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Study on the towing of drilling platform in port waters based on VTS Aid-To-Navigation Service

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STUDY ON THE TOWING OF DRILLING PLATFORM IN PORT WATERS BASED ON VTS AID-TO-NAVIGATION SERVICE

By

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DECLARATION

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

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

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ABSTRACT

Title of Dissertation: **Study on the Towing of Drilling Platform in Port Waters Based on VTS Aid-To-Navigation Service**

Degree: **MSc**

In the past two years, frequent social activities have led to an increase in the demand for resources, and resources such as land, fresh water and coal mines have been exploited to the minimum. And as a country with great marine power, we have more than 470 million square kilometers of marine land. Under these marine lands, there are many resources to be exploited or mined, such as oil, natural gas, flammable ice and other natural sources of energy. Therefore, the exploitation of marine resources has become a new opportunity and a new direction for the development of all countries. The drilling platform is a kind of marine structure for drilling the exploration oil, gas and other resources. It is an important platform for exploring and mining marine resources. The drilling platform has the characteristics of large tonnage, no self-propulsion capacity and is easily influenced by wind and current. Normally, the drilling platform needs to be towed while entering and leaving the port and then transported to the working area of marine exploitation. In the process of towing the drilling platform into and out of the port, due to the complicated navigation environment, narrow channel, many ships near the coast, channel and anchorage, and the factors of the drilling platform, the towing operation is difficult and dangerous.

This paper analyzes the current towing method and its existing problems in the offshore drilling platform. Considering the safety of the operation of the towing drilling platform, this paper makes a relevant study on towing of the drilling platform in port waters:

(1) Through the analysis of the natural conditions of the harbor, the traffic environment of the channel and the human factors, the drilling platform in the port towing safety is studied.

(2) A series of dangerous conditions may occur during the towing process, such as collisions, reefs, stranding, yawing, cable breakage, etc. When planning towing routes

before sailing, even when taking all factors and effects into account, the marine towing environment is changing in real time, and the navigation environment is complex and changeable, which means any negligence or adverse factors of the operator will lead to sudden and dangerous situations. Therefore, this paper proposed a combination of existing towing technology and VTS NAS.

(3) On the basis of platform towing demand, a database and model of navigation aids service are established. Taking Tianjin port as an example, the visual simulation of port towing system is carried out by means of C++ programming, and a simulation model of towing platform with VTS NAS is structured. Besides, the information service automatic push algorithm is designed based on the position relation between the position and service time. Finally, VC++ programming is used to realize the simulation and verification of the service scheme on the electronic chart platform.

KEY WORDS: Drilling platform; Towing; VTS; Aids to navigation service (NAS); Tug operations

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LIST OF ABBREVIATIONS

AIS	Automatic Identification System
CCTV	Closed Circuit Television
CMDS	Common Maritime Data Structure
ECDIS	Electronic Chart and Information Display System
GFM	General Feature Model
GPS	Global Positioning System
IMO	International Maritime Organization
LNLW	Lowest Normal Low Water
MIS	Management Information System
MSP	Maritime Service Portfolios
NAS	Aids to Navigation Service
ROT	Rotation Rate
UML	Unified Modeling Language
UTC	Universal Time Coordinated
VHF	Very High Frequency
VTS	Vessel Traffic Services

CHAPTER 1

INTRODUCTION

1.1 Background and significance of the topic

In recent years, a series of resources shortage or environmental problems have gradually emerged due to the over-exploitation of land resources. Therefore, our attention is directed to marine resources now. Because of the limitation of marine exploration technology, the people's understanding of the ocean is insufficient. Besides, the understanding and exploitation of marine resources is still inadequate. In addition to the mining technology, the most important equipment to exploit the marine resources is the drilling platform. As early as 1896, in the United States, along the coast of California, they built a wooden Zhan Qiao from the breakwater into the sea so as to develop across the land and sea oil. This is an early stage to exploit the marine resources --- Zhan Qiao or Artificial Island. "Ying Chong wells" is the earlist offshore drilling well in China, which is located in the Ying Gehai, but it is not the true meaning of drilling platform; Instead, it is actually a large float at a distance of four thousand meters away from the Ying Gehai coast, with a depth of 15 meters of the place to play a well. In 1966, China constructed a real drilling platform and put it into practice. The Bohai Exploration Well was the first step of China's offshore oil exploration and exploitation. With the rapid development of science and technology in shipbuilding and machinery industry, many countries all over the world built a great variety of offshore drilling platforms and offshore pipeline transportation facilities in order to promote the marine resources exploration and exploitation with a rapid development. So far, there are nearly a thousand offshore drilling platforms that have been instituted around the world.

According to the latest statistics, the proportion of the offshore oil, natural gas and other resources storage account for 70% of the global oil and gas resources. There is no doubt that the national economy, science and technology based on the marine resources exploration drilling platform is promoted, which can supply a large quantity of resources. Due to the complexity of the unpredictably marine situations, the exploitation featured as high risk, high investment, and abundant in offshore oil and gas resources, each well of high yield, the income is high. Nearly all the oil gas, around the globe, which is easy to be exploited, has been mined. We have to be confronted with more challenging marine environment provided for starting the energy exploration and exploitation of oil and gas. The prospects of marine resources exploitation are immeasurable.

Offshore drilling platform is an important infrastructure for marine resources exploration. However, the platform usually has to be tugged from the port to the anchorage for loading, because of the large size and no self-navigation of drilling platform. The navigation environment of the navigation platform is very dangerous because of the complicated navigation environment, the relatively large number of inshore vessels, the limited navigation area, and the larger size of the drilling platform itself. In recent years, a number of collision accidents occurred in the process of towing drilling platform. In 1988, the "Rowan Gorilla 1" drilling platform was towed by the "Smit London" tug, and the big storm broke down the towing rope. "Rowan Gorilla 1" sank in the North Atlantic and lost about $90 million (Xi Q et al, 2000, pp.15-24). Since then, the towing safety of drilling platform has aroused the attention of scholars and society.

1.2 Research Status at Home and Abroad

Tongxin has analyzed the large model of offshore oil gas drilling platform towing method and the capability of the method, and put forward opinions and measures to solve the common problems of towing caution (He X, 2017, pp. 00094-00094). Shen Jianyun has analyzed Shenzhen port waters, visibility, wind flow, swell and other navigational environment and "exploration three" navigation features, and finally gives the program of pilot exploration scheme about No.3 drilling platform export Shenzhen port (Shen JY, 2015, pp.22-25). According to the Bohai No.10 drilling platform, Wang Yantong adopted a double parallel cable tug towing methods to establish Bohai sea towing a large drilling platform model, and analyzing challenges of towing the drilling platform in ice zone of Gulf of Bohai, towing speed and steering to avoid the influence, putting forward the corresponding security towing the measures and precautions of towing drilling platform in ice zone (Wang Yantong, 2015). Sun GC, Bai CJ and Dai ran towing WEST TITANIA drilling platform from Dalian before the salt wharf as an example, which analyzes the towing restrictive condition, in comparison with the three kinds of towing route, the towing and other environmental factors and towing capacity. The final analysis of the emergency treatment of in the process of collision has been stranded on the rocks and broken cable dangerous (Sun CG et al, 2016, pp.18-22). In terms of ship traffic, traffic environment and other factors, the choice of route, arranged tugboat towing rope and other important towing operations, finally towed ultra-deep drilling platform Sevan Driller, which has great implications for the same kind of ship (Zong et al, 2011, pp.105-109). G Chen' team towed the drilling platform between each module docking and high risk, the study of semi-submersible drilling platform towing ship towing stability and response, combined with the actual situation of maritime navigation, towing resistance calculation to ensure the safety and reliability of the whole process of towing (Chen Gang et al, 2016, pp. 586-592). Su R summed up dozens of drilling platform operating towing ship experience, pointing out that the sea is now facing towing danger. According to the timetable to accurately estimate the arrival of drilling position, they put forward a method of towing large drilling platform, and proposed matters in which special attention should be paid in the process of towing taking the sea conditions and fishing boats into consideration (Su R, 1988).

1.3 The Main Contents and Methods of the Study

The main contents of this paper are as follows:

(1) The first chapter is the introduction, which introduces the background, significance and research status of the drilling platform towing both at home and abroad.

(2) The second chapter analyzes the factors that affect the safety of the drilling platform. This chapter analyzed the characteristics of the platform, the hydrological and meteorological conditions, the channel conditions and human factors.

(3) The third chapter studies various towing scheme for drilling platform, including single and double parallel method of towing tug towing method, double tug towing alongside towing method and pushing hybrid towing, and proposed a method of towing tug equipped with navigation method and application of drag port drilling platform VTS based on navigation services.

(4) The fourth chapter is the demand analysis to the navigation assistance service, which specifies the VTS navigation service information, according to the drilling platform. The process of entry and exit is divided, and the data model of S-100 service is established. The design is based on the relationship between the position and the position algorithm to send service time information service automatic push, using VC++ programming simulation of service program in the electronic chart platform to trial the capacity of the service plan.

(5) The fifth chapter is an overview of the research contents mentioned above.

CHAPTER 2

Analysis on Influencing Factors of Towing Drilling Platform

Maritime navigation environment is complex, and the drilling platform itself has a large volume with no self-propulsion, which is not easy to control and vulnerable to wind, waves and streams and other navigation environment, Access to large-scale drilling platform towing operations becomes a difficult, high-risk offshore operation. Especially when towing system navigating in complex sea areas, such as restricted waters or narrow waterways in the harbor, the risk of danger is greater. Of course, there is an important factor affecting the safety of the drilling platform- human factors, such as crew facing psychological problems when there is an emergency, the operator's operational capacity and managerial experience and management level of the safety of drag, which may more or less have an impact. In addition, the coordination between the towing units in the drilling platform and the safety of towing is also essential.

