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WORLD MARITIME UNIVERSITY

Malmö, Sweden

**THE RESEARCH OF MATITIME SEARCH AND
RESCUE PERSONNEL TO THEIR OWN
SECURITY AND RISK AVERSION**

By

LIULEI

The People's Republic of China

A dissertation submitted to the World Maritime University in partial
Fulfillment of the requirements for the award of the degree of

**MASTER OF SCIENCE
In
MARITIME AFFAIRS
(SHIPPING MANAGEMENT)**

2017

DECLARATION

I certify that all the materials in this dissertation that are not my own work have been identified, and that no materials are included for which a degree has previously been conferred on me.

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

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ABSTRACT

Title of Dissertation: **The Research of maritime search and rescue personnel
to their own security and risk aversion**

Degree: **MSc**

Maritime search and rescue is different from the general search and rescue behavior, maritime search and rescue environment is poor, both search and rescue technology or search and rescue equipment are special; On the other hand, during maritime search and rescue process there are many potential risks, more uncertain factors. As the main body of maritime search and rescue behavior, that is, maritime search and rescue personnel, in the complex and dangerous sea search and rescue environment how to protect their own safety, to avoid potential risk of search and rescue has a certain research value.

On the basis of collecting a large number of literatures, this paper analyzes the background of the topic, viewing the purpose and research significance of the article. After combining with the search and rescue system, the size of the search and rescue team, search and rescue equipment, search and rescue technology, The status quo of maritime search and rescue personnel in developed countries was sorted out and summarized. According to the current situation of maritime search and rescue in China, the search and rescue personnel were classified according to certain standards and the personal safety and protection facilities of different types of search and rescue personnel were summarized. with maritime search and rescue personnel risk research, clarify the definition of the characteristics and risks of maritime search and rescue, and risk classification, and then combine the search and rescue risk at different stages of the process may occur in a detailed analysis; after that, the

previous text do research on the basis, this paper presents risk corresponding to specific avoidance behavior, and put forward their own suggestions and thinking to reduce the risk of search and rescue at sea in terms of search and rescue equipment, search and rescue technology, expert knowledge base search and rescue, search and rescue training ; Finally, the summary of the thesis And further research in the future were also discussed.

KEY WORDS: Maritime search and rescue personnel, safety protection, risk analysis, risk aversion

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LIST OF ABBREVIATIONS

EMSA	European Maritime Safety Authority
SAR	Search and Rescue
SARV	Search and Rescue Volunteers
IMO	International Maritime Organization
MSC	Maritime Safety Committee
MOT	Ministry of Transport
NERSS	National Emergency Rescue Security System
DOD	Department of Defense
FAA	Federal Aviation Administration
EU	European Union
TSC	Traffic Safety Commission
NASA	National Aeronautics and Space Administration
RLF	Royal Lifeboat Federation
MCA	Maritime and Coast Guard Auxiliary
COEFC	China Oceanic Environment Forecast Center
UK SARIS	The United Kingdom Search and Rescue instruction system
SAD	Search Area Definition tool
SAC	Search Area Coverage tool
IAMSAR	International Aeronautical and Maritime Search and Rescue
ICAO	International Civil Aviation Organization

VTS	Vessel Traffic Management System
CCTV	Closed-Circuit Television
AIS	Automatic Identification System
ES	Expert System
UAV	Unmanned Aerial Vehicle
USV	Unmanned Surface Vehicle
AUV	Autonomous Underwater Vehicle

CHAPTER 1

INTRODUCTION

1.1 Background

It has been said: "The ocean is the cradle of human life, it is the birthplace of all things, the ocean for human life to provide an environmental basis and material security " (Li, Ch. 1996), in addition to even assert: "In the long river, country once control the ocean, then it could occupy the highest in the world, have the right to speak ". (Cheng, M. Y. 2012) Through the above statement is enough to see the ocean in the human process of the important position. However, the complexity of the marine environment, the complexity and danger of the marine environment in the event of a shipwreck, the direct consequences will be quite bad. The European Maritime Safety Authority (EMSA) released the agency's Annual Review of Maritime Accidents. According to the report, half of the maritime accidents that occurred during the 2011-2015 period were sailing accidents, such as touching, stranding and collision; 39% of occupational accidents were due to slipping, falling and falling. The deaths of passenger ships on 2011-2015 were mainly related to the "*Costa Concordia*" incident and the "*Norman Atlantic*" incident. Among them, the cruise "*Costa Concordia*" in 2012 in the Italian coast sailing unfortunately sank, resulting in 32 people were killed 17 people injured; ferry "*Norman Atlantic*" in 2014

