

Research on safety risk management of restricted ships navigating in the yangtze river

Hu Yuanlun Li Haijiao

Zhangjiagang Pilot Station of Yangtze River Pilot Center, Zhangjiagang, Jiangsu 215633, China

Key words: restricted ship; Risk theory; Grading; Countermeasures; proposal

Abstract

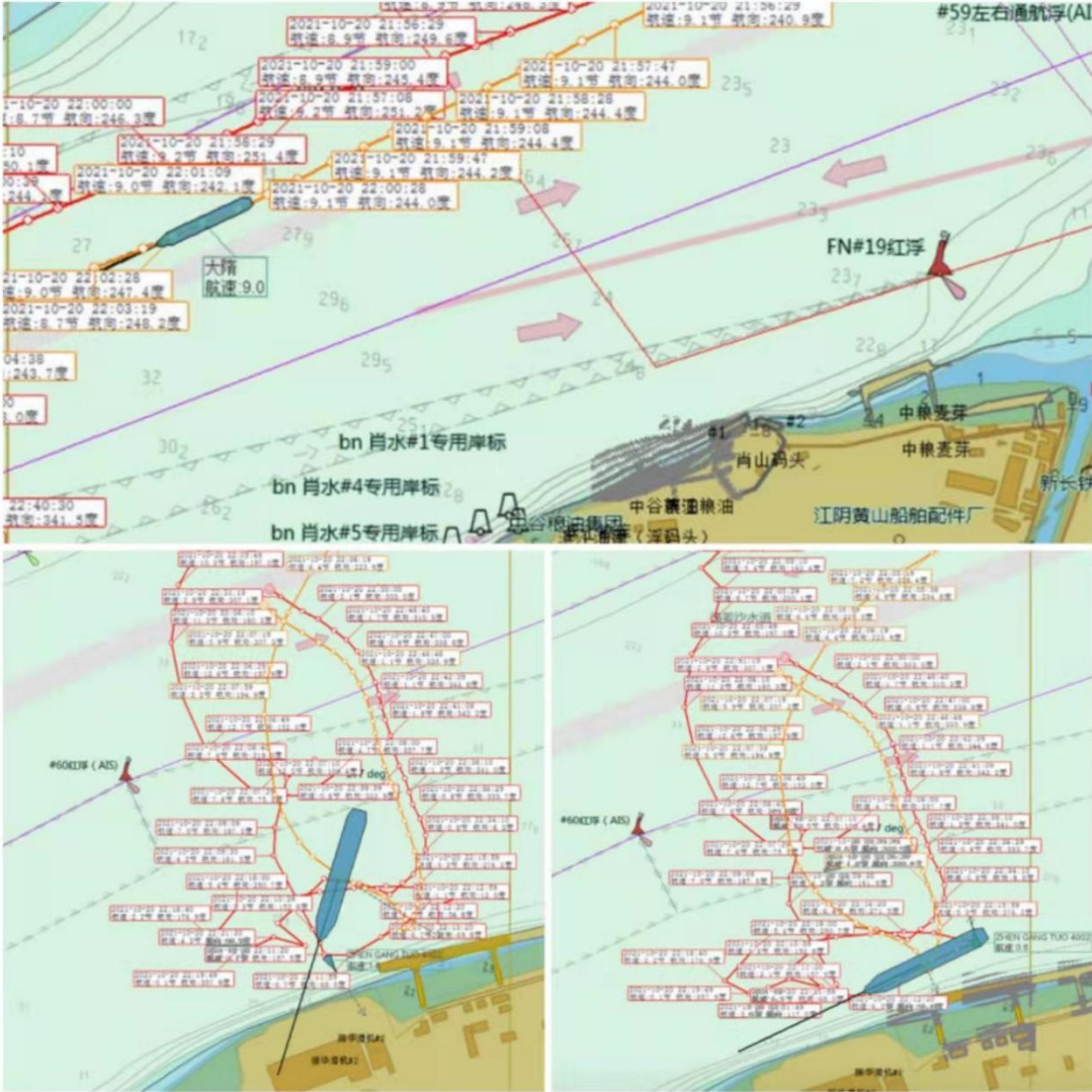
After the opening of the 12.5m deep-water channel below Nanjing of the Yangtze River, the role of the Golden Waterway is further highlighted, and 200000 tonnage seagoing ships can reduce the load and berth at Zhenjiang Port. In recent years, the number of restricted ships entering the river has increased significantly. In 2021, the number of restricted ships led by the Yangtze River Pilotage will be 13914. According to the internal data of the Yangtze River Pilotage Center, the number of out of control restricted ships will reach 37 in 2021, bringing great pressure to the safety management of maritime, pilotage and other institutions. This paper takes the whole process of restricted ships entering the river as the research object, uses risk theory to classify the risk level of ships sailing, turning, crossing and possible out of control situations, and then puts forward corresponding countermeasures and suggestions, which can provide reference for the safety management of relevant departments.