2.1 The influence of the drilling platform’s own characteristics on the safety of the towing drilling platform

Compared with other maritime transport vehicles such as ships, the drilling platform shape is particularly special, with no self-propulsion, which is not easy to tow. With the increase of resource demand and the development of science and technology, a variety of drilling platforms for offshore exploration operations emerged. In terms of the use of the platform, it is divided into drilling platform, oil platform or production platform and drilling platform; According to the platform construction materials, it is divided into wood, steel, concrete and mixed platforms; According to the structure, it is divided into fixed platform, mobile platform and compliant platform (Zhang YX, 2010). Among such a wide range of drilling platforms, there are some common features: bulky, irregular in shape, unable to be self-propelled, not easy to be towed, and vulnerable to wind, waves , streams and other environmental problems. In addition, the platform is not easy to turn, and is easy to leave the planned route on the contrary. Thus, route adjustment and position control is very difficult. Therefore, in the design of the route, the steering point should be reduced as much as possible when selecting the shortest range.

Each drilling platform itself has different characteristics, before towing, the primary task is to understand the platform structure. Taking the following "981 drilling platform" as an example, its size and structural characteristics are described below. "Offshore Oil 981" belongs to the sixth generation deep-water semi-submersible drilling platform. The main dimensions of the "981 Drilling Platform" drilling platform are shown in Figure 2.1, We can see the total length of the drilling platform: 114.07 meters (including the helicopter deck); maximum width: 78.68 meters; towing the largest draft: 8.2 meters (LIN Yaosheng, 2012). From Figure 2.1, the drilling platform is large in size, special in shape, and difficult to be towed or to sail.

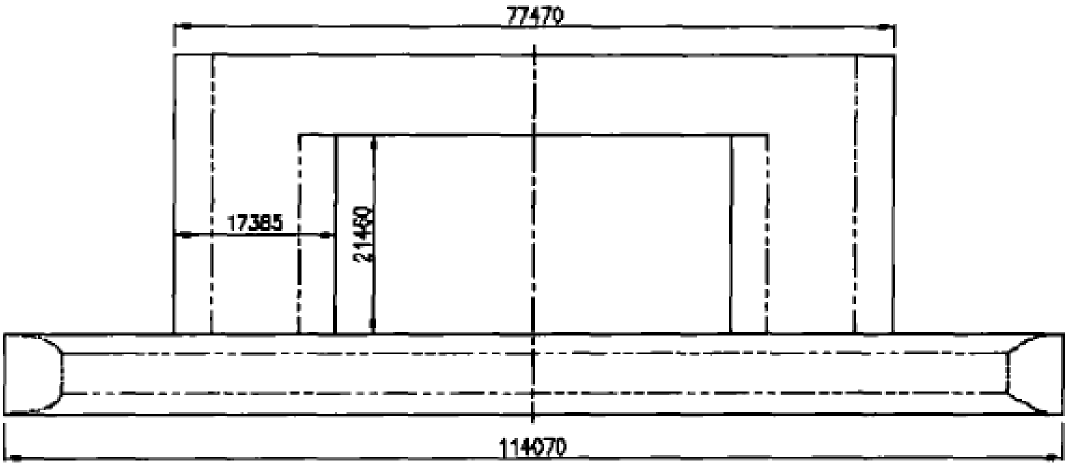

Figure 2.1 Platform Master Dimension Sketch Plan

Source: Lin Yaosheng, Design and Innovation of HAIYANG SHIYOU 981 Semi-Submersible Drilling Unit

2.2 The impact of waterway on the safety of towing drilling platform

In the process of large-scale drilling platform operation, due to the huge size of the drilling platform, without self-propulsion capacity, which is vulnerable to the natural environment of navigation which includes the depth of water, channel width, wind, tide etc. (Yang YD et al, 2015). These natural environmental factors have a crucial impact on the safe towing of the drilling platform. Especially in the harbor channel entrance and restricted waters or narrow waterways, the impact of these factors is more obvious. The natural environment factor in the water area needs to be fully analyzed before the drilling platform, to take the natural environment of Tianjin Port as an example to analyze the influence of these factors on the safety of towing.

2.2.1 The influence of the natural conditions of the channel on the towing drilling platform

The water quality of the different waterways are diverse, so the degree of influence of the natural environment factors in the corresponding waters of each channel may be different. Tug and drilling platform in the channel in the rich water depth, navigation waters width, the number of channel corners and turn bending and other factors have a direct impact on the towing platform (Praught M et al, 1983, pp.666-670).

1． Channel width

In the towing drilling platform of the channel, the greatest impact on its safe operation is the channel width. Drilling platform without self-propulsion capacity, their own larger, received wind, flow, waves and other natural factors after the impact of the route are prone to deflection, and then may deviate from the planned route, Especially in the corner of the fairway or route turn point, the detachment from the planned route, once the towed drilling platform becomes out of control, there will be collision, stranding, crash into the reef and other dangerous situations, In addition, there may be a wall effect or a tandem effect between tugs and so on. In the towing, operations should be concerned about the real-time safety of the channel width changes.

2． Waterway depth

Regardless of any ship sailing in the fairway, including the drilling platform towing operations, it should be stipulated that the channel water depth is greater than the ship draft. If the former in the channel is too shallow, the most direct result is the stranding of the drilling platform. In addition, the shallow depth of the water may also produce shallow water effect, resulting in an increase of towing resistance. Besides, the drag is not easy to control and may easily cause the cable to break, and then deviate from the waterway collision or other ships or other dangerous.

3． Channel direction and curvature

Due to the influence of the natural terrain or the continental frame, the channel is affected by terrain and landscape so that the whole channel is not a straight one. There may be one or several turning points, and the bend channel greatly improves the difficulty of towing the drilling platform. In the channel corners, the flow of water is inconsistent, making the different towing direction of the cable force. This is not only easy to cause the drilling platform at the corners from the channel, but may also cause the cable to break due to uneven forces.

The following analysis is the situation of Tianjin Port double channel (see Figure 2.2), the design of the 10,000-ton about waterway elevation standard is -9.0 m and the navigable depth is -8.6 m; 10 million-ton waterway design elevation standard is -15.5m and navigable depth is -15.1m; 20 million-ton waterway design elevation standard is -18.5m and navigable depth is -18.1m. The effective width of the one-way channel is 100m. The course of the channel mileage of 13 +470 outside the channel is designed for the 250,000-ton oil tanker and 100,000-ton container ship two-way channel. Its' effective width is 420m (Among them, the 100,000-ton container channel navigable depth is -15.1, so you can use part of the slope); The effective width of the channel of 200,000-ton main channel widening section is 104m. In addition, the project slope is set at 1: 5 (Li XT, 2014). On the stable slope of -15.0m below the silt, dredging slope by 1: 5 can also ensure slope stability which tested by the Ministry of Communications Tianjin Water Transport Science Research Institute and Tianjin University and other units.

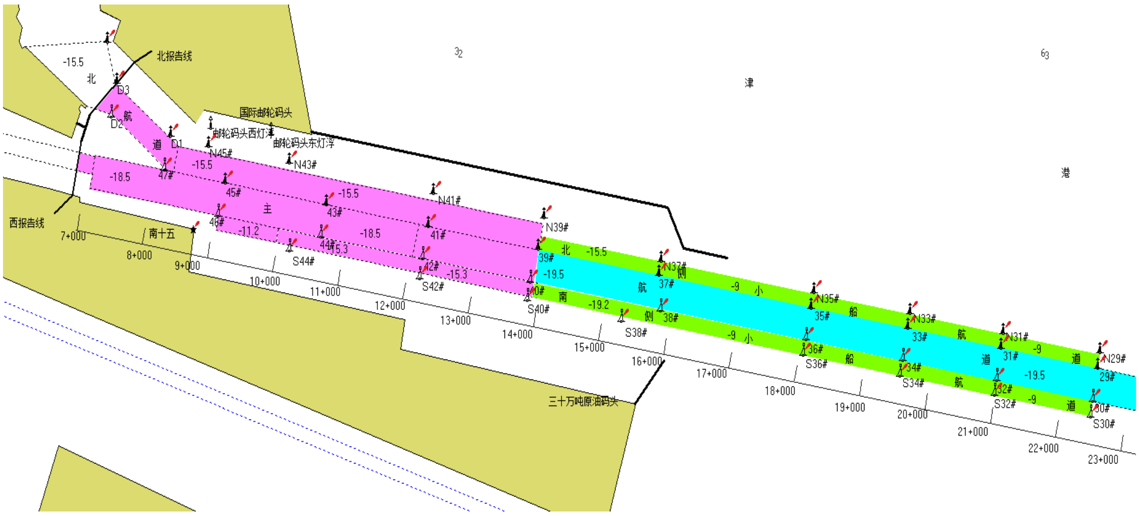

Figure 2.2 Tianjin port double channel diagram

Source: The chart of Tianjin port

2.2.2 Influence of hydrological and meteorological conditions on safety of towing of drilling platform

Wind, fog, tide and other hydrological weather on the drilling platform of the safe towing also has an important impact. Winds may lead to towing cable breakage or platform deviation from the route, etc.; poor visibility in the fog can lead to stranded collision and other hazards; and tides will directly affect the drilling platform in the towing stage of the rich water depth (He JQ, 2008). Familiarity with the port hydrological meteorological environment is necessary, in order to better avoid the hydrological weather conditions caused by the dangerous situation, so that the drilling platform is towed to the designated location safely. The following is an example of Tianjin port to analyze the hydrological and meteorological conditions in Tianjin harbor waters.