the fire caused 11 people were killed and 31 injured. In addition, the Korean time on April 16, 2014 at about 8:58 am, a carrying 476 passenger ships "*years (SEWOL)*" (as shown in Figure 1.1) in Jeollanam-do Jeonju Island, north of the screen 20 Km on the sea side of the flooding gradually sank, resulting in 304 people were killed, the survival rate is only 36%; Beijing time on June 1, 2015 about 21:28, a carrying 456 passenger ships "*Oriental Star*" In the rare storms under the influence of the Yangtze River Jianli County Damascus River sink, resulting in 442 people died, the survival rate of only 3%, the two incidents of follow-up rescue work has been widespread concern, which makes the maritime search and rescue during this period has become the focus of world attention and discussion. According to the statistics report of China Donghai Rescue Center in 2016, it is clear that from January 1 to December 31, 2016, the East China Sea rescue Center organized a total of 7,475 days of waiting for the sea duty, and carried out all kinds of search and rescue tasks. Times, rescue all kinds of distress personnel 670 people, rescue distress ship 31, the value of direct rescue property estimated about 1.1 billion for the stability of the maritime security situation and economic and social development has made a positive contribution. In the face of such a bad shipwreck, the results of maritime search and rescue directly determine the degree of damage to the shipwreck accident, and maritime search and rescue personnel as the main body of search and rescue operations, they will play an important role in the whole operation.



Figure 1.1:“SEWOL”SHIPWRECK

Source: Baidu Encyclopedia index keyword “SuiYue”

Search and Rescue at Sea(SAR) is mainly composed of two parts: sea search and maritime rescue. Its specific concept mainly refers to the ship after the distress alarm, any available maritime rescue forces, including professional rescue team and search and rescue volunteers(SARV) and the surrounding sailing ships and other non-professional search and rescue forces, in the first time to obtain distress alarm measures For maritime relief. The International Maritime Organization (IMO) classifies the global sea as a thirteen search and rescue coordination zone at the 25th MSC, and China, as a member of the IMO (LI, L. 2006), has the responsibility and obligation to comply with the relevant provisions of the IMO. China is in the northwest Pacific search and rescue coordination zone (Lin, Ch. G. 2010). At present, China is responsible for the waters of the Bohai Sea, the Yellow Sea east of 124 ° west of the East China Sea east of 126 ° west and the South China Sea east of 120 ° west, north latitude 12 ° north of the sea. China's Ministry of Transport East China Sea rescue bureau "*thirteen five*" plan clear the work of the rescue center: First, all-round coverage, rescue site layout to further improve the professional rescue force effectively cover China's rescue area, in the focus of the formation of rescue power in the waters Position multiple coverage. Second, all-weather operation, with the ability to rescue in the 12 wind conditions, with the implementation of offshore deep-sea international rescue mission. Third, the rapid rescue, the general conditions of sea conditions, offshore 100 or less within the rescue life emergency arrival time, not more than the national standards. Fourth, effective relief, in the 9 wind conditions to implement effective relief, the general conditions of sea conditions, human salvage efficiency to meet the requirements of the state.

