Research on Navigation Methods for Vessels to Enter or Leave Xiushandong Anchorage before or after Receiving Zhoushan Bonded Marine Fuel

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Abstract: At present, the bonded marine fuel supply business in Zhoushan are mainly carried out at the fuel supply anchorages approved by the maritime authorities. Among them, Xiushandong anchorage is located in the mid port area of Zhoushan. It enjoys excellent geographical and strategy conditions and has become the oil supply anchorage with the largest refueling volume in Zhoushan. Xiu Shandong anchorage not only provides fueling services, but also serves as the primary anchorage for ships entering and leaving the mid port area of Zhoushan. The frequent entry and exit of various vessels at the anchorage area has led to a high density of vessel traffic and complex traffic flow around this anchorage. This article aims to, based on the current traffic flow situation in the waters near Xiushandong Anchorage, summarize the navigation methods for ships to safely enter and exit the anchorage, propose the precautions and safety measures for ships to enter and exit the anchorage, and provide technical guidance for ships traveling to and from Zhoushan for refueling with bonded marine fuel.

Keywords: Bonded Marine Fuel Refueling; Xiushandong Anchorage; Receiving Vessel; Navigation Methods

1. Introduction

Since the establishment of the Zhejiang Free Trade Zone, Zhoushan has been striving to build itself into a Northeast Asia bonded marine fuel refueling center for ships and a world-class international maritime service base[1]. In 2023, the scale of oil refueling operations in Zhoushan exceeded 7 million tons for the first time, firmly ranking first in China and fourth globally among oil refueling ports. In 2024, the total amount of fueling for ships in Zhoushan reached 7.26 million tons. Among them, there were 252 occasions where the fueling volume exceeded 3,000 tons for foreign vessels. In 2025, the total amount of bonded marine fuel refueling in Zhoushan reached 8.03 million tons, representing a year-on-year increase of 10.6%[2].After years of efforts, Zhoushan has become the region with the largest volume of ship fueling in Northeast Asia, the strongest price competitiveness, and the supply and service quality on par with international standards. At present, the bonded marine fuel supply business in Zhoushan are mainly carried out at the fuel supply anchorages approved by the maritime authorities, such as Xiushandong anchorage, Tiaozhoumen anchorage, Xiazhimen anchorage, Mazhi anchorage and Qushan temporary anchorage. Among them, the Xiushandong anchorage is located in the mid port area of Zhoushan. It is an internal anchorage and is less affected by factors such as strong winds and heavy fog. The actual number of days available for operation throughout the year is approximately 310 days[3]. However, this anchorage can partially enjoy the "out-of-port anchorage" policy in terms of bonded marine fuel supply. Vessels can enter and exit for refueling without the need for a pilot. The refueling cost is lower and the efficiency is higher. It has now become the oil supply anchorage with the largest refueling volume in Zhoushan.

The existing fairways around Xiushandong Anchorage is shown in Figure 1, mainly include the public fairway outside Ma'ao port area, Guanmen fairway and Guishan fairway[4]. Xiu Shandong anchorage not only provides fueling services, but also serves as the primary anchorage for ships entering and leaving the mid port area of Zhoushan. With the further expansion of the fuel supply business for ships in Zhoushan, the number of ships entering and

leaving Xiushandong Anchorage has been increasing continuously, which has led to an increasingly severe traffic safety situation near the anchorage. Therefore, it is necessary to guide and regulate the traffic order of vessels conducting fueling operations when entering or leaving the anchorage.

