Safety of Commercial Ship's Cargo Operation in Antarctic Waters
——An example of the First Voyage of Chinese Merchant Vessel Yongsheng in Antarctic Waters

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Abstract: Taking "the last 1 nautical mile" of reconstructing the materials at the Brazil Feilazi science station in Antarctic waters for the first time in "Yongsheng" as an example, this paper analyzes the characteristics of cargo operations in Antarctic waters and compares the differences between the operations of commercial vessels and scientific research ships. It summarizes Antarctic waters cargo operations risk response measures and provides reference for the Chinese merchant ships engaged in such operations.

1. Introduction

In November 3, 2016, MV Yongsheng, belonging to COSCO Shipping Specialized Carriers Co., Ltd. (hereinafter referred to as the "company"), carried Brazil Feilazi station reconstruction materials and set sail from the port of Shanghai, King George Island to the south pole, as China's first Antarctic expedition ship service. The project lasted for more than 120 days, and the voyage was 14500 nautical miles. The transportation and loading and unloading including landing craft, barge, vehicle machinery, container and naked form goods amounted to 4715. In what was considered the highest risk, long duration of the last 1 mile, MV Yongsheng landing craft and barges 45 times, landing craft towing barge unloading a total of 883.7 hours, barge shuttled 383 times, rolling off cargo 75 times, berthing operations 308 times, with zero accident successfully completed this research service project.

2. Characteristics of cargo operation in Antarctic waters

2.1 Lack of port facilities

The port facilities in Antarctica are short of facilities. There are no large wharfs, and some of the better scientific research stations are built with permanent small and simple wharves, which can only be berthing for small boats or barges. Large ships need to be transported on the anchorage, transported to the shore by barges or loading craft, or directly berthing on ice shelves, and transported to the destination by snowmobile. There are no special docks in the Antarctic area, and the operation of the goods depends on the crew of the ship. No special terminal facilities near the Feilazi Antarctic research station, transport station supplies large ships anchored in the waters near the only station expedition, then the cargo will be transferred to the shore by small boats.

2.2 The unloading order of the goods is strict

The ship's cargo operations in the Antarctic are mainly done by their own strength, so there is a strict requirement for the unloading order of the goods. To the Brazil station reconstruction as an example, the boat reproduced and construction vehicles, with construction materials shipped to the reconstruction of the waters near the ground, must first discharge into the water or transported to the shore. There is no permanent wharf facilities near the rebuilt area. In order to ensure the efficiency of cargo operation, materials for loading temporary Wharf on board should also be discharged to the
shore first, and temporary Wharf Works can be done well. There is not enough yard to store materials in the vicinity of the expedition station, and only take the way of unloading while constructing. According to the progress and construction requirements, we need to unload the needed materials.

2.3 The state of the ship is in danger

The Antarctic continent is covered by ice and snow up to 98%[1]. There are about 200000 icebergs floating in the coastal waters. Large floating ice or icebergs affect the safety of ship navigation and anchorage. Nearshore floating ice will impede barge berthing or landing. The extreme wind speed is the 100 m/s hurricane observed by Dewey station in France. The largest wind speed recorded in the world is [2]. The strongest winds near the coast, where the operation near King George Island wind is very big, the maximum wind speed of 36.5 m/s, the annual strong wind weather (wind is greater than 8) for 132 days, summer monthly formation of cyclonic 6-8, average 3–4 days there is cyclonic intrusion in the region [2]. Frequent wind and wave sea conditions endanger the safety of large ship anchorage and cargo operation.

2.4 The number of days in the operation of goods is limited

King George Island is located in the northernmost region of Antarctica, a kind of mild oceanic climate; at the same time, located in the depression belt around the pole, affected by cyclone frequent transit, the sky is often low stratus and stratocumulus, with characteristics of turbulent weather "and" haze "; perennial humidity, cloudy and rainy days. Strong and frequent [4], meet the operating conditions of the limited number of working days. According to the experience of "Snow Dragon" for many years in King George Island waters, because of the good weather and bad weather, only half of the days in summer can work normally.

2.5 Deck operation is plagued by low temperature

The Antarctic is called the earth's "cold pole". According to the March 1, 2017 Antarctic temperature record announced by the expert committee of World Meteorological Organization (WMO) in Geneva, the highest temperature is 19.8 degrees, and the lowest temperature is -89.2 [5]. This work is located near King George Island, the island is covered with ice and snow perennial, the highest temperature is L2 C, and the lowest temperature is -30 C. Although summer winter temperatures rise, 70% of the more than 0 degrees C, but within 5 degrees from C [4]. Low temperature has a direct impact on the operation of goods. People are cumbersome and are not flexible enough to cause industrial injury risk and efficiency reduction. Low temperature will also lead to poor performance or even loss of working equipment.