In the face of various shipwrecks, the society is often concerned only with the safety of ships and personnel, and little is known about the SAR personnel involved in maritime search and rescue work. Therefore, the safety issues involved in maritime

SAR personnel have not been taken seriously. Maritime search and rescue is different from other search and rescue work, due to the sea environment is extremely complex, at any time weather conditions, storms, reefs, undercurrents and so on to the sea search and rescue work with a lot of difficulties, these factors increased maritime search and rescue personnel Search and rescue risks, so the maritime search and rescue work has been a high-risk career. In the process of maritime search and rescue, SAR personnel not only to face the dangerous search and rescue environment, but also to overcome their own fear (Liu, Sh. Y. 2011), China's maritime search and rescue personnel in their own areas of security research results less, lack of risk analysis of the search and rescue personnel, The avoidance of these risks, this article based on the above background needs to be studied.

1.2 Objectives and significance of research

1.2.1 Objectives of research

Summed up the status of safe operation of domestic and foreign maritime search and rescue personnel. This paper plans to analyze the status quo of the search and rescue personnel at home and abroad from the macro perspective, including the search and rescue system, the size of the search and rescue personnel in the country; search and rescue equipment (Cheung, S. 2001), the current domestic and foreign maritime search and rescue of the main equipment, by comparing developed countries to find China weakness in search and rescue technology, summed up the search and rescue technology at home and abroad search and rescue personnel of the latest progress; search and rescue rules, summed up the current domestic and foreign search and rescue personnel on the mission and operational requirements, including the release of relief manuals, then according to the classification of maritime search and rescue personnel, from the micro-specific analysis of different types of search and rescue

personnel in the maritime search and rescue process of security measures, including equipment and operational points.

Found that the existence of the risk in current SAR personnel at Maritime search and rescue, and analyze the main causes of risk. Through the summary of the present situation of the safe operation of the maritime search and rescue personnel at home and abroad, it is possible to analyze the search and rescue risks of different types of SAR personnel under different search and rescue stages according to the present situation, analyze the specific links in the search and rescue operations, and analyze the main reasons about the risks.

Proposed to protect the safety of maritime search and rescue personnel. According to the analysis of the search and rescue risks and causes, to propose specific ways to avoid risks, these methods may be the nature of the prevention may also be practical operational guidance, search and rescue equipment to strengthen, in any case, Aims are to improve the safety of maritime search and rescue personnel.

1.2.2 Significance of research

Through the summary of the current situation of the safe operation of maritime search and rescue personnel at home and abroad, we can study the main problems in the current maritime search and rescue process, so as to further study how to improve the safety protection of search and rescue personnel in the future, such as the search and construction of search and rescue equipment, Targeted to strengthen the future of maritime search and rescue personnel training, the high degree of risk of search and rescue work to pay more attention (such as the storm in the sea search and rescue), to avoid future risks that may occur.

Through the study of the safety protection of maritime search and rescue personnel, it can further guarantee the life safety of maritime search and rescue personnel, including the further investigation of the search and rescue behavior in the search and rescue process, strengthen the emergency treatment in the search and rescue process, Perfect has some reference significance (GOERLANDT, F. & MONTEWKA, J. 2015).

Through the study, it can give non-professional volunteers to provide a reference. At present, the main body of China's maritime search and rescue is still under the Ministry of Transport(MOT) of the *North Sea, the East China Sea, the South China Sea rescue center* of professional rescue personnel, but in the actual collection process, in addition to professional rescue forces in addition to a group of non-professional volunteers (Figure 1.2), this study can provide a search and rescue reference for these non-professional salvors, to avoid the blind action in search and rescue led to the progress of search and rescue adverse, and even endanger their own lives (GOERLANDT, F. 2014).



Figure 1.2: THE 1st SAR VOLUNTEER GROUP in “LIAONING”

Source: http://dalian.runsky.com/2011-12/16/content_4107584.htm

1.3 Structure of dissertation

Chapter 1 Introduction. This part mainly introduces the background, writing purpose and significance of the topic.

Chapter 2 analyzes the status quo of maritime search and rescue personnel at home and abroad. This part including of the search and rescue system, search and rescue team size, search and rescue equipment, search and rescue technology, search regulations and guidelines in five areas, compared the gap between China and foreign developed countries, lay the foundation for the following research.

Chapter 3 safety and security measures for maritime search and rescue personnel. This chapter first analyzes the status quo of China's maritime rescue, and then classifies the search and rescue personnel according to the search and rescue environment and responsibilities. Finally, the safety protection measures of the classified search and rescue personnel are described in detail according to the specific situation of the classification.