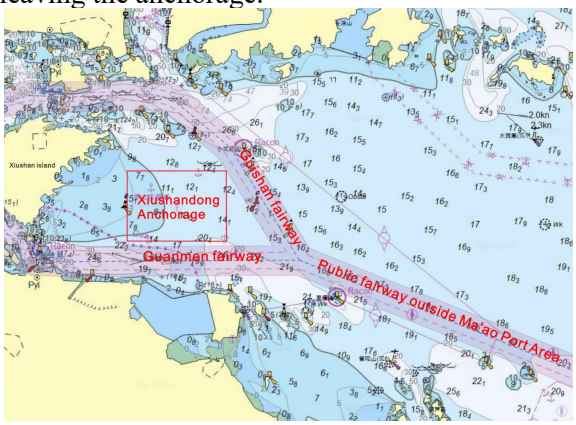

Figure 1. Location of Xiushandong Anchorage

2. Overview of the Fuel Supply Anchorage

Xiushandong anchorage is located in the mid part of Zhoushan Port, and it is an open water area, as shown in Figure 2. The water depth in Xiushandong anchorage is shallower to the west and deeper to the east, and shallower to the north and deeper to the south. The water depth ranges from 6 to 18 meters. The seabed is composed of mud[5]. The anchorage is 6,363 meters long from east to west and 4,342 meters wide from north to south, covering an area of 27.6 square kilometers. The coordinates of the control points in the anchorage are as follows: Point A, 30°10′15″N, 122°13′19″E; Point B, 30°10′15″N, 122°17′18″E; Point C, 30°07′54″N, 122°13′19″E; Point D, 30°07′54″N, 122°17′18″E.

The functions of Xiushandong anchorage include berthing, wind avoidance, joint inspection, supply, oil and wastewater reception, fuel replenishment, and other services. A total of 25 fixed anchor points have been set up (22 automatic verification anchor points, 2 priority anchor points for Bonded Marine Fuel Refueling, and 1 emergency anchorage position). The tidal currents in the anchorage area are reversing current, and the flow direction on the east side of the anchorage is approximately southeast-northwest. Due to Obstruction of Xiushan Island, the water flow in the anchorage area near the Guanmen narrow channel is relatively fast, and the flow direction is approximately east-west. According to the nautical charts, the tidal current speed within Xiushandong anchorage is approximately 3 to 3.5 knots.

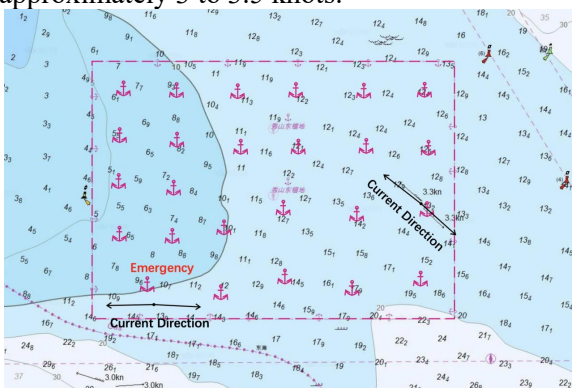

Figure 2. Chart of the Xiu Shandong Anchorage and Fueling Anchor Points

3. Current Situation of Vessel Traffic Flow

Zhejiang Maritime Safety Administration issued the "Announcement on Adjusting the Main Public Navigation Routes in Zhejiang Coastal Areas" on August 30, 2021, which came into effect officially on September 10, 2021[6]. After years of efforts, the main shipping traffic flows in the Zhoushan Archipelago waters have been significantly regulated within the designated routes as announced. The vessel traffic organization and navigation safety at the marine fuel refueling anchorage in Zhoushan are mainly under the jurisdiction of the Vessel Traffic Service Center (VTS) of Zhoushan Maritime Safety Administration[7]. As shown in Figure 3, it is the AIS trajectory of ships near Xiushandong anchorage over a period of three consecutive months.

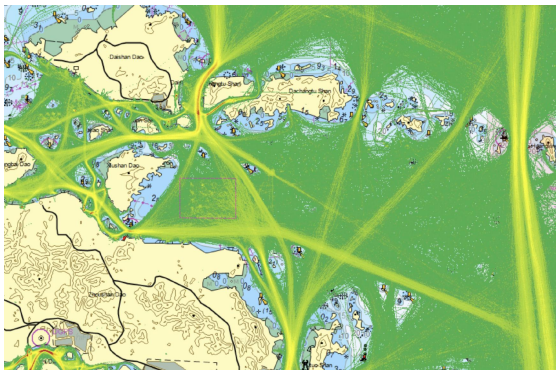

Figure 3. AIS Trajectory of Ships Near Xiushandong Anchorage (October to December in 2024)

According to traffic flow statistics, there are mainly three traffic flows near Xiushandong anchorage (as shown in Figure 4): ① The first flow is the vessel traffic flow entering and exiting Guimen channel through the public fairway outside Ma'ao port area and Guanmen

fairway, and this flow includes a certain number of large vessels and even super-large repair and construction vessels; ② The second flow is the vessel traffic flow entering and exiting Guishan channel through the public channel outside Ma'ao Port and Guishan Channel; ③ the third flow is the small vessel traffic flow traveling back and forth to Shenjiamen between Guishan Channel and east side of Xiushandong anchorage crossing the Guanmen fairway.