3. The necessity of the commercial transport in Antarctica

3.1 The shortage of scientific investigation ship in material transportation

The supplies of most of the science stations in the Antarctic are dependent on the scientific vessel. Compared with merchant ships, there are obvious shortages in materials transportation. (1) weak capacity. In order to meet the needs of scientific research, maintain stability and better navigation performance, expedition ship kept Limited cargo capacity. Taking the "Snow Dragon" as an example, its full load displacement is 21 025 t, and the net deadweight is only 8759 t. The ice breaking capacity of the new generation polar research ice breaking ship under construction in China is stronger than that of the snow dragon. However, its full load displacement is much smaller than the "Snow Dragon" number, whose full load displacement is only 14 000 t, and its cargo capacity is smaller. The loading and unloading equipment of a science examination ship is a priority to meet the needs of scientific investigation, and it is also easy to be stretched when dealing with special goods and important goods. (2) the efficiency of the operation is low. Although there are many crew members, there are only about 20 professional seafarers, and the rest are scientific researchers. During the operation of goods, a certain number of professional seafarers are required to participate in ship duty. Only part of the
professional seamen can carry out the loading and unloading tasks, and the manpower is seriously insufficient. In order to seize the time, a lot of scientific research personnel put down their work to take part in the cargo operation. Because of the lack of systematic training, the risk of operation has risen abruptly, but the efficiency of operation is not high.

(3) the shipping cost is higher. The cost of the research ship is much higher than that of the merchant ship. The main task is to carry out the expedition. The high cost, high maintenance cost and high fuel consumption research boat used for material supply has caused great waste. The summer in the Antarctic is short, and a scientific vessel has spent a considerable amount of time on supplies, which directly compresses the valuable time that can be used for scientific research.

3.2 Advantages of merchant ships in material transportation

In order to successfully complete the project, the company chooses MV Yongsheng, which has many experiences in the Arctic voyage, as a carrier.

(1) MV Yongsheng built in September 2002, a general multi-purpose dry cargo ship, Finland Sweden standard ice class 1A (equivalent to CCS Ice Class B1), 159.985 m in LOA, maximum width 23.70 m, depth 11.95 m, summer draft 8.424 m, gross tonnage 14357, net tonnage 6985, net deadweight 19561.59 t, 3 cranes, single crane lifting capacity of 60 t, two crane joint lifting capacity reached 120 t, type of main engine MAN & B & W 6S46MC-C, main engine power 7860 kW, design speed of 14.5kn, 3 holds.

(2) deck structure and open space of MV Yongsheng suitable for the reconstruction of scientific investigation of major pieces of cargo loading, cargo container station required; hatch wide design is conducive to the establishment according to the schedule needs lifting unloading goods of ship, reduce the possibility of turning down cargo cabin; ship cranes will be landing craft, some of the major cargo barge crane or lifting ship smoothly. The ship type is beneficial to improve the efficiency of the cargo operation and ensure the completion of the goods during the window period.

(3) as a shipping company with a certain scale, the company has a considerable number of long-term seamen engaged in multi-purpose ship transportation, members have the ability to skillfully use all kinds of ship cargo operation equipment.

4. Risk response of cargo operation in Antarctic waters

Fully understanding the characteristics of cargo operation in Antarctic waters, correctly assessing the risk points in every operation link and adopting targeted countermeasures, can effectively resolve risks and ensure smooth operation.

4.1 Risk assessment and control of workers

Risk assessment: the operation area is located in the Antarctic waters, people are relatively short of operation experience in such areas. Various forms of work need to be done by ship personnel, and low temperature environment increases the difficulty of operation.

Countermeasures: (1) in order to adapt to the complex requirements of cargo operation in Antarctic waters, the company takes the navigation experience of polar waters, skillfully operate ship crane, forklift, truck and equipment maintenance capability as the standard of selecting candidates. (2) the organization personnel to participate in specialized training, and understand the Antarctic meteorological ice characteristics, environmental protection requirements such as learning knowledge, emergency rescue and low temperature protection related skills; China Polar Research Center experts invited lectures, understand the characteristics of Antarctic waters, and the risk of cargo operations. (3) before the loading of the goods, the personnel of the organization actually operate the landing craft and barge towing, and have mastered the essentials of the landing craft and the towing barge operation. (4) the organization personnel research and discuss the excavator, loader, crane, transport car and other large mechanical equipment roll off the bank matters, and carry out simulation operation.