According to the statistics and analysis of eigenvalues of Tanggu Ocean Station in Tianjin from 2000 to 2006, the characteristics of hydrological meteorological elements are as follows (Tianjin Port, 2010):

1． Temperature

The annual average temperature 13.1℃

Annual average maximum temperature 16.4 ℃

Annual average minimum temperature 10.9 ℃

Extreme maximum temperature 40.9 ℃

Extreme minimum temperature -13.5 ℃

(Note: January 17, 1953 had a minimum temperature of -18.3 ℃)

2. Fog

When port water visibility is less than 1km, there are on average 16.6 fog days annually. Sea fog occurred in the annual autumn and winter over the season; In December each year, about 30% of the days are foggy ones, with a longest delay of up to 24 hours or more. According to statistics on the actual occurrence of foggy days at sea, the average is 8.7 days per year (Yuan XL, 2015).

3. Wind conditions

Wind on the drilling platform also has a direct impact on the towing process. In the process of towing, as the drilling platform without self-propelled, it is vulnerable to the wind and may offset the route. There may even be collision, stranding or other dangers. In addition, the wind on the large drilling platform of different focal points has different forces, thus easily leading to broken cable and other dangerous things. For the self-propelled drilling platform, the size and direction of the wind are uncontrollable. In order to ensure the safety of its towing operations, we can only rely on tugs to resist wind, and reduce the impact of wind on the drilling platform. Therefore, in the selection of tugs, towing points and cables should take into account the emergency situation of the surplus, and select the appropriate horsepower and the number of tugs according to the current wind conditions. In addition, crew should choose the right conditions what is the smaller winds, airworthiness of the time to carry out towing operations as much as possible (Fan YJ et al, 2011, pp.63-67).

The wind is a factor of instability in the meteorological elements, and there is a certain difference between the annual and the observed statistic values. According to the observation data of wind speed and wind direction in Tianjin Port from 1996 to 2005 (totally 10 years), the positive wind direction is S, and the frequency is E, and the frequency is 9.89% and 9.21% respectively. Strong wind direction is E, and the strong wind direction is ENE. The frequencies of winds are 0.32%, 0.11% which consignment is more than Level 7, as Wind Frequency Statistics Table 2.1 and Wind Rose Figure 2.3 shows (Li Bo, 2010).

Table2.1 table of wind directions and frequency

Wind Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	C
Annual	4.23	2.67	4.25	4.48	9.21	4.97	7.43	6.64	9.89	6.33	8.14	6.51	6.53	2.75	8.69	5.94	1.33

Source: Gray Fuzzy Pre - evaluation of Navigation Safety of Tianjin Harbor

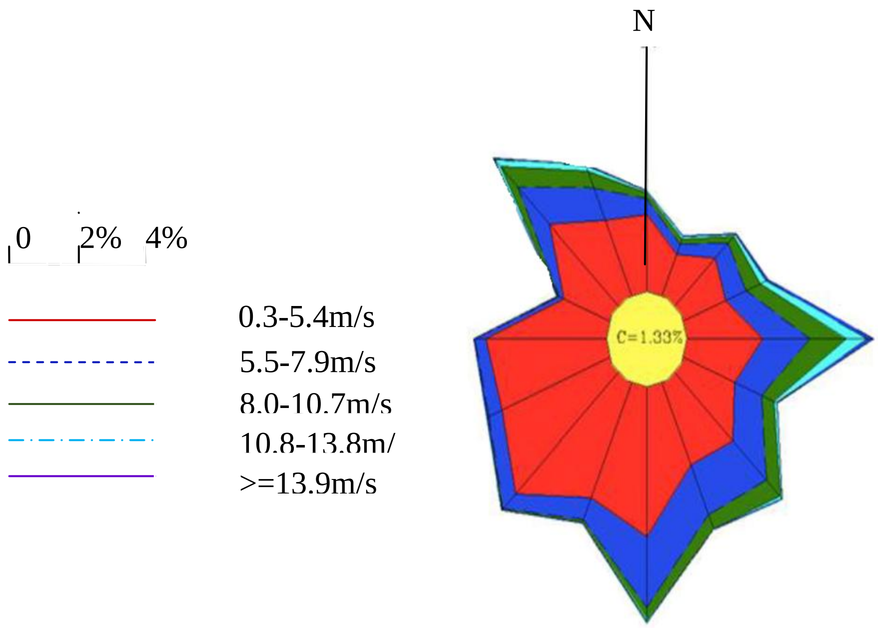

Figure 1.3 the rose chart of Wind speed and direction

Source: Gray Fuzzy Pre - evaluation of Navigation Safety of Tianjin Harbor

4. Tide

The tidal type of the Tianjin harbor area is an irregular half-day tide, and it's $\frac{H_{O1}+H_{k1}}{H_{M2}} = 0.53$, the relationship is shown in Figure 2.4 below.

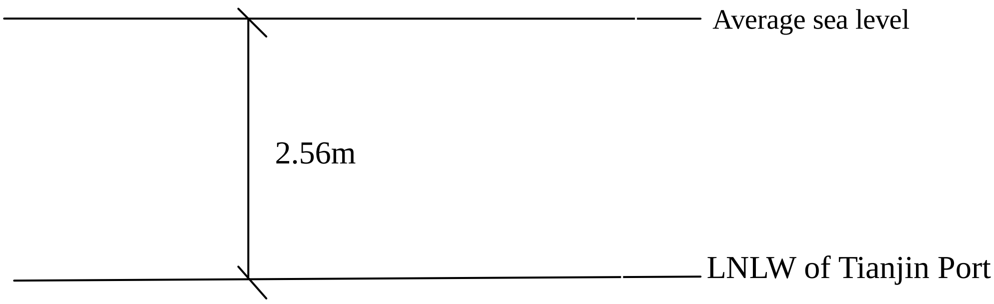

Figure 2.4 Datum Plan diagram

Source: Guide to Tianjin Port

① Tidal bit eigenvalues (Tianjin Port theory to the lowest tide)

Highest climax 5.81m (September 1, 1992)

The lowest low tide -1.03m (November 10, 1968)

The average high tide is 3.74m

The average low tide is 1.34m

The average tidal range is 2.40 m

Average sea surface is 2.56m

② Design water level

Design high water level 4.30m

Design low water level 0.50m

Extreme high water level 5.88m

Extremely low water level -1.29m

③ Level of tide while taking the tide see Table 2.2.

Table 2.2 Tide level of the whole year

Delay frequency	70%	75%	80%	85%	90%
Taking tide for one hour(m)	3.49	3.43	3.36	3.26	3.14
Taking tide for two hour(m)	3.39	3.32	3.26	3.16	3.04
Taking tide for three hour(m)	3.24	3.18	3.12	3.01	2.89
Taking tide for four hour(m)	3.05	3.00	2.93	2.82	2.71

Source: Tide table of Tianjin port

2.2.3 Impact of traffic environment on the safety of towing

The self-propelled drilling platform trains through the tugs to the anchorage or from the anchorage to the berth. During the towing process, the navigational aisle and the internal navigation environment are complex, so the traffic environment and traffic density have the obvious impact on the towing drilling platform. There are more vessels in the harbor area, and the water depth and channel width are limited. The towing operation needs to focus on the traffic environment in the waters. Real-time understanding of the traffic flow in the harbor has a positive effect on the towing operation of the drilling platform, as is shown in Figure 2.5, for the Tianjin port traffic flow diagram. It can be seen from Figure 2.5 that there is a large flow of ships near the main channel of Tianjin Port, with a daily ship flow of 104.4 ships on average, excluding ships without AIS. It can be seen that the traffic environment in the port area is very complicated.

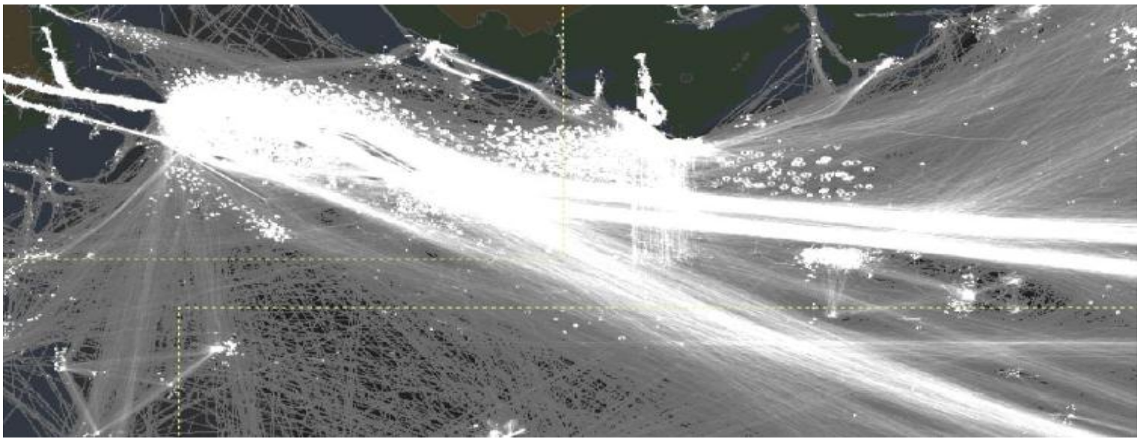

Figure 2.5 Traffic flow in Tianjin Port

Source: Compiled by author, 2017

2.2.4 The influence of human factors on the safety of towing

It is difficult to control the characteristics of drilling platforms with a large volume, no self-propulsion. In the high-risk operation of the towing drilling platform, there is a slight risk of collision, stranding, sinking and so on. According to the survey data, the normal cargo ship accidents are mostly due to human factors caused by the shipwreck. Human factors mainly include the professional quality of the crew and the psychological quality of the emergency, the situational awareness of the operation, the health status of the operation and the management level of the managers. These factors lead to the problem of any link to huge property damage and casualties. Besides, the platform towing system for navigation safety plays an indispensable role as well. Towing drilling platform is a very difficult task, which requires the need for various departments, the staff on duty to help each other complete, on the basis of a very skilled tacit understanding by the unified command operations by the managers to improve the safety of the platform drag and navigation efficiency.