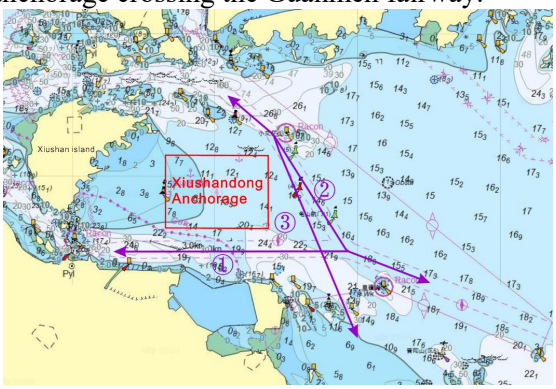

Figure 4. Main Vessel Traffic Flow Near the Xiushandong Anchorage

Figure 5 shows the typical AIS track of a vessel to be refueled to Xiushandong anchoage. Most of the vessels entering or leaving Xiushandong anchorage do so by directly passing through the public fairway outside Ma'ao Port area. However, it should be noted that there are currently two large temporary anchor points for ship repair and construction on the southeast side of Xiushandong anchorage[8]. When there are ships anchoring at the temporary anchor points, one should avoid approaching them. Vessels coming from Guanmen channel or Guishan channel can also enter the anchorage from the south or north side according to the navigation habits.

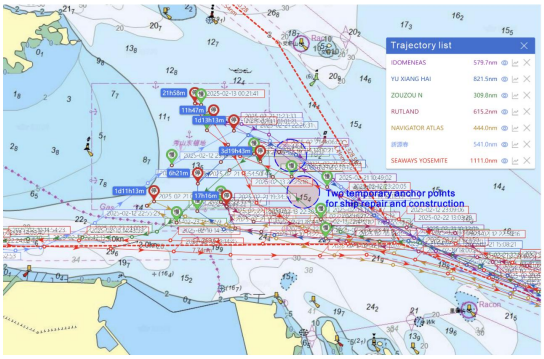

Figure 5. The Typical AIS Track of a Vessels to be Refueled to Xiushandong Anchoage

4. Recommended Navigation Methods and Precautions for Vessels Entering and Leaving the Anchorage Area

4.1 Recommended Navigation Methods for Entering and Exiting Xiushandong Anchorage

Receiving vessels entering and leaving Xiushandong anchorage mainly come from three directions: direction from the public fairway outside Ma'ao port area, direction from Guanmen fairway, and direction from Guishan fairway. When entering or leaving the public fairway outside Ma'ao port area, vessels can proceed directly leaving the fairway into the anchorage or leave the anchorage into the fairway. Vessels entering or leaving the anchorage from Guanmen fairway or Guishan fairway can also turn into or out of the anchorage at an appropriate time when the fairway is clear, considering the current direction, as shown in Figure 6. considering the relatively large number of anchor points available for bonded fuel bunkering in Xiushandong anchorage, the specific route for a vessel to enter or leave the anchorage can be flexibly determined based on the location of the specific bunkering position: if the bunkering position is on the north side of the anchorage, entry can be from the north side; if the bunkering position is on the south side, entry can be from the south side.

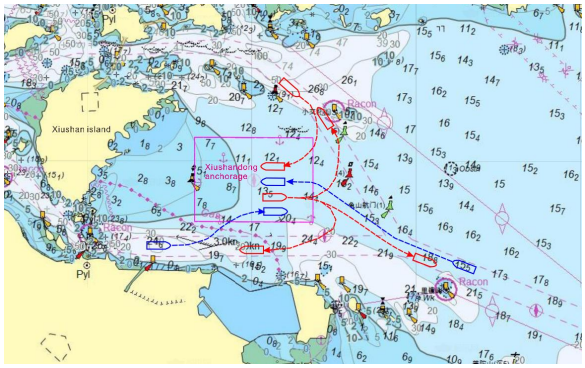

Figure 6. Recommended Navigation Methods for Entering and Leaving Xiushandong Anchorage from Different Directions

At present, there are two temporary anchor points for 300,000 DWT repair and construction vessels on the southeastern side of Xiushandong anchorage. When there are vessels anchor at the temporary anchor points, attention should be paid to avoiding approaching them. It is noteworthy that these two temporary anchor points outside Xiushandong anchorage obviously affect anchor points 9# and 12# in Xiushandong Anchorage. When large repair and

construction ships are anchored at the temporary anchor points, it is advisable to use the following recommended approaching methods to enter anchor points 9# and 12# for anchoring. Figure 7 shows the entry route of ships to anchor piont 9# and 12#.

