of cable breakage (the long chain and bridge chain of the platform are broken), the emergency towing cable of the towing platform is adopted, and the tugboat takes the following actions:

① The tugboat immediately recovers the broken cable, and redeploys the towing system on the tugboat to prepare for towing. At the same time, the tugboat gives a warning to the surrounding ships in time to remind them to avoid it. And report to the shipping company and nearby competent authorities, and start emergency procedures.

② The tugboat approaches the leading buoy of the emergency towing cable of the towed object, picks up the leading cable, adjusts the position of the tugboat to an appropriate position, and connects the emergency towing cable of the towed object with the towing cable of the tugboat.

③ When the tugboat approaches the emergency towing cable of the towed object, it

should be carefully operated to avoid winding the propeller.

④ The emergency towing cable is not suitable for towing navigation, but only for controlling the drift of the platform.

(2) In case of cable breakage (the main towing cable of the main tugboat is disconnected), the auxiliary tugboat is used to connect the bridge chain of the towing platform, and the auxiliary tugboat takes the following actions:

① the main tugboat shall inform the towed object and the auxiliary tugboat in time, and keep away from the towed object, so as not to hinder the auxiliary tugboat from towing.

② The auxiliary tugboat shall prepare for towing, and approach the direction of the towed object across the bridge chain.

③ The towed object shall adjust the long beard chain and the bridge chain, and control the ship position by measures including tail-throwing anchor or main towing assistance as far as possible, which is beneficial for the auxiliary towing boat to hang and tow.

④ The auxiliary tugboat approaches the bridge chain, and the captain of the auxiliary tugboat controls the ship position to avoid collision and other dangers.

⑤ The auxiliary tugboat picks up the bridge chain by using the short rope and winch, releases the broken towing cable of the main tugboat and hangs it.

⑥ The towed objects are put away from the tail anchor/main tugboat, and the auxiliary tugboat pays out the streamer with appropriate length. According to the company's requirements, control the speed of the boat and the stress of the streamer, and continue towing.

(3) The emergency towing cable is broken

Once the emergency streamer is broken, the captain gives out-of-control drift alarm of the platform, which is equivalent to adopting the emergency procedures for the ship's out-of-control to enter the emergency. Meanwhile, good ship skills and all contingency measures suitable for the situation at that time are adopted to control the drift of the

platform, including emergency cable taking and other measures. If the sea conditions permit, measures such as personnel boarding the platform to cooperate with emergency connection can be considered. If safety permits, the company may consider sending personnel to the platform by helicopter to participate in/assist in emergency rescue.

5.1.2 Emergency safeguard measures for ship out of control

When the ship is out of control, the captain is responsible for commanding the whole ship to take effective measures immediately to get out of control as soon as possible, and at the same time report to the company and start the emergency procedure. The tugboat takes the following measures:

(1) Send out the alarm of ship out of control and display the out-of-control signal, and arrange special personnel to observe the nearby sea surface, keep radar observation, and do a good job of collision avoidance with passing ships.

(2) Pay close attention to the water depth and assess the risk of grounding.

(3) Start the emergency generator to ensure power supply to emergency equipment.

(4) If the water depth permits, after the relative position between the tugboat and the platform drift is stable, the tugboat can be anchored to stabilize the ship position. The tugboat shall take measures to repair the power or electricity of the ship and resume towing.

(5) If the towing process is out of control, and the surrounding sea area is complex or there are many ships coming and going, the escort ship will take over the towing and stabilize the ship position.

(6) If the tugboat can't anchor or the rescue boat doesn't arrive before, when the ship drifts and collides with the offshore island reef or facilities, check and confirm that the watertight doors, windows and vent holes are closed, close the relevant oil tank valves, and prepare corresponding plugging equipment.

(7) When the towed objects pose a direct threat to navigation, offshore structures or coastlines due to drifting away or other reasons, the master will send a notice to the nearby ships by all means he has mastered, including the report of the competent authority at the nearest coastal location that can be contacted with him, and ask for assistance.

(8) The arrangement for recovering drifting towed objects shall be made in accordance with good navigation technology under all circumstances, and seasonal climatic conditions and operation areas shall be considered.