4.2 Cargo stowage and risk control
Risk assessment: a wide variety of goods, stowage requirements, the unloading process of high density, it is difficult to improve the efficiency of discharge; excavators, forklifts, cranes and other goods must give priority to some work of mechanical unloading to the shore for temporary pier construction, otherwise it will affect the cargo operation schedule; construction materials must be in accordance with the station station construction schedule from cargo unloading to the shore. It is easy to cause the turn down goods warehouse.

Countermeasures: (1) the representative of the cargo owner was invited to introduce the construction plan of the science station and the construction of material supply plan in advance, and the order of unloading order was mastered. (2) in advance to check the goods and goods manufacturers, according to the weight, lifting unloading configuration tools and machinery. (3) to identify the goods at the port of loading according to the order of unloading the goods at the port of loading to identify the goods in color. (4) analysis and study of the performance of large mechanical equipment, combined with the construction needs of temporary wharf and the opinions of the owner, to determine the order of unloading large machinery and equipment.

4.3 Ship cargo refutation operation risk and control

Risk assessment: arrogant ship to barge cargo lifting is a key link of cargo operations, before and after the lifting of the lifting and falling hanging before and after dropping the hanger, hanger with accounting, suspension control, hoisting and unloading operating errors easily cause the goods into the sea, by boat and barge barge boat personnel; cargo lashing, liner is not strong easy to cause the damage of goods, goods, or boat capsized boat deck barge barge accidents; the space is narrow, the above personnel easily crush goods.

Countermeasures: (1) before lifting, the cabin personnel familiar with and master each piece of cargo lifting points, hoist and hoist way, and analyzed the security check; command staff to assess the air surrounding environment, safety instructions issued after the lifting of goods. (2) after lifting, the bottom of the cargo is slightly off the support. The commander confirms the safety of the whole cargo, so that it can continue lifting. The operator controls the goods and ensures that the whole process of the goods is stable in the air. (3) before and after the drop of the crane, the barge operator protects, liner and lash the goods according to the plan. After inspection and confirmation, the barge can be removed from the ship.

4.4 The risk and control of the sea conditions in bad weather

Risk assessment: Antarctic waters are prone to weather changes, severe freezing, sea ice impact, iceberg cracking and other bad weather and sea conditions, which will lead to ship failure, barge damage, water intake, barge damage, oil spill, cargo movement, cargo movement, big ship anchor and so on.

Countermeasures: (1) according to the weather, sea ice frozen mutation serious impact, the tip of crack, man overboard, injury, failure, damaged boat boat barge, barge, barge boat damaged oil spill, cargo movement, ship heeling anchor and other risks, to develop a special emergency pre plan. (2) adopt the designated meteorological forecast service of the national marine environment forecast center, and do a good job of early warning of disaster weather. (3) according to the proposal of the Chinese Polar Research Center, deception island is chosen as the preferred shelter for the large ship. (4) combined with the reload experience of the barge of the Chinese Polar Research Center, the plan for the drop of water on the boat refutation has been further improved.

3.5 window period of cargo operation is limited

Risk assessment: Antarctica cargo operation window period is limited. If we cannot deliver goods to the shore in the window period, the construction of the scientific research station will not only stagnate, but also will be damaged by bad weather in winter.

Countermeasures: (1) to shore ship docking, by the shore in advance to confirm the second day of the unloading list; if the loading list changed, at least half a day in advance to inform the ship; before the barge arrived at the temporary pier, near the shore using mechanical cleaning notice of wharf
shore ice barrier; according to the loading list ready, mechanical the spreader and the vehicle, can effectively improve the efficiency of unloading temporary pier. (2) do barge docking: according to the characteristics of the rational allocation of personnel barge operations team, can give full play to the collaborative team; according to the unloading list to make double barge loading scheme, can give full play to the energy efficiency of the landing craft; according to the design standard of scientific barge stowage barge, barge can make full use of space and weight. After a short period, "operation way round goods Yongsheng" by a single boat into a single boat double single barge alternately, single day (24 hours) transfer of goods up to 16 times, the maximum discharge volume reached 600 tons.

5. Conclusion

MV Yongsheng first opened the Chinese merchant vessel to carry forward the Antarctic Science and materials, and achieved a great success. It provided a new way for the material support of the Antarctic science examination. In May 2017, MV Yongsheng successfully completed the first Antarctic expedition service project to return to Xiamen, and China institute of navigation awarded her the title of "Antarctic expedition service pioneer".

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