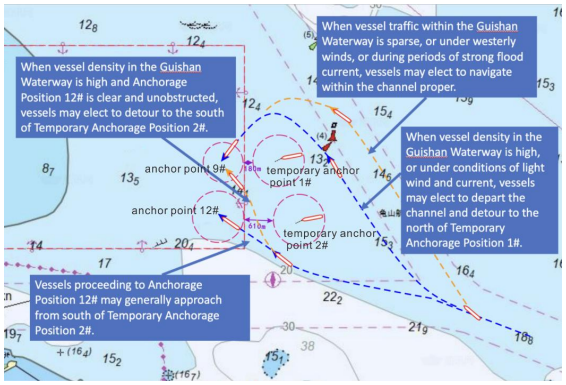

Figure 7. The Entry Route of Ships to Anchor Piont 9# and 12#

1) Vessels entering anchor point 12# can generally approach it from south side of temporary anchor point 2#.

2) Vessels entering anchor point 9# should design an appropriate approach plan based on the traffic flow situation in the waters at the time: When there are many vessels in Guishan fairway, and anchor point 12# is not occupied by any vessel affecting access, a vessel may choose to detour via the south side of temporary anchor point 2#. When anchor point 12# is occupied by an anchored vessel, and there are few vessels in Guishan fairway, or during strong westerly winds or strong flood currents, one may choose to detour after passing buoy No.4 of the Guishan fairway within the waterway. When anchor point 12# is occupied by an anchored vessel, and there are many vessels in the Guishan fairway, or when wind and current influence is minimal, one may choose to leave Guishan fairway and detour between temporary anchor point 1# and buoy No.4 of the Guishan Waterway.

4.2 Precautions for Safety

The obstructions near Xiushandong anchorage mainly include: the mosquito mountain, wild duck reef, baldhead reef, Jiaobeishan island and small Jiaobeishan island near Guishan fairway on the north side of the anchorage, as well as the submerged reef on the east side of Zongzishan near the Guanmen narrow channel on the south-west side. The shallow water area in the west of Xiushandong anchorage has a relatively small water depth, especially the minimum water depth near the western boundary of the anchorage is less than 5 meters. When entering or leaving Xiushandong Anchorage, one should keep away from the shallow water area. In addition, there is an LNG pipeline in the waters southeast of Xiushan Island. Ships should avoid anchoring in the waters near the pipeline. Figure 8 shows the main obstructive objects and special areas to be noted.

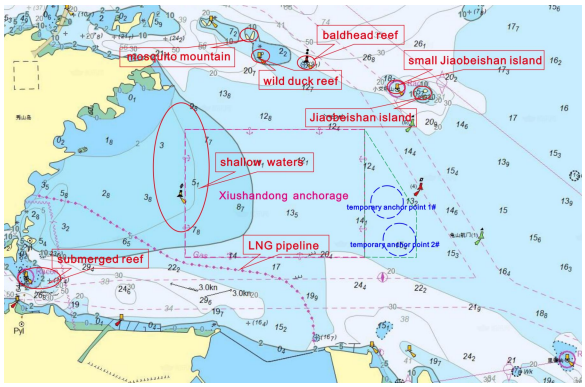

Figure 8. Illustration of the Main Obstructive Objects and Special Areas to be Noted

The prevailing and strong wind directions in Xiu Shandong Anchorage throughout the year are northwesterly winds. The secondary prevailing and secondary strong wind directions are southeasterly winds. When influenced by the southeasterly winds, the waves at the anchorage become quite large. During the major tidal periods, it is necessary to know in advance the tidal control time at Xiushandong anchorage, which can be queried on the vessel traffic organization platform of Zhejiang Maritime Safety Administration. Receiving vessels should avoid entering Xiushandong anchorage to drop anchor during periods of strong flood or ebb currents.

Pay close attention to ship anchoring movement of the two temporary anchor points on the southeast side of the anchorage in advance. The anchoring of large ships under repair or construction may obviously impact the navigation routes of other vessels entering or leaving Xiushandong Anchorage.