5.1.3 Emergency safeguard measures for severe weather

(1) Collect weather information, analyze weather trends and development trends, and evaluate the impact on towing.

(2) In case of bad weather, the tugboat shall adjust the length of the towing cable and control the tension of the towing cable, and if necessary, take the measures of stagnation or lift the ship at the temporary lifting point to avoid the wind.

(3) According to the towing force of tugboats, the load condition of towed objects, and the characteristics of routes and seasons, if it is predicted that the predicted wind speed in the sea area ahead of the route will reach 20m/s or above due to the influence of severe weather, choose favorable safe routes or windward anchorages to avoid departure. If it is impossible to avoid departure effectively, in any case, adjust the course

to the course of stopping the ship against the wind before encountering the influence of severe weather and sea conditions, especially when sailing along the wind and waves.

(4) If the wind speed is expected to be 15-20m/s, the windward direction protection measures can be taken or the nearest anchorage can be selected to avoid the wind.

(5) If the wind speed is below 15m/s, you can proceed as scheduled.

(6) When sailing in fog, strictly abide by the International Rules for Preventing Collisions at Sea 1972, strengthen the observation on duty, properly adjust the length of towing cable and towing speed, correctly use radar and VHF, and take effective avoidance measures in time. According to the provisions, display or hang the corresponding lights and shapes.

5.1.4 Emergency safeguard measures for people overboard

(1) If a drowning person is found, the personnel on duty at the tugboat bridge immediately drop the lifebuoy with life-saving floating rope and send out an alarm for drowning, and then try to keep an eye on the drowning person at a high place and report to the captain.

(2) The captain enters the cab as the chief commander, and the first mate as the on-site commander, and organizes rescue according to the duties in the Contingency Deployment Table.

(3) If the drowning person catches the lifebuoy, a climbing net can be arranged on the side of the tugboat to help the drowning person climb onto the boat and avoid the propeller from hurting the drowning person.

(4) The tugboat releases the rescue boat, and the rescuers board the boat and operate the rescue boat to approach and rescue the drowning person. After the drowning person rescues the tugboat, he shall be given medical aid.

(5) The captain shall report to the shipping company.

Conflagration

(1) Inform the bridge by shouting fire fighting or sounding fire alarm/button immediately if the fire is found to be in the initial stage or light, immediately put out the fire with nearby fire extinguishing tools, cut off the ventilation of the cabin and evacuate to a safe area if the fire is considered uncontrollable, and immediately notify the captain to the bridge after receiving the alarm, and send out an alarm signal before the captain goes to the bridge to know the fire and the fire location and take effective control measures.

(2) The captain goes to the bridge to quickly understand the fire and its location, issue fire emergency alarm and organize the implementation of firefighting. If the ship needs to adjust its course and speed during navigation, put the fire location on the leeward side and reduce the relative speed between the wind and the ship.

(3) In addition to taking self-rescue measures in time according to the requirements of the ship's emergency deployment table, the ship shall immediately report to the shipping company and the nearest maritime authority; Start the emergency procedure.

(4) The crew shall participate in rescue according to the emergency duties in the emergency deployment table.

(5) Fire detectors wear firemen's equipment to conduct fire detection and search and rescue for the injured, and notify the bridge after confirming that there is no possibility

of resurgence. The captain shall issue ventilation instructions according to the situation and report to the emergency agency.

(6) If it is necessary to abandon the ship in case of fire fighting failure, it shall be implemented according to the Emergency Plan for Abandoning the Ship.

5.1.5 Emergency safeguard measures for serious personal injury (illness)

(1) In case of serious injury, serious illness or food poisoning on board, the ship shall immediately report to the shipping company in addition to on-site first aid by existing means; Start the emergency procedure.

(2) For the crew members suffering from epidemic infectious diseases, the captain shall take immediate measures to isolate and control the spread of infection.

(3) The emergency center of the shipping company shall formulate an emergency rescue plan, and coordinate to send the sick and wounded to land for rescue by appropriate means.

(4) When the situation of seriously injured (sick) personnel is very urgent and some preliminary measures need to be taken as soon as possible, the emergency center of the shipping company shall contact the China Maritime Search and Rescue Center and the hospital to provide remote rescue and medical guidance to the ship.