CHAPTER 3

Study on Towing Plan of Drilling Platform

3.1 Towing method

Due to the large size, no self-propensity, difficult to control and other characteristics of the drag process, the towing system is susceptible to external factors, such as wind, waves, streams and other environmental factors. Besides, due to the crew of human factors, there will be deviations from the route, collision or stranding and other hazards. If you choose the right drag horsepower and towing way, it can effectively reduce the possibility of these emergencies.

3.1.1 Single tug towing mode

As is shown in Figure 3.1, for a single tug towing diagram, the single tug towing method connects the towing tail towing connection point to the trailing point on both sides of the front section of the drilling platform. There are two kinds of cables with a single tug, which is close to the tug as a main cable, two for the drilling platform for the dragon cable, P point is the main cable and the dragon cable connection point, the connection point fixed.

The single tug towing mode avoids the conflict between the tugs and, to a certain extent, inhibits the drift of the drilling platform during the towing process. In the drilling platform, by the impact of the larger external factors, the two dragons' cable forces are uneven. According to the direction of the wind and waves together, one cable is able to withstand greater force, and the other cable is to withstand the smaller influence of wind and waves to reduce the rolling angle and the amplitude of the swing.

However, for sudden danger, single tug towing lacks flexibility, which makes it difficult to control the drilling platform. In addition, under heavy waves situation, two cables have uneven forces, it is easy to cause breakage of cables and the platform will be out of control.

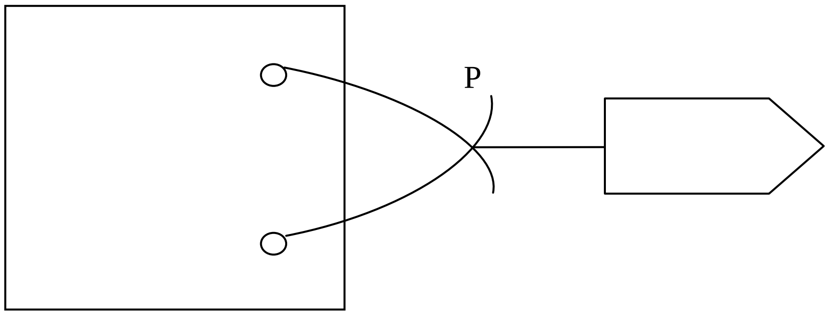

Figure 2.1 single tug towing

Source: Compiled by author, 2017

3.1.2 Double tug parallel towing mode

As is shown in Figure 3.2, there are two tugs parallel in towing, with two main cables. The two main cables are connected parallel to each other on the side of the drilling platform. The tension of the two tugs acts directly on the drilling platform (Zhan HD et al, 2008, pp.424-427).

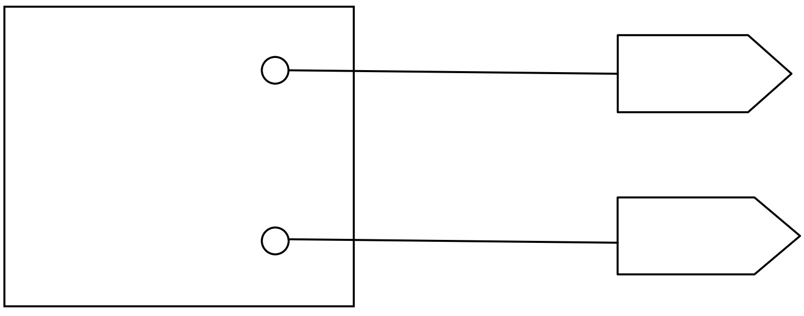

Figure 3.2 Double tugs towing by parallel lines

Source: Compiled by author, 2017

The double tug towing is more flexible in the process of towing. If the drilling platform is subject to external force or other emergencies during the towing process, the two tugs can simultaneously control the drilling platform separately and modify the heading and position of the drilling platform. In addition, compared with the single tug towing, double tug towing can more easily steer the operation. In the process of towing, you can control the size of the two tugs drag and direction and the length of the cable to ensure safe towing operations. However, the double tug towing mode requires the two tugs with high precision coordination and coordination under the drag operation, and the need for a unified manager of the command, human factors in the towing on the drag flight safety factors are relatively large, and the crew and managers of the professional quality, situational awareness is extremely high.

3.1.3 Double tugs panting way

As is shown in Figure 3.3, the two tugs are trailed by two other tugs, which are located on the lateral sides of the drilling platform, each tug with the first cable, horizontal cable and cable three cable and drilling platform fixed connection towing operations [twenty one]. Compared with the parallel towing method of double tugs, the double tugboat trailing method occupies less water in the towing operation and is suitable for restricted waters or narrow waterways. Compared with the single tug towing method, it can not only occupy the smaller waters, but also be more flexible, which means it can respond quickly. However, this drag and drop mode also has shortcomings. When the towing system by external factors interfere with the larger and sometimes turbulence, the trenches and drilling platform between the lateral force increases, which is likely to cause broken cable or tug power system paralysis, leading to the entire drilling platform’s out of control, or the occurrence of a series of collision or stranded dangerous shipwreck. In addition, in the steering, the two tugs in the towing system are contrary to each other: one side being the drag state, the other side the pushed state. For two tugs, not only need tacit cooperation, but also towing force and state have to make some adjustments according to the circumstance, otherwise, it is likely to cause the breakage of the cable.

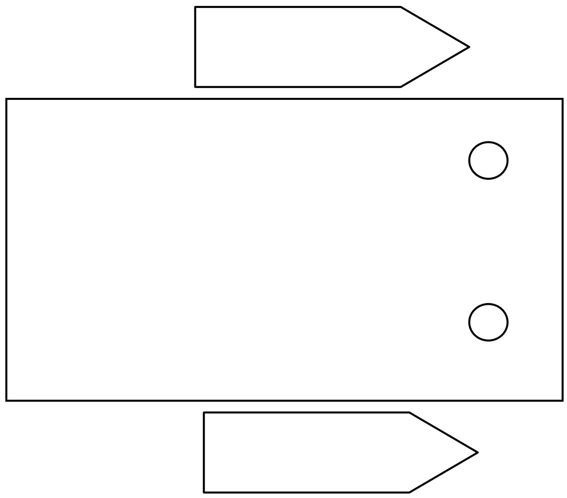

Figure 3.3 Double tugs alongside towing

Source: Compiled by author, 2017

3.1.4 Towing and pushing the hybrid towing

Towing the top of the push drag trailer with a tug towing, two tugs push the way of operation (Han Feng, 2011).

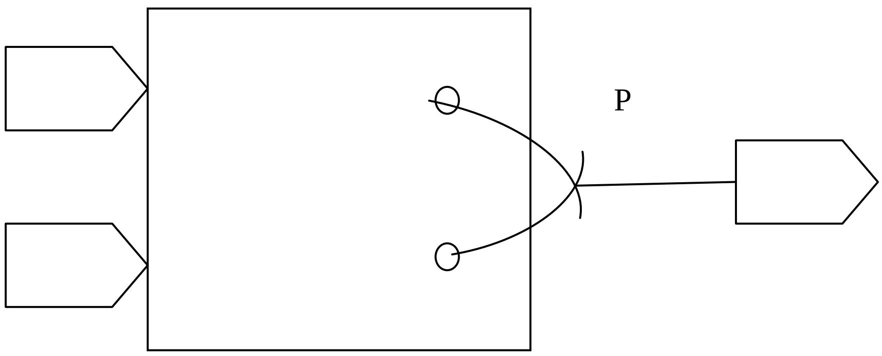

Figure3.3 Towing and pushing mixed method

Source: Compiled by author, 2017

As is shown in Figure 3.4, the tugs in the front of the drilling platform operate in a manner similar to the single tugboat operation. The two towers are connected to the drilling platform. The tug passes the main cable to the two towers. The fixed point “P” is the connection point of main cable and the dragon cable; the drilling platform is behind the two tugs to push the operation. This type of towing is currently the most widely used one, with almost all of the advantages of towing and pushing the two towing operations, which can not only increase the drag force and drag the flexibility of the operation, but also effectively inhibit the tow process In the system of yaw and turbulence phenomenon, this dragging method also incorporates the advantages of panting, in the restricted waters, making it easier to operate, and also easier to drag the corners of the operation or turn.

3.2 Tackling Method of Drilling Platform Based on VTS NAS

3.2.1 VTS NAS

Aids service is a service that helps a ship to make a voyage decision and monitor its effect, especially in cases where the voyage environment is poor, in visibility, or has difficulty in navigating the ship, which is usually at the request of the ship or when VTS is deemed necessary when provided (Zheng XH, 2015).

(1) the form of navigational services

There are two forms of navigational services: the first is the request by the ship to provide services; the second is the VTS Center according to the maritime traffic situation, which is necessary to provide active services.

(2) the need to provide navigational services to the drilling platform

① Drilling platform’s towing environment is harsh. When the drilling platform is towed into and out of the port, the navigation conditions of the harbor channel are bad, such as the limited width of the channel, the diversion of the traffic flow, the confluence of the ship, the large density of the ship and the large curvature of the channel. Taking Tianjin Port as an example, the main channel width and depth of Tianjin Port are limited, and the channel mark is imperfect. The "Y" shape navigation route is complicated, since the tidal range is relatively large, with too many ships, plus the boat on both sides of the main channel, which brings some difficulties to the towing operation of the large drilling platform In this case, the VTS Center will monitor the dynamics of the towing system in real time and, in the event of an emergency, assist in the service of the towing system.

② The hydrological weather conditions of the towed waters are bad. Hydrometeorological conditions mainly refer to the wind, flow, waves and visibility. Either a big storm, inrush or due to rain, snow, or fog caused by poor visibility, will seriously affect the drilling platform of the towing safety. From the Tianjin port investigation, the waters of Tianjin Harbor waters in the autumn and winter exchange time in general, the annual 10-12 months for the fog, fog the visibility in a foggy weather is only 0.5n mile below, which directly affects the towing drilling platform. At this point, VTS should respond timely for the trawling system to provide navigation services.