When leaving the anchorage, if there are a large number of inbound vessels, one should choose an appropriate time to enter the fairway according to the current speed of the ships, and then follow the general direction of the ships in the fairway. Or, before heaving the anchor, observe the traffic flow in the vicinity, and wait until it is clear.

5. Safety Assurance Suggestions

Xiushandong anchorage is an internal harbor

anchorage, and the surrounding area of the anchorage has relatively better shelter conditions. The wind force for the navigation and anchoring operations of the vessels entering and leaving Xiushandong anchorage should refer to the "Weather Forecast for Zhoushan Port and Shipping": the wind speed should be no more than 20.7m/s (Beaufort Wind Scale 8). When the wind direction is northeast, east, or southeast, the vessels entering and leaving Xiushandong anchorage need to ensure that the wind speed is no more than 17.1m/s (Beaufort Wind Scale 7). The overall traffic organization and safety measures that the vessels come to the Xiushangdong anchorage for fuel refueling should follow when entering and leaving the anchorage are as follows.

1) Before entering or leaving the anchorage, the receiving vessel should have the engine and rudder standby, maintain a safe speed, properly use all available means such as radar and AIS, maintain a proper lookout, and promptly identify the movements of surrounding vessels.

2) The agent should proactively contact the vessel in advance to confirm the correct navigation routes for entering or leaving the anchorage and anchorage requirements, continuously monitor the vessel's movements entering or leaving the anchorage, and provide thorough tracking and guidance services throughout the process. Simultaneously, if the vessel has any uncertainties regarding the routes or procedures for entering or leaving the anchorage, it should promptly contact the agent for consultation and clarification.

3) Bunkering anchor positions for bonded marine fuel should apply online through the "Vessel Traffic Organization Service Management Platform" or the "Haishitong APP" according to relevant management regulations; the scheduling plan for dedicated bonded fuel bunkering anchorage positions is coordinated by the Zhoushan Comprehensive Bonded Zone Bonded Oil Dispatch Center.

4) Before entering or departing an anchorage area, the receiving vessel should apply to VTS in advance and consult for navigational information and avoidance suggestions, striving to avoid creating collision risks with vessels navigating within the traffic lanes during turning maneuvers associated with entering or leaving the anchorage.

5) If the receiving vessel is entering the anchorage from a public route, it should leave the route according to the recommended navigation methods provided in this notice, while taking care to actively give way to vessels proceeding normally along the public route.

6) The receiving vessel should avoid entering the anchorage to drop anchor during periods of strong flood or ebb currents during major tidal periods.

7) Due to the numerous anchorage positions within anchorage areas, receiving vessels should maneuver based on the actual situation when entering or departing their designated anchorage position, paying attention to the effects of current pressure and wind influence.

8) If the receiving vessel or its master is calling at a specific bonded marine fuel bunkering anchorage for the first time, it is recommended to engage a local pilot to provide pilotage services for entering and departing the anchorage.

9) After the receiving vessel has dropped anchor securely, the bunker tanker may then enter the anchorage area; the anchor dropping times for receiving vessels at adjacent anchorage positions should be spaced at least half an hour apart; for receiving vessels using the same anchorage position, the subsequent vessel may only enter the anchorage after the preceding vessel has departed.

10) During the bunkering operation, communication shall be maintained unobstructed, and all vessels shall keep watch day and night; after the completion of the vessel's operation, it shall immediately report to the VTS.

6. Summary

The waters of Zhoushan Archipelago are located in the middle section of the north-south shipping route in China. There are numerous islands, with complex waterways and meteorological conditions. The navigation density of ships entering and leaving the port is high. With the annual increase in the volume of bonded marine fuel refueling business in Zhoushan, in order to further standardize the navigation order of ships entering and leaving Xiushandong anchorage, ensure the safety of ship navigation and entering and leaving the anchorage, and tap the potential of bonded marine fuel refueling, it is necessary to conduct research on the recommended navigation methods for ships entering and leaving the anchorage and related safety measures. Through this research, the recommended navigation methods and related

safety measures for ships entering and leaving the Xiushandong anchorage for bonded marine fuel refueling are sorted out and proposed. This has important reference value for the safe navigation of ships entering and leaving the Xiushandong fuel supply anchorage and the water traffic safety management of relevant departments in Zhoushan.

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