(5) When helicopter assistance cannot be provided, the captain has the right to decide to report to the nearest competent authority and ask for assistance.

5.1.6 Emergency safeguard measures for hull damage

(1) When the tugboat finds that the hull is flooded, it shall immediately report the water inflow position, water inflow and the preliminarily analyzed water inflow reason to the driver on duty at the bridge.

(2) After receiving the report, the bridge shall report to the captain immediately, and the captain shall board the bridge and send out a leakage stoppage alarm to all crew members by broadcasting or sound signals (two long sounds and one short sound, which shall be played for one minute). The captain reports to the shipping company; Start the emergency procedure.

(3) If the water inlet is located in the engine room, bulk cargo cabin, rudder engine room and side push cabin, the chief engineer will act as the on-site commander and organize rescue; If the water inlet is located in other compartments, the first mate shall act as the on-site commander and organize rescue.

(4) The bosun measures the water level of each tank, and the chief engineer instructs the duty pipe wheel to measure the oil tank, sewage tank and sewage ditch.

(5) The on-site commander shall confirm the water inlet position, water inlet quantity, water inlet reason and hull damage degree as soon as possible, and report the details to the captain in time.

(6) After knowing the situation, the captain decides the plugging scheme and notifies the on-site commander to implement it.

(7) If plugging fails, abandon ship according to Emergency Plan for Abandoning Ship.

5.1.7 Oil spill emergency safeguard measures

(1) Whenever the personnel on board discover that an oil spill accident has occurred on the ship, they should immediately report it to the duty pilot. After receiving the report, the duty pilot immediately sends out an oil spill alarm signal (one short, two long and one short sound, • —— —— • for one minute) and reports it to the captain. The crew of the whole ship shall implement emergency response according to the "Checklist" and "Oil Spill Contingency Deployment Table" in the Oil Pollution Emergency Plan on Ship.

(2) When implementing emergency response, the ship with oil spill shall immediately report to the shipping company and the nearest maritime authority through radio and other means according to the reporting requirements in the Oil Pollution Emergency Plan on Ships. The contents of the radio report mainly include:

--Ship name, date and time, ship position, oil spill location, accident cause and estimated amount of oil spill;

--Meteorological conditions in the oil spill area, including velocity and direction of flow, wave height and direction of wind and waves, etc.;

--Type and quantity of fuel oil on board;

--Oil spill control, polluted sea area, measures being taken and assistance required.

(3) The emergency center of the shipping company starts emergency procedures, formulates emergency plans, mobilizes internal resources, coordinates relevant forces and external resources, provides shore-based support for emergency ships, and guides ships to implement emergency.

5.1.8 Emergency safeguard measures for ship abandonment

(1) When the ship encounters an emergency that seriously threatens the life safety of the personnel on board, the captain has the right to decide to abandon the ship.

(2) When the captain decides to abandon the ship, he will give an alarm for abandoning

the ship, with a sound of seven short and one long. All personnel shall follow the deployment of abandoned ship. The captain shall report to the shipping company and the nearest competent authority; Start the emergency procedure.

(3) After the ship abandonment alarm is issued, all crew members shall bring corresponding articles, communication equipment, emergency alarm signals and legal records to the designated place according to the emergency responsibilities of ship abandonment. The personnel of the engine department are responsible for closing the main engine, generator, quick-closing valve, all watertight doors and windows, starting the emergency power supply, and the first mate is responsible for preparing for releasing the lifeboat (raft).

(4) When abandoning the ship, check and open the satellite position indicator and other alarm systems.

(5) When leaving the ship, the sick and wounded should be arranged to board the boat (raft) first, and then other crew members should board the boat (raft) after the captain confirms that all the personnel have been evacuated.

(6) When the crew is waiting to be rescued on the lifeboat (raft), they should send out a distress signal, and the captain should actively get in touch with the boats and helicopters coming for search and rescue, so as to get rescued ashore as soon as possible.

(7) The emergency center of the shipping company shall coordinate resources to rescue the ship abandonment personnel.