Restricted ships refer to ships (or fleets) with limited maneuverability. Their classification is determined by combining draft, LOA and clearance height. According to the classic rescue and emergency response success cases of Yangtze River pilotage ships in 2021, the selected typical events have certain characteristics. Typical cases are mostly concentrated in restricted ships, including five in Cape ships and one in Panamax ships, Two occurred on the Panamax heavy haul ships and one occurred on the super large and super long trailer fleet. The Yangtze River pilots successfully responded to the situation of out of control limited ships, showing a high level of professionalism, superb piloting skills, and strong psychological quality. Relevant research shows that in each link of the accident chain, ship, pilot, maritime, tugboat and environmental factors are indispensable, among which the most important is the on-site operator. Based on the actual situation of ship navigation, this paper classifies and grades the navigation risks of restricted ships by using risk theory, and proposes the most effective means to avoid collision accidents by combining the corresponding risk types and levels.

1. Review of typical cases

On October 20, 2021, the Hong Kong based bulk engineer "DS", with a length of 291.97 meters, a draft of 11.36 meters, a gross tonnage of 93186, a net tonnage of 59500, a deadweight tonnage of 178978, and a load of 89043 tons of iron ore, will sail from Baoshan to Zhenjiang Port. At 2202, the bridge gave an alarm, and the whole ship was powered off, causing the main engine and steering gear to be out of control. At that time, the speed was 9.1 knots, starting the emergency rudder was invalid, and full speed reversing did not respond. When the ship starts to deflect to the left due to the influence of the current, the pilot immediately reports to Jiangyin Traffic Control Department for tugboat assistance and sea patrol boat rescue. At the same time, the deputy pilot issues the out of control status. At 2208, the residual speed of "DS" still reached 5.8 knots, and the pilot immediately ordered the emergency dropping of double anchors to restrain the deflection of the ship and reduce the speed. At the same time, he required the escort tugboat "Zhengang Tuo 4002" to push at full-ahead in the left front of "DS" to prevent the ship from going backwards to the wharf and ship on the south bank. As the main engine and steering gear were out of control at the same time, and the spring tide of the lunar calendar, the

tugboat could not hold the "DS", and could only slow down the trend of turning left. At 2209, the main engine recovered and the remaining speed was 5.6 knots. The pilot ordered the rescue tug "ZL1" to push the stern. As the transverse distance is too close and the ship inertia is too large, it is inevitable that the "DS" ship will collide with the moored ship on the wharf due to the pressure of falling water. At 2213:00, the pilot used good ship skills and gave full play to the role of engine, rudder, tugboat and anchor, so that the ship was parallel berthed on the moored ship at the wharf, avoiding serious accidents.



2. Introduction to restricted vessels navigating in narrow channels of the Yangtze River

The 12.5m deep-water channel below Nanjing of the Yangtze River was officially put into trial operation in May 2018, and passed the completion acceptance and handed over to the channel department for management in May 2019. The successful construction of the 12.5m deep-water channel has provided the necessary navigation guarantee for the safe navigation of Cape ships in the Yangtze River. That is to say, at this stage, the scale available for safe navigation of Cape ships is 250-300 meters, and the general heavy load draft is not more than 12 meters (sufficient water depth must be reserved). The shipyard has built new container ships or bulk engineers, and the LOA has reached 350 meters. At present, the ports where ships berth are Taicang Port, Nantong Port, Zhangjiagang Port, Jiangyin Port, Jingjiang Port and Zhenjiang (Yangzhou) Port. Cape ships can now reach the waters of Zhenjiang Dagang (about 245km from Baoshan to Zhenjiang Dagang).