Chapter 4 Analysis of Maritime Search and Rescue. This chapter first describes the definition, characteristics and classification of maritime search and rescue risk, and then divides the search and rescue into three stages according to the chronological order, and explains the search and rescue tasks at each stage.

Chapter 5 Maritime search and rescue risk avoidance measures and recommendations. On the basis of the fourth chapter, this chapter summarizes the corresponding avoidance measures for the search and rescue risks that various types of search and rescue personnel may encounter, and then analyzes the early warning

mechanism of maritime search and rescue risk, and finally puts forward the latest development trend at home and abroad. Some Thoughts on Reducing the Risk of Maritime Search and Rescue.

Chapter 6 Conclusion and Prospect. Summarizes the main work done in this paper, and make future prospects for further research.

CHAPTER 2

An Analysis of the Current Situation of Maritime Search and Rescue Personnel in China and Foreign Countries

2.1 Search and rescue system

Chinese maritime search and rescue work is based on the national maritime professional rescue force as the main body, the army rescue forces, public power, social forces and maritime search and rescue volunteers and other forces to participate (Du, Y. D. 2008). The People's Republic of China Salvage Bureau of the North Sea rescue bureau, the East China Sea rescue bureau, the South China Sea bureau, Yantai salvage Bureau, the Shanghai Salvage Bureau and the Guangzhou Salvage Bureau and the North Sea rescue fleet, the East China Sea rescue team, the East China Sea second rescue flight Team and the South China Sea rescue team is a professional rescue salvage team, is an important part of the national emergency rescue security system(NERSS) and an important force in national defense and combat readiness. Rescue system to protect the life of the sea, the environment (Chen, M. D. 2007), property safety for the purpose of bear the emergency response to the waters of our country, life assistance, ship and property relief, marine fire, oil spill pollution and other important duties and maritime transport and sea Resource development to provide security and many other tasks. China has established a relatively complete rescue network in the coastal areas, the formation of the rescue

team, salvage team, flight team Trinity team formed; commitment to human life relief, property bailout, environmental relief trinity job responsibilities; with air security, Rapid response, underwater diving salvage trinity of the integrated function. Chinese maritime search and rescue system as an integral part of the whole social system, its structure as shown in Figure 2.1.