5.1.9 Emergency safeguard measures for collision

(1) In case of collision, the driver shall immediately take effective measures to avoid or

reduce collision losses, and immediately notify the captain to board the cab. The captain broadcasts to inform the whole ship of the collision, and the personnel are assembled into an emergency state, and informs the towed objects to start the relevant emergency, and immediately starts the on-site collision emergency treatment plan of ship average.

(2) Inform the auxiliary tugboat to prepare the main engine, streamer and other equipment to arrive at the scene immediately, and bring the auxiliary streamer to assist the main tugboat; In case of collision with other ships during navigation, judge the collision angle, position and damage degree, and take measures suitable for the current environment. The captain shall confirm the injury of the personnel of this ship and the opposite ship. The chief engineer and first mate shall investigate the hull damage and power equipment, and report to the captain.

(3) Both parties to the collision shall investigate the ship collision loss, take photos and collect evidence, and form a written loss report, which shall be confirmed and signed by both parties. If feasible, report orally to the dispatching room of the operation company, the operator and the nearest maritime bureau in time.

(4) The captain shall report to the dispatching room of the company: the time, place, location, bottom material, water depth, sea condition, damage, threat degree to ships and personnel, measures taken and shore-based support required, etc.

(5) The captain shall evaluate the collision damage, watertight integrity and subsequent operation ability of the ship, and judge the seaworthiness of the ship and whether it can complete the expected operation tasks of the voyage. Put forward shore-based support requirements and report them to the operator and shore-based emergency center.

(6) If the ship is seriously damaged by collision, which affects the seaworthiness of the ship and needs to return to Hong Kong for repair, the ship shall take necessary security

measures, such as strengthening the duty of cab and engine room, adopting safe speed, closing watertight doors and windows, keeping floating, site monitoring, patrol inspection, cabin liquid level monitoring, etc. In case of leakage stoppage, ship abandonment, serious injury and other emergency actions, they shall be implemented according to the corresponding on-site emergency disposal plan.

5.1.10 Emergency safeguard measures for cold wave and windy weather

In case of weather influence such as cold wave and strong wind during towing operation, the following emergency measures shall be taken for safety:

(1) The towing group needs to find nearby waters with suitable environmental conditions to avoid the wind.

(2) In case of sudden severe weather and sea conditions, adjust the course to the course of stopping the ship against the wind in advance, especially when the waters in front of the route are restricted when sailing along the wind and waves, pay special attention to it, strengthen the lookout duty of the bridge, strengthen the cruise alert around the auxiliary tugboat, and make preparations for emergency assistance towing.

(3) The towing fleet should reduce the speed and control the towing force to prevent cable breakage.

(4) The main tugboat for this towing is a high horsepower tugboat in Bohai Bay, which has the ability to safely brake and operate the platform under the conditions of wind speed 20m/s, water flow speed 0.5m/s and significant wave height 5m.

(5) In case of sudden bad weather, the towing fleet can choose to yaw around properly, or slow down at low speed, or even sail backwards at low speed, so as to ensure the

safety of towing cable system of the fleet and ensure the navigation safety of the whole fleet under the condition of avoiding collision and stranding.

(6) The main tugboat discharges some materials that can be adjusted, such as fresh water, ash and mud.

(7) When the water depth is appropriate, the towed platform should properly lower the leg of the pile by 3~9m, lower the height of the center of gravity and reduce the wind load.

5.1.11 Emergency safeguard measures for poor visibility

(1) measures taken before entering the fog zone

① Before the ship leaves the port or offshore facilities and is about to sail, if there is fog or fog in the sea area where it passes according to the weather forecast, the captain shall hold a pre-sailing meeting, formulate the fog navigation measures, and record the meeting in the Safety Activity Record Book.

② In case of heavy fog when a ship enters or leaves the port or starts towing, it can actively and timely negotiate with the operator to avoid entering or leaving the port or starting towing when heavy fog exists. And record the communication in the Log.

③ Before entering the fog area, the pilot on duty shall use all means to measure a measured ship position.

④ The pilot on duty informs the captain to get on the bridge.