③ The main equipment of the drilling platform or the towing system has failed or damaged. In accordance with the International SOLAS Convention, any ship, including a drilling platform and a tugboat, is required to be equipped with a variety of instruments in accordance with the provisions of the Convention in order to ensure the safety of the ship's navigation. For the drilling platform, the main equipment includes: compass, radar, electronic chart, ship automatic identification system (Automatic Identification System, referred to as AIS) and other positioning and display equipment; rudder, host, auxiliary equipment and other power equipment. If the visibility is poor, and the radar fails at this time, the towing system should take the initiative to request the VTS Center to provide navigation services.

④ Towing system in a tight or dangerous situation. Port waters or waterways more vessels, easy and drilling platform towing system dangerous or emergency situation. When the drilling platform has the risk of collision, grounding, the VTS center must provide a collision avoidance measure to assist the safe towing of drilling platform and ensure the effectiveness of the real-time monitoring measures until the drilling platform completes the towing operation.

(3) Method of assisting

① Relationship between VTS and drilling platform. IMO interprets the term VTS in the VTS Guide (Li HX, 2012). It can be seen that it is imperative that the VTS Center's ship traffic management and services are provided and that the information services and assistance services provided are of a recommendation or guidance, and the ship may voluntarily adopt or give up on the request of the master and the particulars of the ship. In the course of the towing of the drilling platform, VTS provides navigational services which should not be in conflict with the command of the master and should not violate the master's responsibility for safe navigation.

② Method. VTS should provide navigational services for the drilling platform on the basis of the relationship above. Here are a few typical navigational aids:

a. Provide speed, heading correction services when found the drilling platform out of route, and as well as the drilling platform location;

b. When the drilling platform passes through limited waters such as narrow waterways, lathe and latitude information may be provided to the towing system relative to the channel axis or to a reference point;

c. In the case of a ship with a high bulk density or a complex environment of the navigation environment, the relative position of the other waterborne navigation objects may be provided to the drilling platform to determine the situation;

d. If necessary, carry out real-time supervision of the entire towing system and provide navigation services at any time. When it is in danger, warn the drilling platform in a timely manner;

e. When the drilling platform towed by the system is illegal in operation, it should be prevented, in order to ensure the safety of the platform and other ships' safety of navigation.

(4) The end of navigation services

Between VTS and the drilling platform towing system, the start and end of the navigational service should be clearly stated, and both parties will inform each other. The passive service provided by the drilling platform should be selected by the towing system to complete the opportunity, after the two sides can confirm the end of the assistance service; VTS provides the active service by the VTS center according to the specific situation of the decision to terminate the helpless service time, and with the trailer system, it can be confirmed after the end of navigation services.

3.2.2 VTS NAS Towing System and its Application

Drilling platform of the drag operation is a multi-unit cooperation in a systematic project, and has difficulties with high-risk characteristics. VTS NAS combine electronic chart system and ship's positioning system. It can real-time monitor the drilling platform's towing state, location, towing speed, heading and other dynamic data, and real-time displaying in ECDIS and radar. At the same time will be integrated after the drilling platform static, dynamic parameters exchange to the VTS center (ZHENG J et al, 2011, pp.121-126). The VTS Center will provide navigational services for the towline commanders and supervise the actual navigation of the platform and tugs by intuition the monitoring system through electronic charting and dispatch, in order to ensure the safe operation of towing.

(1) VTS NAS towing system

VTS NAS towing system is mainly composed of drilling platform supervision subsystem, data communication subsystem and VTS center monitoring system (Peng JIANG et al, 2011).

① drilling platform monitoring subsystem

Drilling platform monitoring subsystem mainly consists of the radar, AIS, electronic chart display system and other equipment. It is used mainly for completing the drilling platform drag static data and dynamic data collection, processing and electronic chart positioning and other functions.

② Subsystem for data communication

The subsystem for data communication is mainly responsible for the automatic sorting of communication and exchange of information between ship-ship and ship-shore (Duan Xin et al, 2010, pp.183-190). At present, ship communications have entered into the satellite age and digital age. In the drilling platform, the data communication subsystem mainly refers to AIS, radar and Beidou satellite communication system. The navigation service system is similar to the front, back and side of the coin, and the data communication subsystem is equivalent to the side of the coin, as a bridge between the drilling platform monitoring subsystem and the VTS center, responsible for the integration of data and exchange of information.

③ VTS center

VTS center is mainly composed of radar monitoring system, communication system, computer system and electronic chart display system and other equipment (Gao Lin, 2016, p.298). VTS Center’s real-time access to drilling platforms, tugs and other towing static information and dynamic information is in the configuration of the electronic chart of the computer or large screen display. After analysis and processing, the navigation service information is sent to the drilling platform and tugs.

(2) The main function of the system

As is shown in Figure 3.5, it displays the drilling platform towing system structure and function in chart.

① electronic chart: Electronic chart has the real-time tracking function and drag data visual display function, which is an important part of the system. It can support the standard S-100 data format chart, and carry out any operation on the chart, including hierarchical display, route design, mode settings of display, chart symbol query and other functions. You can display the dynamic information and the location of the drilling platform in real time.

② GPS information collection: GPS information collection, includes the drilling platform towing static and dynamic information collection, real-time access to the trailer system latitude and longitude, to the ground heading, speed, and meeting situation with other vessel and other information.

③ target positioning: VTS Center and the drilling platform and the tugboat will meet the location of the ship tracking, real-time access to both latitude and longitude and speed, as well as heading and other relevant state information.

④ platform, ship tracking: Navigation system can be in the VTS center electronic chart on the real-time tracking drag process. Qualitative navigation tracking of locked single targets or multi-targets includes drilling platforms, tugs and meeting ships.

⑤ platform and ship monitoring: Drilling platform towing system has a more optimized monitoring and scheduling functions, which can be used for towing the system monitoring and towing scheduling.

⑥ data interaction between platform and dispatch center: This interaction is not only from the drilling platform’s towing system collected by the navigation data sent through the AIS to the VTS center, but also from the towing system ship near the ship's navigation information which was sent to the towing system.

⑦ towing alarm: After providing assistance to the towing system, monitor its execution effect. If there is deviation from the route or any data interruption or other emergencies, the system will send sound or light alarm information. VTS center staff is to correct the problem in a timely manner.

⑧ track playback: VTS center can see any ship and drilling platform or tug of the history of navigation information, and thus show drilling platform through the ECDIS.

⑨ electronic display large screen: Drilling platform towing system can receive any ship or drilling platform’s AIS data, including static information, dynamic information and trailing voyage information; such information displayed on the electronic display screen, is the VTS center scheduling and monitoring integrated system which is to improve the efficiency of towing.

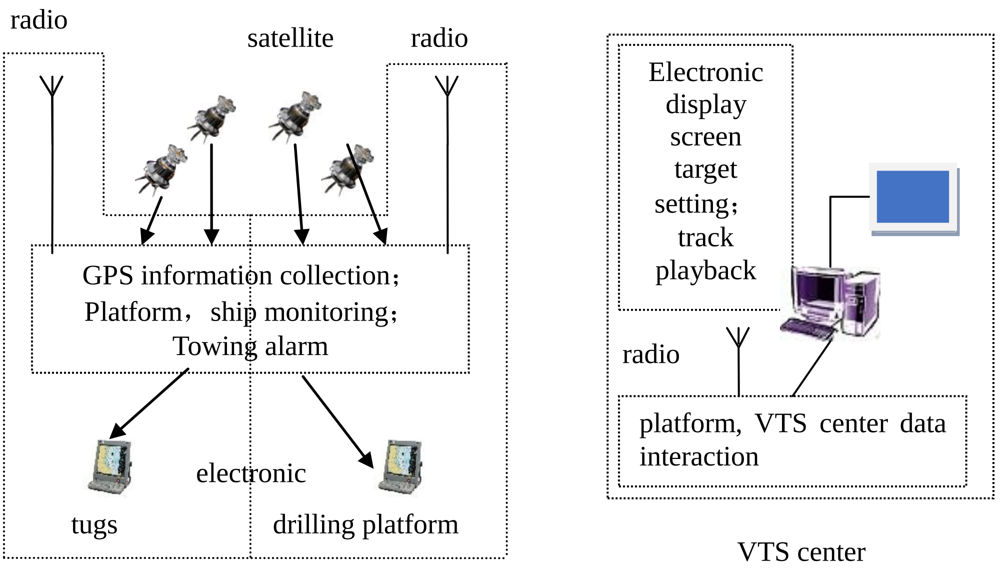

Figure3.4 Structure and Function of towing drilling platform

Source: Compiled by author, 2017

CHAPTER 4

Modeling and Simulation of VTS NAS on Towing of Drilling Platform

This chapter constructs the simulation program design of the drilling platform based on the VTS service, and analyzes and summarizes the demand and structure of the VTS service by user demand. Based on the principle of on-demand service, it is proposed by the drilling platform to tow the process of entering and leaving the port service mode of service. Based on the functional requirements and structural analysis of the navigation service and the research of the S-100 standard, the standard navigation service data model and database are established to provide the logical basis for the follow-up modeling and simulation.

4.1 Analysis of the demand for NAS

The VTS Center is responsible for the management, use and maintenance of the vessel traffic management system. The system consists of radar, meteorological, AIS (Automatic Identification System), CCTV (Closed Circuit Television), VHF (Very High Frequency), MIS (Management Information System) and other subsystems. VTS mainly uses VHF and AIS to achieve the drilling platform of navigation services, real-time monitoring of the dynamics of the towing system (Fukuto J et al, 2005, pp.843-865).