Table 1 Statistics of pilotage ships and pilotage accidents in the Yangtze River in 2021

Quarterly	pilotage	mileage of the project, km,	gross ton	net ton	limited ship pilotage	accident
First quarter	15781	1970005	314850134	175077250	3597	1
Second quarter	17359	2187338	317611501	175193146	3604	4
Third quarter	14152	1801852	279404115	155471437	3224	2
Fourth quarter	14092	1716636	299250185	167825313	3489	4

Table 2 Statistics of out of control accidents of Yangtze River pilotage in 2021: (unit: number)

	Ship out of control	Engine failure	total	Above Panamax	Proportion
First quarter	10	20	30	8	26.7%
Second quarter	26	14	40	13	32.5%
Third quarter	10	13	23	7	30.4%
Fourth quarter	10	16	26	9	34.6%

According to statistics and analysis throughout the year, 119 out of control failures were registered, 56 out of control failures, accounting for 47%. There were 63 failures, accounting for 53%. There were 37 Panamax and above ships, accounting for 31% of the total, and 9 Cape ships, accounting for 7.5% of the total. It shows that there are about 1/3 large ships with main and auxiliary steering gear failures, and the failure rate of Cape type crew members is also large. The larger the ship is, the higher the possibility of major accidents. There are major navigational risks, and the more obvious the potential safety hazards. The key point is that there were 10 ship wide power outages, accounting for 8.4% of the total. Other situations occur, such as main engine failure, steering engine failure, engine room abnormality, etc.

3 Analysis of main risks of restricted ships entering the river

According to the relevant risk theory, the risks of ships sailing into the river can be divided into major risks, major risks and general risks.

3.1 Major risks

3.1.1 Overtaking

Due to the large ship width, the navigable width of the navigation branch in Jiangsu section of the Yangtze River is limited. In the curved and narrow section, the safe transverse distance is too small, which is prone to the

dangerous situation of ship suction and reverse channel driving. Heavy loaded ships will catch up with a large number of small ships and seagoing ships with a LOA of 100-230 meters due to the need to catch up with the tide. The special restrictions of the Yangtze River channel increase the safety risk for Cape vessels to overtake other types of sea going vessels. In 2021, there are 6 pilot accidents related to overtaking, accounting for 55% of the total accidents

3.1.2 Crossing

When entering and leaving the anchorage, berthing and leaving the wharf, and crossing with ships traveling along the channel, collision accidents are likely to occur, especially in the tidal reach of the Yangtze River, when heavy loaded ships cross the front of ships traveling along the channel along the current, and need to turn around to cast anchor. The situation that ships need to cross in and out of the special channel of Yonggang, Funan Waterway and Fubei Waterway is marked as a major and major potential safety hazard. In 2021, there will be 5 pilot accidents related to crossing, accounting for 45% of the total accidents.

3.1.3 Power loss of the whole ship

In case of power failure of the whole ship, there are few available measures, which mainly depend on the inertia of the ship and are affected by external forces, including wind flow and tugs. Therefore, it is the most difficult situation for emergency treatment. If the ship is unable to supply power for a long time, heavy and super large ships are more likely to have major safety accidents, resulting in incalculable losses.

3.1.4 Steering gear and main engine failure

During navigation, the steering gear breaks down, and the bow deflects, which can not be corrected. It is easy to cause collision risk to surrounding ships and fixed objects. The failure of the main engine will affect the forward and backward movement of the ship. During berthing and unberthing operations, special attention should be paid to the failure of the main engine. In case of main engine failure during navigation, corresponding safe operation measures can be taken to ensure the safety of the ship by taking advantage of the residual speed and favorable channel conditions.

3.1.5 Water and underwater structures

The water structures of Cape ships are high, posing a threat to bridges and river crossing cables in Jiangsu section of the Yangtze River. Once the calculation is not in place, accidents are very likely to occur. During navigation, underwater obstacles should be avoided as much as possible. Avoid accidents such as hitting rocks, damage and leakage.