⑤ Make full use of navigation AIDS such as radar, AIS and electronic chart to master the dynamics of ships around the towing group, and get VHF contact with ships in collision danger with the towing group as soon as possible to coordinate collision avoidance actions.

⑥ Keep the doors and windows of the bridge open. Keep the whole ship silent so as not to disturb the hearing of the personnel on duty.

⑦ Change automatic steering to manual steering.

⑧ When entering or leaving the port or passing through a dense fishing boat area, or when the captain thinks it necessary, he sends his head and prepares anchors.

⑨ The pilot on duty informs the engine room to prepare for fog navigation

⑩Attending streamers should be shortened properly to facilitate operation.

(2) Sailing in fog

① Strictly abide by the provisions of Article 19 of the International Regulations for Preventing Collisions at Sea, which stipulates the rules of action of ships in poor visibility.

② Strictly abide by Article 35 of International Regulations for Preventing Collisions at Sea.

③ Drive at a safe speed so that proper and effective collision avoidance actions can be taken and the ship can be stopped within a distance suitable for the environment and situation at that time.

④ After the captain arrives at the bridge, the pilot on duty will report the ship's position, surrounding conditions and measures taken to the captain, and the captain will check whether the measures taken are appropriate.

⑤ When the captain is on duty at the bridge, the duty of the pilot and sailor on duty is not exempted.

⑥ Keep uninterrupted observation, and keep regular observation with sight, hearing and all effective means suitable for the environment and circumstances at that time, so as to fully estimate the encounter situation and collision danger. All lookout personnel shall perform their duties, and shall not leave their posts without permission. If any light, sound, echo, ship shadow, smell, land or other abnormal conditions are found, they shall immediately report to the captain.

⑦ Pay attention to master the ship's position during navigation, and fully consider that the ship will be greatly affected by wind flow after slow speed, especially in restricted waters such as narrow waterways or waterways, and check the ship's position with radar

and GPS.

⑧ Use VHF and other effective communication means to communicate with other ships in time, obtain the dynamics of other ships and coordinate avoidance actions. The main tugboat and the auxiliary tugboat shall issue a towing alarm every 5 minutes to warn the passing ships to stay away from the towing group.

⑨ Fully and skillfully operate and use radar, make continuous and uninterrupted observation, pay attention to the characteristics and limitations of radar equipment, and strictly abide by the requirements of Article 7 of the International Regulations for Preventing Collisions at Sea.

⑩ For the following cases, reduce the speed to the minimum speed that can maintain its course. When necessary, stop the ship completely, and drive with extreme caution no matter what, until the collision danger is over:

- When you hear the fog sign of his ship, it seems that it is before the ship is crossing;
- When it is impossible to avoid the urgent situation with other ships before abeam;
- There is doubt about the close-range arrival dynamics tracked by radar or the close-range arrival target is lost;
- If there is any doubt.

Any action taken to avoid collision, such as the environmental permit at that time, should be carried out actively and early, and attention should be paid to the use of good boating skills.

(3) Others

① Engaged in towing ships according to the provisions of article 35 of the 1972 rules for preventing collisions at sea cast sound signals.

② According to the provisions of the cast fog, pay attention to don't make the ship's fog and other ships or shore fog synchronization, lest cause misunderstanding.

③ Fog signals from lighthouses and beacons can only be used as a reference for bearing, not as a basis for judging ship position.

④ The time when the fog starts to disperse, the sound signal is sounded, the radar is turned on, the captain gets on the bridge, etc., the observation time at the bow, the names of the personnel, the time, conditions and measures when the ship arrives and the avoidance measures are found, etc., must be recorded in the Log in detail.

5.1.12 Other circumstances

(1) The above-mentioned emergency measures do not hinder the master's professional judgment according to the site conditions, the ship's performance, crew capacity, etc., and the implementation of corresponding emergency measures based on his professional judgment.

(2) In case of a large number of fishing boats fishing on the air route, the course can be adjusted appropriately to avoid the operation area of the fishing boat group and use the escort boat reasonably.