Based on the analysis of IMO's qualitative description of navigation services, as well as the IMO research on e-navigation requirements and VTS user guide (IMO A857(20)), this paper combines NASMSP, service needs analysis (Yang GL, 2007, pp.10-11; Zhao SL, 2008, pp.9-11; Wong D, 2010, pp.50-51; Miyake R et al, 2013, pp.97-102), navigation experience and so on, further refine, analyze and summarize the navigation services provided by VTS, and get the information needed by the user, such as hydrological and meteorological information, radar tracking information, pilotage information, search and rescue information, anchorage information, berth information, channel information, navigation mark information, port basic information, ship identity information, towing system dynamic information, Ship peak flow information, ship entry and exit records, ship violation records a total of 13 kinds of information (Li SB, 2015, pp.20-26; Peng GJ et al, 2012, pp.66-70). 13 kinds of information have their own attributes, including the specific content as follows:

(1) Hydrometeorological information includes 13 items, including information release time, temperature, water temperature, relative humidity, wind direction, wind speed, flow direction and velocity, height of tide, visibility, precipitation, meteorological type, weather memo.

(2) Radar tracking information consists of five items, specifically the image number, orientation, distance, heading, and speed;

(3) The pilot information consists of seven items, specifically the pilot ID, name, grade, telephone, location longitude, location latitude, and the estimated arrival time;

(4) Search and rescue information includes a total of 10 items, specifically for the sea mobile identification code, ship name, call sign, distress time, longitude and latitude of location, sea conditions remark, dangerous notes, state notes, and required assistance;

(5) The anchorage information consists of six items, specifically the anchorage ID, the maximum of the latitude, the minimum of the longitude, the minimum of the latitude and the water depth.

(6) The channel information includes 13 items, namely the channel ID, the starting point and the end point of the center longitude, the end of the center latitude, channel length, channel width, (center longitude, channel water depth, starting point latitude, recommended into the course, recommended heading, recommended heading off course maximum speed, starting point remarks, and channel classification remarks;

(7) Berth information includes 10 items, namely the berth ID, center longitude, center latitude, berth length, berth width, berth depth, allow maximum tonnage, terminal type, terminal company, and heading of mooring;

(8) There are nine items of navigation information, specifically for the number, type, longitude, latitude, light quality, lamp height, range, structure, change notes (Sun F

et al, 2009, pp.54-57);

(9) Port basic information includes a total of 10 items, namely the port ID, country, center longitude, center latitude, contacts, fixed telephone, fax, address, mailbox, and port notes;

(10) There are seven pieces of information on the ship's identity, specifically the maritime mobile communication identifier, vessel name, call sign, IMO number, ship type, flag state, and port of registry;

(11) The dynamic information of the towing system includes 15 items, including the sea mobile communication identification code, UTC time, longitude, latitude, ground heading, ground speed, ship heading, rotation rate (ROT), first Inclination, roll, pitch, poor draft, destination, intention, and sailing status

(12) The peak information of the ship includes 7 items, which are the number, the expected dredging time, the longest value of the longitude, the minimum of the longitude, the maximum of the latitude, the minimum of the latitude and note.

(13) The ship's entry and exit records contain 7 items, including the sea mobile communication identification code, the Universal Time Coordinated (UTC), the entry/departure, the estimated arrival time, the dangerous goods, the port of departure, the port of destination.

Based on the drilling platform, the process of navigating and entering the port is divided into stages, and the service is carried out on the towing system. The main significance is as follows:

(1) There are differences in the navigational status of the drilling platform at different stages of entry and exit, and there is also a difference in the required navigation services. According to the purpose of the drilling platform in and out of the port, it is necessary to judge the necessary navigational services so as to provide real-time and efficient service for the platform.

(2) According to the process of drilling platform into and out the port to divide service, which is exemplification of the VTS active service and intelligent service function. This method can avoid information overload, and provide the currently available navigational service and key information for the platform in order to better assist the towing system for navigation decisions. And also can reduce the processing of

unnecessary information to improve the efficiency of navigation.

4.2 Modeling and Database Implementation of Sailing Service Based on S - 100

Based on the advantages and prospects of the S-100 standard, IMO has been studied and demonstrated to use the S-100 standard as the CMDS of the e-navigation system (Bergmann M, 2013, pp. 371-374). The General Feature Model (GFM) is an essential part of the S-100 feature catalog and product specification (Dou HX, 2013). The GFM of the S-100 which plays the role of a generic model (Ministry of Transport Maritime Affairs, 2011; IHO, 2015) is the basis for the establishment of the NAS element catalog.

The main elements of GFM in S-100 are named types, element types, feature types, attribute types, simple attribute types, and attribute binding types. Elements and feature attributes are associated indirectly through the attribute binding. The main associations used in this paper are generalization and aggregation.

4.3 Establish a navigational service data model

The S-100 feature catalogue is a directory containing definitions and descriptions of feature types, feature attributes, feature associations, and executable element operations for one or more sets of geographic data (International Hydrographic Organization, 2010; International Standard Organization. ISO19101, 2002; IHO Publication S-57,Edition 3.1, 2000). The operation of the elements is described by the interoperability model. The model built in this paper is the data transmission model. The S-100 is the standard of the data transmission model. The operation part is not supported. Therefore, this paper does not include the operation of the feature type. The element catalog is an integral part of the S-100 standard, which describes the content of S-100-based data products.

Based on the previous description of the generic feature type model, this section will establish a navigation service feature type model. Based on user needs, this paper divides the service elements of VTS into VTS basic information, port resource information and ship information. Among them, the first part of the VTS's basic information derived from the VTS identity information, hydrometeorological information, navigation notice, radar tracking information, pilot information, as well as search and rescue information, which altogether forms a total of six sub-types. The types of element structure are shown in Table 4.1below.

Table 4.1 NAS_FC_ Feature Type Part1

Role Name	Name	Description	Remarks
class	NAS_FC_ Feature Type		Derived from NAS_FC
Attributes	Name	VTS basic information	String
Attributes	Definition	VTS related to the basic information	String
Attributes	Code	Identifier=St1	String
Attributes	isAbstract	No	Boolean type
Attributes	Feature Use Type	Aggregate elements	multiple feature type combinations of feature types
Role	VTS Identity Information	Subtype	Identifier=St1.1
Role	Sailing Notice Information	Subtype	Identifier=St1.2
Role	Hydrometeorology Information	Subtype	Identifier=St1.3
Role	Radar Tracking Information	Subtype	Identifier=St1.4
Role	Pilot Information	Subtype	Identifier=St1.5
Role	SAR Information	Subtype	Identifier=St1.6

Source: Compiled by author, 2017

The second part of the NAS_ FC_ element type is the port resource information class. The port resource information class is the information related to the port resources provided by the VTS, and derives from the anchor information, the channel information, the berth information, the navigation sign information, the port basic information, with a total of 5 sub types of NAS_ FC_ Element type. The structure of the second part is shown in Table 4.2.

Table 4.2 NAS_FC_ Feature Type Part2

Role Name	Name	Description	Remarks
Class	NAS_FC_ Feature Type		derived from NAS_FC
Attributes	Name	Ship information	String
Attributes	Definition	ship-related information provided by VTS	String
Attributes	Code	Identifier=St2	String
Attributes	isAbstract	No	Boolean type
Attributes	Feature Use Type	Aggregate elements	multiple feature type combinations of feature types
Role	Port Basic Information	Subtype	Identifier=St2.1
Role	Anchorage Information	Subtype	Identifier=St2.2
Role	Channel Information	Subtype	Identifier=St2.3
Role	Berth Information	Subtype	Identifier=St2.4
Role	Aids to Navigation Information	Subtype	Identifier=St2.5

Source: Compiled by author, 2017

The third part of NAS_ FC_ Element type is the ship information, the which is provided by VTS, deriving from the ship identity information, ship construction information, drilling platform dynamic information, ship peak flow information, ship entry and exit records, violation record information in a total of 6 types. The structure of NAS_ FC_ feature type is shown in Table 4.3.

Table4.3 NAS_FC_ Feature Type Part3

Role Name	Name	Description	Remarks
Class	NAS_FC_ Feature Type		derived from NAS_FC

Attributes	Name	Ship information	String
Attributes	Definition	information provided by VTS	String
Attributes	Code	Identifier=St3	String
Attributes	isAbstract	No	feature types
Attributes	Feature Use Type	Aggregate elements	multiple feature type combinations of feature types
Role	Ship Identity Information	Subtype	Identifier=St3.1
Role	Ship Built Information	Subtype	Identifier=St3.2
Role	Ship Dynamic Information	Subtype	Identifier=St3.3
Role	Entering And Leaving Port Report Information	Subtype	Identifier=St3.4
Role	Ship Illegal Report Information	Subtype	Identifier=St3.5
Role	Ship Peak Flow Information	Subtype	Identifier=St3.6

Source: Compiled by author, 2017

This article uses UML to model the NAS feature catalog and build the UML model diagram for the first part of the NAS_ FC_ feature type, as is shown in Figure 4.1. The model diagram contains the VTS basic information class and its six sub-element type VTS identity information, which includes hydrometeorological information, navigation notice, radar tracking information, pilot information, search and rescue information modeling.