3.1.6 Water area of key segment

Very large ships sailing on the Yangtze River are usually guided by a pilot. However, the LOA should also make necessary reminders when sailing to the waters between the Yangtze River 6 # - the Yangtze River 10 #, the waters of Sutong Bridge 1 # - the Yangtze River 22 #, the waters of the Yangtze River 30 # - Husu Tong Bridge 4 #, and the waters of the Yangtze River 63 # - the Yangtze River 65 #, which need special attention. Ships sailing through the bridge waters have special navigation requirements. In order to ensure the safety of the bridge, it is even required to equip tugs to maintain the bridge. Ship collision with bridge is rare. The ferry area is more special. The crossing of steam ferry, train ferry and train ferry is the engineer with high personnel density. Once a dangerous situation occurs, it will cause serious social impact.

3.2 Large risks

3.2.1 Possible non-standard behaviors of pilots. In such cases, the LOA, pilot and helmsman can challenge the relevant personnel and try their best to correct the unsafe operation.

3.2.2 The ship did not drive in strict accordance with the traffic separation (reverse channel, wrong route selection, etc.), and did not take the specified safe speed (overspeed behavior in bridge area, shoal, steam

crossing waters, and construction waters).

3.2.3 The risk of safety accidents caused by pilots' poor business skills, weak sense of safety responsibility, insufficient situational awareness, overconfidence, poor emotional control ability, mental paralysis, failure to keep a regular lookout, failure to understand the rules of ship activities in the port and channel, or failure to fully estimate the unexpected abnormalities of other ships. (Nothing is absolute. Generally, Cape ships will be equipped with experienced and skilled pilots to engineer out piloting tasks, but the risk itself is real.) Failure to effectively communicate with the ship.

3.2.4 The ship itself has poor maneuverability, the radar equipment is old, the ship repair equipment is unstable, and the communication equipment has defects.

3.2.5 The impact of bad weather on ships includes heavy fog, heavy snow and poor visibility in winter from October to February every year, pilotage in flood season of the Yangtze River from May to September, and severe convective weather in July and August in summer.

3.2.6 Small ships do not travel according to the specified route, forcibly cross and occupy the channel, which is easy to cause collision accidents. Ships navigate in narrow and curved sections with high traffic density (Yonggang, Fubei, Funan, Sanjiangying), bridge area waters, and waters with turbulent water flow (21-1 Heifu is prone to sudden drop in speed and uncorrectable yaw due to obvious changes in water depth and abnormal flow patterns. 42 In Heifu's flood season, many ships overturned, causing collisions with other ships and touching the dock. It is recorded that Anzhou dock pushed away the flow).

3.2.7 The pilot and the ship's side did not cooperate properly, and the negative state or improper speech of the crew in their work affected their work. Or extreme terror caused by abnormal emotions caused by quarrels among crew members (crew members jump into the river, or navigate the ship in violation of instructions).

3.2.8 Safety measures are not implemented in place, and the ship owner fails to effectively prepare the anchor head as required (previously, when anchoring, the anchor cannot be loosened) The wharf fails to keep enough safe berthing span. The frequently occurring situation that the anchor position cannot be put in place in time. The anchoring situation of heavy loaded ships during the flood period (Nantong Langshan Anchorage, anchoring collision accident at 19), and the situation of entering and leaving the anchorage, channel, berthing and unberthing during the peak period of ship flow.

3.3 General risks

Sailing at night, berthing and unberthing, and dropping anchor. Lack of navigational aids. Berthing and unberthing of special berths, navigation in the narrowest section (no boat crossing waters), mixed flow navigation of large ships and small ships (Zhenjiang Dagang Taizhou Bridge waters). Inaccuracy of ship data may cause major potential safety hazards to navigation. Misjudgment caused by too much pressure on pilots. Possible fatigue of pilot, helmsman, LOA and pilot. High frequency does not effectively listen. AIS equipment works abnormally. The anchorage shall avoid all underwater river crossing cables. Inefficient cooperation among port workers, maintenance boats and tugs. Wrong command of sea patrol boat. etc.