(3) If the propeller of the main tugboat is entangled by fishing nets and loses power, the emergency plan for ship out of control shall be implemented. In actual operation, it is necessary to make full use of the auxiliary tugboat, hang up the auxiliary towing cable in time, try to keep the safe distance between the main tugboat and the drilling platform, and keep the safe distance between the towing fleet and other surrounding ships, and broadcast the navigation safety notice in time.

(4) Plan the selection of sheltered anchorage or temporary ship lifting point along towing operation in advance. Comply with the relevant handling principles of bad weather and ensure the safety of personnel and ships under the leadership of the captain.

5.2 Emergency safety measures for oil spill and pollution

The purpose is to ensure that the onshore base and ships of the Shipping Division can quickly take effective measures to minimize the losses caused by pollution when oil spills and pollution accidents occur.

5.2.1 Responsibilities of staff

(1) The ship's oil spill treatment is under the command of the captain.

(2) The captain of the ship in the port of the base shall immediately report the oil spill accident to the maritime authority and be responsible for the emergency command at the accident site.

(3) The emergency department of the Shipping Division coordinates all available internal resources to provide shore-based support for ships.

5.2.2 Emergency Response Procedures

(1) Whenever the personnel on board discover that an oil spill accident has occurred on the ship, they should immediately report it to the duty pilot. After receiving the report, the duty pilot immediately sends out an oil spill alarm signal (one short, two long and one short sound, which lasts for one minute) and reports it to the captain. The crew of the whole ship shall implement emergency response according to the "Checklist" and "Oil Spill Contingency Deployment Table" in the Oil Pollution Emergency Plan on Ship(Zhang, 2020).

(2) When implementing emergency response, the ship with oil spill shall immediately report to the room and the nearest maritime authority through radio and other means

according to the reporting requirements in the Shipboard Oil Pollution Emergency Plan. In case of an oil pollution accident of a ship abroad, in addition to making a local report according to regulations, the ship shall submit a written report to the maritime authorities at the port of arrival within 24 hours after returning to the first port in China according to the format of the mandatory reporting system of the International Maritime Organization (see the requirements in the "Shipboard Oil Pollution Emergency Plan" for the format and content of the written report). The contents of the radio report mainly include:

① Name, date and time, position, location and cause of oil spill accident, and estimated amount of oil spill;

② Meteorological conditions in the oil spill sea area, including velocity and direction of flow, wave height and direction of wind and waves, etc.

③ Type and quantity of cargo and fuel oil on board;

④ Oil spill control, polluted sea area, measures being taken and assistance required.

(3) After starting the emergency procedures, the emergency agency shall formulate emergency plans, mobilize internal resources, coordinate relevant forces and external resources, provide shore-based support for emergency ships, and guide ships to implement emergency.

(4) If the situation is extremely urgent and seriously endangers the safety of personnel and ships, the captain shall abandon the ship according to the Emergency Plan for Abandoning Ships.

(5) The actions taken against oil spill shall be implemented according to the Shipboard Oil Pollution Emergency Plan.

(6) Emergency institutions and ships shall record the whole emergency response process in detail.

Chapter 6: Conclusions

Towing operation on the sea is a systematic project. The maneuverability of towing group is greatly limited and the speed is slow. The length of towing group of large offshore platform can reach 500-700 meters. Compared with ordinary ships, the risk of collision avoidance operation on the sea increases. At the same time, the operation procedure of the drilling platform is complex and the risk is high, so it is necessary to fully prepare and prevent the risk before towing (Zhang, 2020).

In order to ensure the navigation safety, the towing group shall display or hang the corresponding lights and models according to the regulations, and be equipped with sufficient qualified staff. The drilling platform, main tug, auxiliary tug and relevant towing equipment shall apply for towing inspection according to relevant regulations to verify the standardization of towing group. The towing operation shall be carried out after passing the inspection of classification society and Issuing the towing certificate.

When the towing group passes through the fishing area, the cross area of the customary route and other traffic flow intensive areas, it should pay close attention to the dynamics of the surrounding ships, strengthen mutual communication and coordination, and take effective avoidance measures in time to avoid an urgent situation. When necessary, working boats should be arranged to assist in the area with dense fishing vessels along the coast.

In the waters with dense traffic flow, it is necessary to apply to the relevant maritime authorities for issuing navigation warning before towing.

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