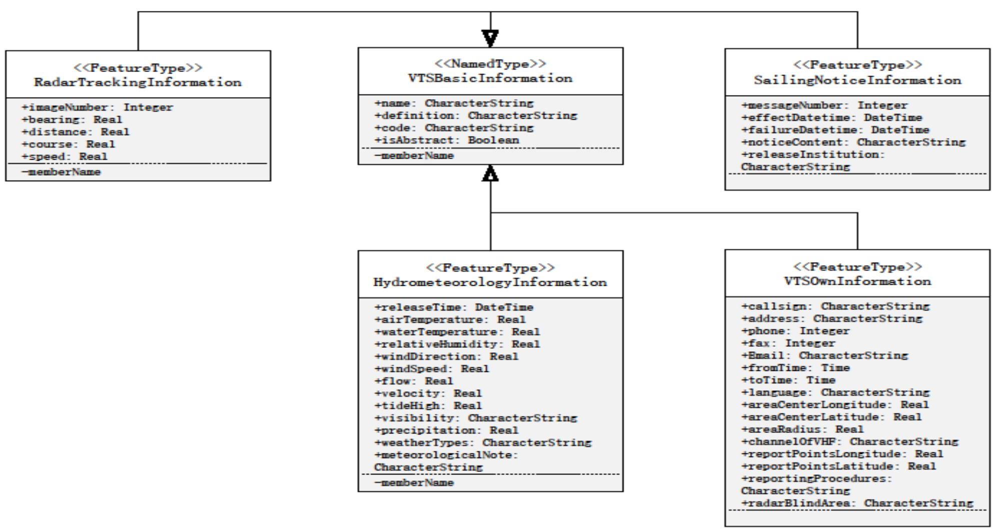

Figure 4.1 UML model figure of NAS_FC_ Feature Type part 1

Source: Compiled by author, 2017

The second part of NAS_ FC_ Element type is the feature type modeling method and channel information modeling method is the same. Figure 4.2 is the UML model diagram for the second part of the NAS_ FC_ feature type.

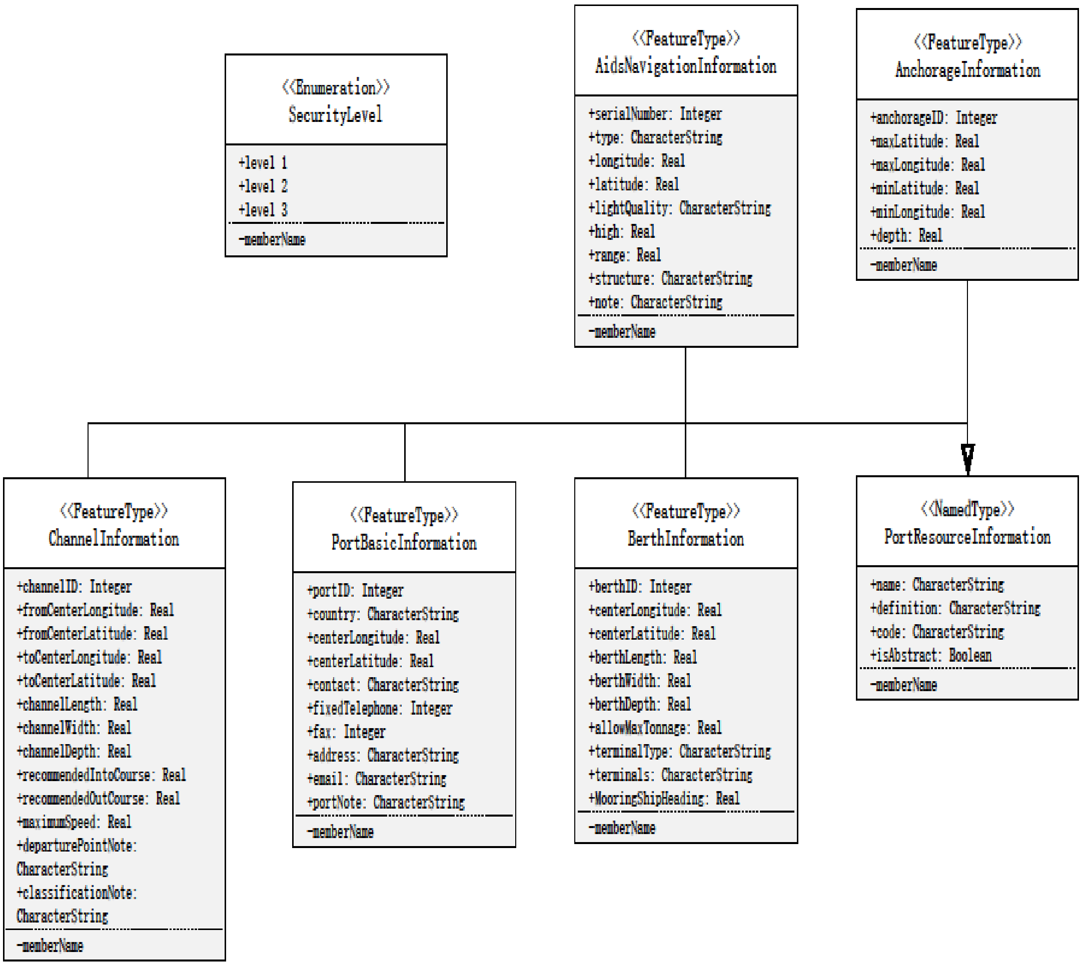

Figure 4.2 UML model figure of NAS _FC_ Feature Type part 2

Source: Compiled by author, 2017

In NAS_ FC_ Element Type Part 3, the modeling method for other feature types is the same as that for ship peak flow information. Figure 4.3 is the UML model diagram for the third part of the NAS_ FC_ feature type.

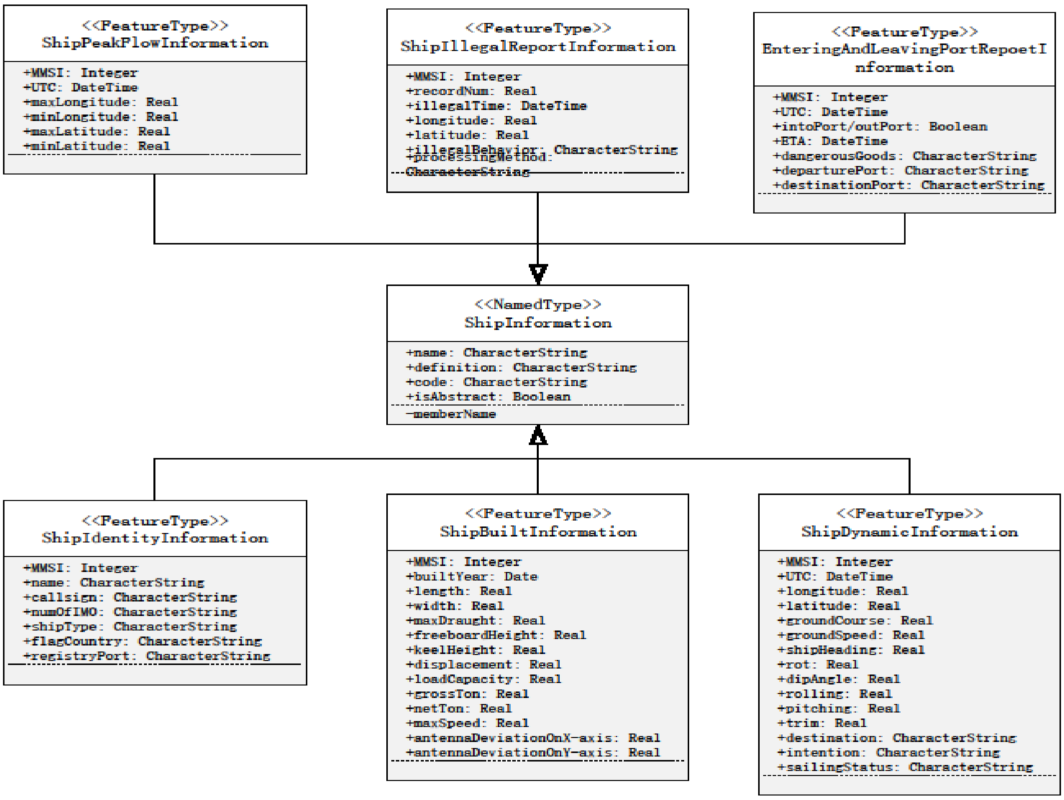

Figure 4.3 UML model figure of NAS _FC_ Feature Type part 3

Source: Compiled by author, 2017

Based on the research above, this paper uses UML to establish NAS data model.

4.4 NAS data model verification and NAS model simulation

Based on the NAS data model, this paper designs a service automatic push algorithm based on the position relation between the drilling platform and the service time. The simulation experiment of automatic push service is realized on the electronic chart by VC ++ programming.

As the drilling platform of the towing operation is from the anchor to the berth or the other way around, in the process, the service time for the trigger area, can be used to automatically push the line area’s navigation services.

This paper takes the north of Tianjin harbor warning area as an example to illustrate the warning route and the service time trigger line of the warning area which is also known as the line segment. The algorithm principle is the same as the algorithm of the north report line of the warning area. The service mechanism of the line area automatic push service is to determine whether the ship is crossing the area by determining whether the distance from the ship's point C to the line AB is less than △ (whose value is obtained from the simulation experiment). The geometric model of the line segment triggers is shown in Figure 4.4.

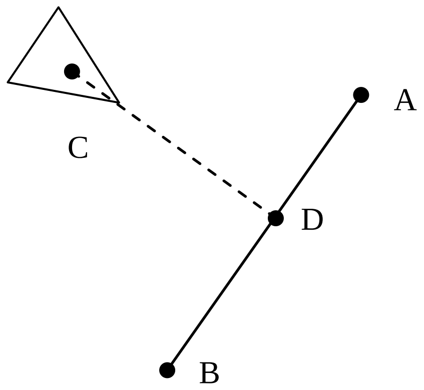

Figure 4.4 Geometric model of segment trigger line

Source: Compiled by author, 2017

In this figure point $A(\varphi_A, \lambda_A)$ and point $B(\varphi_B, \lambda_B)$ are the two endpoints of the warning area north of the warning area, the point is the current position of the ship, the length d of the CD is the plane distance from point C to line AB. The algorithm is as follows:

① Respectively, A, B, C three points of the geographical coordinates into plane coordinates(X_A, Y_A)、(X_B, X_B), and(X, Y), and in accordance with the coordinates of A, B two points line AB is drawn.