4 Effective measures to reduce accidents

4.1 Good ship handling habits

The famous "Heinrich" rule holds that behind one death, serious injury or major accident, there are 29 minor injuries or minor accidents, and behind 29 minor injuries or minor accidents, there are 300 non injury, false alarm or dangerous events, as well as a large number of unsafe behaviors and unsafe conditions. Cape ships are usually led by experienced first class pilots. Pilots have formed their own fixed pilotage operation habits in their year-round work. Good habits can avoid dangerous situations in advance, but bad habits can easily lead ships into dangerous situations. As the most basic piloting skill, good ship handling habits seem very simple, but it is

extremely difficult to do. The pilot shall pay attention to the following situations: make an effective and regular lookout. Use standard language to communicate effectively and meticulously with the ship. Ensure that each instruction is correctly implemented. Supervise the vehicle and steering at any time. Make the navigation plan that can best guarantee the safety in advance. Repeatedly deduce the emergency steps to be executed in case of dangerous emergency. Keep close contact with the patrol boat, maintenance boat, tugboat and VTS center, be reasonable and disciplined, and seriously implement safety operation instructions. Good piloting habits are the most important condition to save the crisis and ensure pilotage safety.

4.2 Good bridge resource team

The pilot shall be a member of the bridge resource management since boarding, and shall quickly integrate into the team to form a whole with sufficient communication, wide attention range, sensitive response and smooth information. The pilot and the ship's bridge team should have a general idea. The pilot should give full play to his own advantages, perceive the characteristics of the ship at the first time, perceive the environment around the ship at that time, master the dynamics of the surrounding ships, the situation of the wharf and the tugboat, so that the ship is always in the most favorable environment, so as to put safety and efficiency into practice. The bridge team of the ship shall actively respond, cooperate with the pilots, help them to quickly integrate into the bridge team, be familiar with the ship's maneuverability and characteristics, and the use of navigation aids on the bridge, and at the same time, supervise and remind them as necessary to avoid dangers or even accidents caused by the pilots' personal negligence. The pilot shall coordinate and make good use of the resources of each bridge through scientific methods, make engineful plans in advance, organize and implement effective control on site, conduct correct operation and command, coordinate and cooperate reasonably, form a systematic, professional and scientific working system of pilot bridge resources, and complete the pilotage task safely and efficiently.

4.3 The ship is in good condition

Before sailing, the equipment on the ship shall be checked to ensure that it can be used at any time in case of emergency. Ensuring the normal operation of ship equipment is also the premise of ensuring navigation safety. If VHF communication is not smooth, radar, AIS, etc. cannot work normally, blind manipulation shall be avoided.

4.4 External assistance

When navigate on the Yangtze River, super large ships are usually equipped with necessary measures to ensure their safety. The sea patrol boat shall maintain the order on site and command the ships on site to observe the navigation rules. The maintenance boat makes effective supplement and assistance to the enforcement of the sea patrol boat, so as to maintain the normal navigation channel traffic conditions of super large ships to the greatest extent, especially when entering and exiting the special channel needs to cross the peak flow of ships. Tugboats take effective assistance measures to help turn around, control speed, turn around, etc. when super large ships enter and leave the anchorage, pass through bridge areas, steam crossings, and complex navigation areas. When the main engine, steering gear and auxiliary engine of a seagoing ship fail, the tugboat is the only assistant and the most important external means. The maritime department has built an integrated monitoring system based on VTS, integrating AIS, CCTV, GIS and other auxiliary monitoring means. Zhangjiagang Maritime Safety Administration introduced UAVs to participate in cruising and law enforcement. Strengthen the monitoring of ship navigation, anchoring and operation in VTS waters, correct violations in time, eliminate dangerous situations in time, strengthen the organization of ship traffic, provide all-round and multi-channel information services for sea going ships entering the river, pay equal attention to supervision and service, so as to better ensure the safety of ship navigation.

4.5 Prepare for emergency at any time

For navigation along the Yangtze River, effective anchor preparation is the bottom line that ships must adhere to.

The left and right anchors must be loosened to the position close to the water surface so that they can be dropped and retracted. When passing through the bridge area, crossing, traffic density is high, and narrow channel waters, large and heavy loaded seagoing vessels should also take the maintenance tugs to the Panama-hole in the middle of the stern. When the ship is out of control, the tug at the stern can help control the ship's speed and reduce the risk of collision. In the emergency operation of "DS", every person in the tugboat, anchor, maritime, marine patrol and maintenance boat, vehicle rudder, bridge management team has performed perfectly in all steps, so that a major safety accident can be successfully resolved. Therefore, any link in the accident chain must be fully prepared.

4.6 Compliance with navigation regulations

The situation of the navigation waters of the ship must be fully mastered to avoid walking in the wrong channel for a long time. In flood season, buoys are prone to abnormal displacement, so pilots should always update charts and learn NOTAM. When two pilots perform their tasks, they can refer to the red, yellow and green modes in the bridge duty, and formulate pilotage schemes and human resource allocation according to the safety risk degree of the navigation waters, working hours and other factors, so that pilots can not only supervise and remind each other, but also get the necessary rotation rest, so as to ensure that at least one pilot can maintain sufficient physical strength and energy to perform pilotage tasks in high-risk waters or when approaching and leaving the wharf.

4.7 Make pilot plan

Ships entering and leaving the anchorage, special channel and navigation shall avoid the peak period of small ships entering and leaving the port (Taicang Port prohibits ships from calling and leaving the wharf during the peak period and entering and leaving the anchorage), For night navigation in inland rivers, the risk factor is large, and the navigation time should also be effectively controlled.

5 Summary

In the case of "DS", we saw that the pilot had put all the safety measures in place, prepared double anchors for the whole journey, and arranged the tugs and escort boats properly and used them reasonably. Be calm and responsive after a dangerous situation occurs, make full use of good pilotage skills and bridge resources, and seek maritime cooperation. According to the movement situation of the ship and the surrounding environment at that time, make correct judgment in time, seize the opportunity, and use the tugboat properly. Emergency reverse braking shall be adopted at the first time of recovery of the main engine steering gear to reduce the forward rush trend and try to control the ship position; When a collision is unavoidable, we should quickly use all available resources, such as vehicles, rudders, anchors, tugboats, etc., to level the hull as much as possible, reduce the collision angle, minimize losses, and avoid major accidents.

Anchors, tugs, main engines and steering engines are the means of emergency operation. It must be the lifelong goal of navigation pilots to reasonably use the impact of water and wind on the ship and choose the most suitable method to eliminate the danger. The safety risks of ship navigation are objective. Only when the pilots try their best to reduce the risks, can they avoid the potential safety hazards as much as possible and reduce the occurrence of accidents. The safety work of drivers and pilots is to subtract. Only by making as few mistakes as possible, can the maximum navigation safety be guaranteed.

Reference

(1)Cai Feifei, Ge Hailiang. Application of bridge management system based on role positioning in pilotage [J]. World Shipping.2021,44(05)9-11

- (2) Wei Xiaojun. Emergency towing and maneuvering navigation technology for CAPE bulk engineerier berthing at Caofeidian No. 6 berth where the main engine is out of control [J] 2021,(06)1-3
- (3) Huang Xiaomei. Study on Navigation Safety Countermeasures of Seagoing Ships Entering the Yangtze River in Jiangsu Section [J]. Jiangsu Shipbuilding. 2009, 26 (06) 28-30
- (4)Feng Jiachang. Some insights on ensuring navigation safety [J]. Tianjin Navigation. 2007, (02) 9-11
- (5) Sun Zujie. Risk Analysis and Countermeasures for Safe Navigation of Ships [J]. Ship Materials and Market. 2020, (04) 68-69
- (6) Wang Yalin. Essentials of Maneuvering Cape Ships Entering and Exiting the Yangtze River [J]. China Water Transport. 2010, (03) 44-45
- (7)Liu Qianxiang. Research on Pilotage Risk Response Measures in Jiangsu Section of the Yangtze River [J]. China Water Transport (the second half of the month). 2017, 17 (05) 24-25
- (8) Wang Honggen, Zhu Yaoqiang, Yu Jingtian. Analysis of unsafe behavior habits of pilots [J]. Pearl River Water Transport. 2019, (08) 115-116
- (9)Zhang Feng. Analysis of Navigation Safety and Collision Accidents in the Yangtze Narrow Channel [J]. Journal of Qingdao Oceangoing Crew Vocational College. 2018, 39 (04) 10-13

Author's Biography

Hu Yuanlun (1982 -), First class Pilot of Zhangjiagang Pilot Station of Yangtze River Pilot Center, 18921951101, 120159294@qq.com

Li Haijiao (1986-), First class pilot of Zhangjiagang Pilot Station of Yangtze River Pilot Center, 13196525976,lihajiao13@163.com