② Calculate the distance from point C to line AB, as is shown in 4.1.

$$d = \frac{(x - x_A)(y_B - y_A) - (x_B - x_A)(y - y_A)}{\sqrt{(x_B - x_A)^2 + (y_B - y_A)^2}} \tag{4.1}$$

③ Ordering d <4, this experiment obtained △ = 0.00004 to meet the conditions.

Based on the simulation experiment of the algorithm above, the navigational aids to navigation services provided by the drilling platform are described as an example.

According to the navigation announcement information simulation data shown in Table 4.4, the results of the program running in the electronic chart are shown in Figure 4.5.

Table 4.4 Sailing notice information

Number	Notice content	Effective time	Failure time	Publishing uni
1	At 9o'clock on April 6th,the international voyage cruise ship "Mediterranean lyric" round by cruise ship port Y2 terminal, Please be aware of collision avoidance	6:30 on April 5th	19:00 on April 6th	Tianjin VTS
2	Tianjin Port 39 lights floating fault extinguished, temporarily unable to recover, Please pay attention to navigation environment	7:30 on April 5th	12:30 on April 6th	Tianjin VTS

Source: Compiled by author, 2017

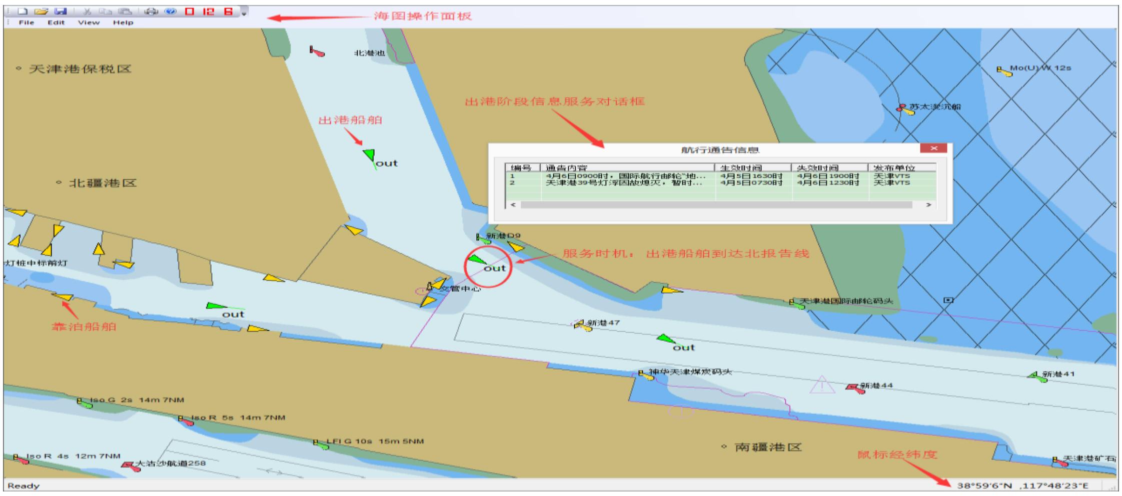

Figure 4.5 Automatic push program of NAS information service for ship leaving the port

Source: Compiled by author, 2017

This paper describes the hydrological and meteorological information of the anchorage provided by the ship anchored stage. The simulation data of the ship anchored phase service is shown in Table 4.5, and the result of the program running is shown in the electronic chart of Figure 4.6.

Table4.5 Hydrometeorology information of anchorage

Anchorage ID	Wind direction	Wind speed	Flow direction	Flow speed	The time of tide	High tide	Visibility	Release time
1	N	15kn	SW	2kn	1850	2m	mist	April 5 at 19:00 hours

Source: Compiled by author, 2017

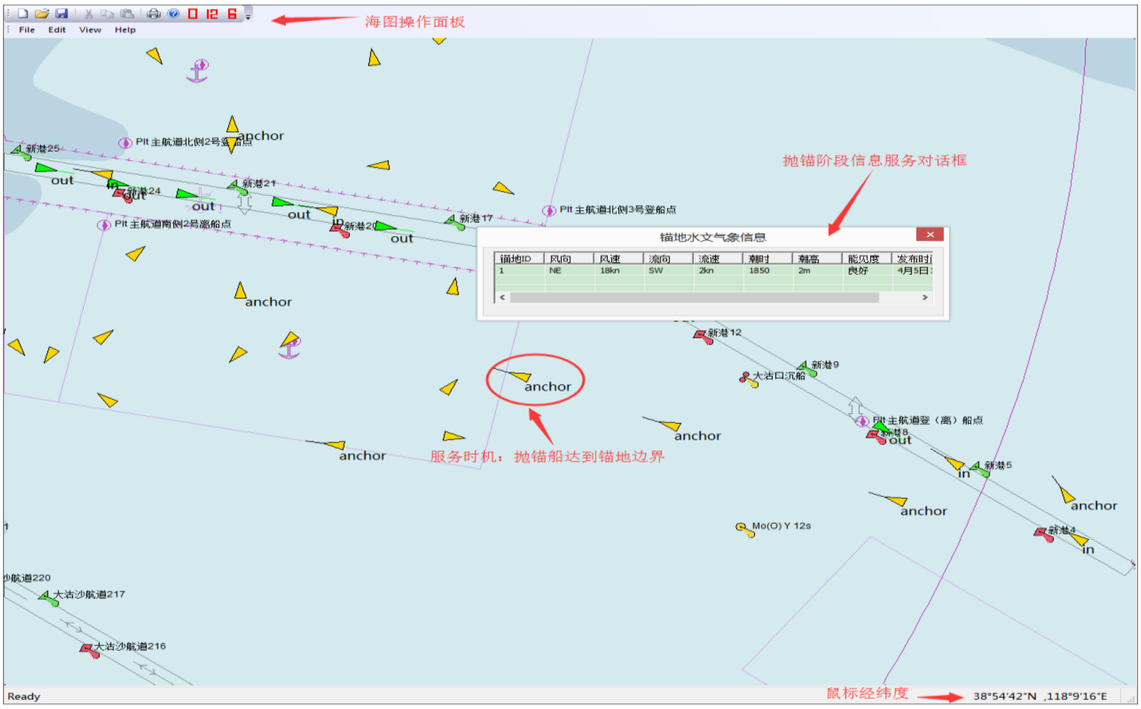

Figure4.5 Automatic push program of NAS service for ship entering the anchorage

Source: Compiled by author, 2017

4.5 Summary of this Chapter

This chapter first introduces the VTS navigation service and the demand analysis of the navigation service in the process of the drilling platform. Secondly, based on the "drilling platform trailing operation demand", taking Tianjin Port as an example, the establishment of S-100 data based on Navigation service data modeling and database function is achieved. Finally, the simulation model of the drilling platform drag method is constructed based on the user's demand, and the information service automatic push algorithm based on the position relationship between the position and the service time is designed. The VC ++ programming in the electronic chart platform is used to achieve the service program simulation verification.

CHAPTER 5

Summaries and Prospects

5.1 Summary

This paper is based on the original drilling platform towing scheme, which puts forward the method for the drilling platform port towage of VTS. Based on the hybrid towing, combined with the VTS navigation services (NAS) features, an analysis of VTS navigation service on towing of drill platform is based on the analysis of S - 100 navigation service database, with the help of the data to construct in accordance with the port traffic actual VTS navigational towing service model. It is also adopted in computer language to simulate the operation of the tow. This article mainly works as follows:

(1) Based on field investigation and research of Tianjin port and Tianjin VTS center, the drilling platform port traffic data is obtained, and discussing with the relevant personnel work on the towing of drill platform, the relevant literature is referred to, the principle of promoting the towage safety and improving the efficiency of towing drilling platform is analyzed to identity the influencing factors of towing security, in preparation for the modular design of the modeling and simulation.

(2) This paper research on the existing method of towing through research and access to relevant literature, including single tug towing method, double parallel towing method, dual tug alongside towing tug and tow pusher hybrid towing. Then the paper analyzes the advantages and disadvantages of this method and the applicable conditions. Finally, the method of towing the port of the drilling platform based on

VTS service is proposed.

(3) Demand analysis was carried out on the navigation service, refined VTS information navigation service, with a total of 13 kinds of information including the hydrometeorological information, radar tracking information, pilot information, search and rescue information, anchorage, berthing information, channel information, basic information, AIDS to navigation information, port, shipping status information, towing system dynamic information, ship’s peak flow information, shipping records, and vessel traffic roads. According to the process of entering and leaving the drilling platform, the data model of the navigation service of S-100 is established.

(4) Towing system was achieved by C++ programming for port towing visualization simulation. In Tianjin, for example, according to the user requirements, the VTS navigation service is established to build the VTS navigation service towing method simulation model, and design the automatic push service algorithm of information service based on the relationship between the position and service timing. Then use VC++ programming on electronic chart platform to realize simulation of service plan.

5.2 Prospect

Although based on the existing towing methods, the author established a port towage simulation model based on VTS navigation service platform, yet because of the author’s limited knowledge on towing as well as the limited technical skills on computer simulation, this established model suffers from many deficiencies, which still needed to be further perfected including but not limited to the following aspects:

(1) More intelligent drilling towing navigation services should be established. In addition to meeting the towing pusher hybrid towing method, other methods of towing the VTS navigation service such as towing methods should also be added to meet the other of different types, dimensions of navigation platform.

(2) In the simulation model, it should not only consider the natural condition, the hydrological and meteorological conditions, the traffic impact on the environment, but also increase the human factors involved to describe the impact of these factors on the towing port.

(3) Detailed information about the various factors of the various factors should be given, in order to make the requirements of the navigation service more comprehensive, and enrich the data model of the navigation service.

(4) Because of the limited amount of data, the discipline of statistics is not precise enough, having certain approximation and simplification. Besides, more data should be involved to establish a more accurate model based on VTS port navigation service towing model.

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