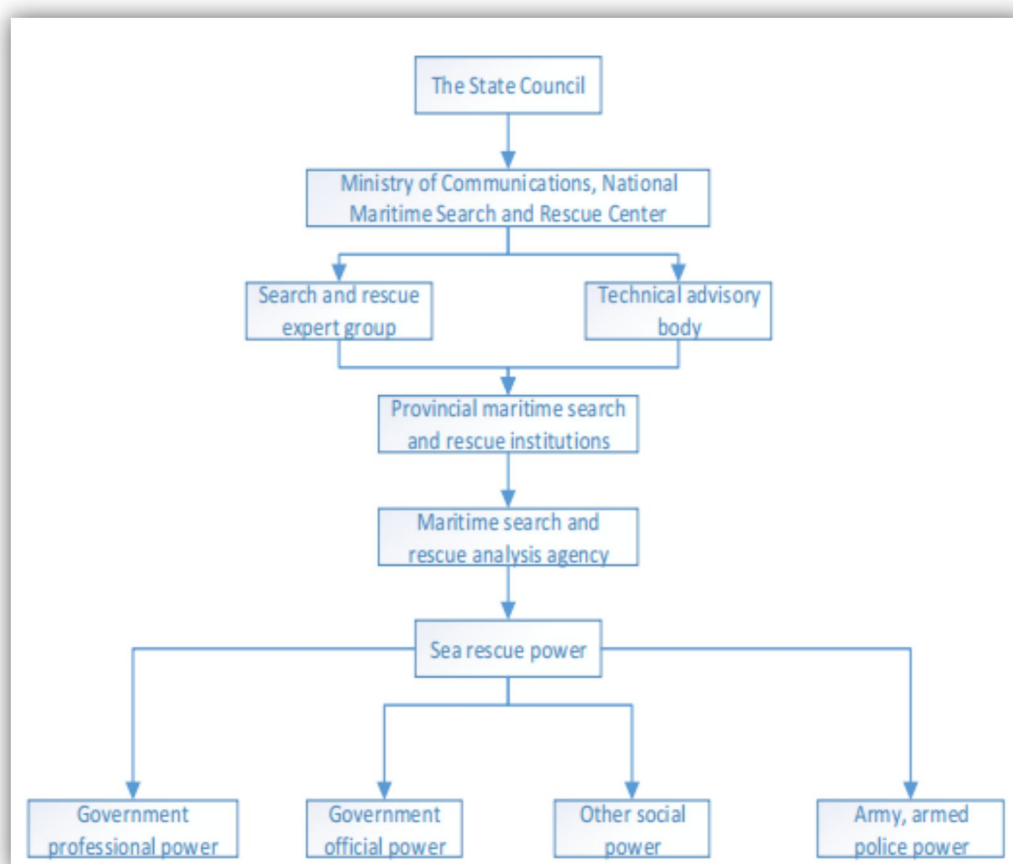


Figure 2.1: National Maritime Search and Rescue Emergency Organization Command System

Source: Compiled by author

For the foreign search and rescue system. This article mainly analyzes the search and rescue system of the United States and the United Kingdom. The United States is the

national waters into water, coastal and offshore three areas. Water (ie, the river and the Great Lakes region) by the Department of Defense(DoD) Air Force rescue team to undertake the ocean (Commandant, U.S. 2006); the remote area by the Ministry of Defense responsible for the sea, the Air Force commander of the command and management. Participating in the waters of the regional search and rescue work and defense contingents and naval small fleet. In addition to being coordinated by the regional management department, the US Federal Aviation Administration(FAA), the Traffic Safety Commission(TSC), the Interim Search and Rescue Committee, the Marine Meteorological Service, the Federal Communications Commission, the National Aeronautics and Space Administration(NASA), the Federal Relief Agency, the American Red Cross And other 12 institutions as a cooperative unit to participate in maritime relief work. The UK rescue industry is made up of government departments, emergency response agencies and other organizations. Some charities and volunteer organizations also play an important role in the rescue. These government departments and organizations have a close relationship of cooperation, the purpose is to provide effective national search and rescue capabilities to provide protection. (Including the British Search and Rescue Strategy Committee, the British Search and Rescue Executive Committee and the local search and rescue committee); government departments have the Ministry of Transport, the Ministry of Defense, the British Cabinet, the Scottish executive authorities and the National Assembly of Wales; official institutions have public security departments, Fire departments and medical departments; non-governmental organizations have the Royal Lifeboat Federation (RLF)and other relevant voluntary organizations.

2.2 Search and rescue team scale

As the end of 2016, China's salvage system currently employs 8963 people, the proportion of staff as shown in Figure 2.2. In the management of personnel, the

rescue system a total of 1124 people, accounting for 12.5% of the total number of employees; in the professional and technical personnel, the rescue system a total of 2977 people, accounting for 33.2% of the total number of employees, senior, intermediate, The number of people is 4:35:61. Professional and technical team, land professional and technical personnel 977 people, accounting for 11.0% of the total number of employees; water professional and technical personnel (senior crew) 2000 people, accounting for 41.4% of the total number of crew, including 25 senior captains, senior engineer 33 , The captain of 205 people, 198 long wheel. In the flight personnel, the rescue system a total of 386 people, accounting for 4.3% of the total number of employees. Among them, the commander of seven people, 11 captain, 16 co-pilot, 28 flight attendants, 6 students, 28 responsible mechanics. Staff skills in the staff, the salvage system a total of 2614 people, accounting for 29.2% of the total number of employees, including a senior technician, technician 4 people. Senior workers, intermediate workers, the proportion of primary workers for the 36:35:29; workers in the staff of the diver (including emergency personnel) 407 people. Among them, the saturated diver and mixed gas divers more than 50 people.

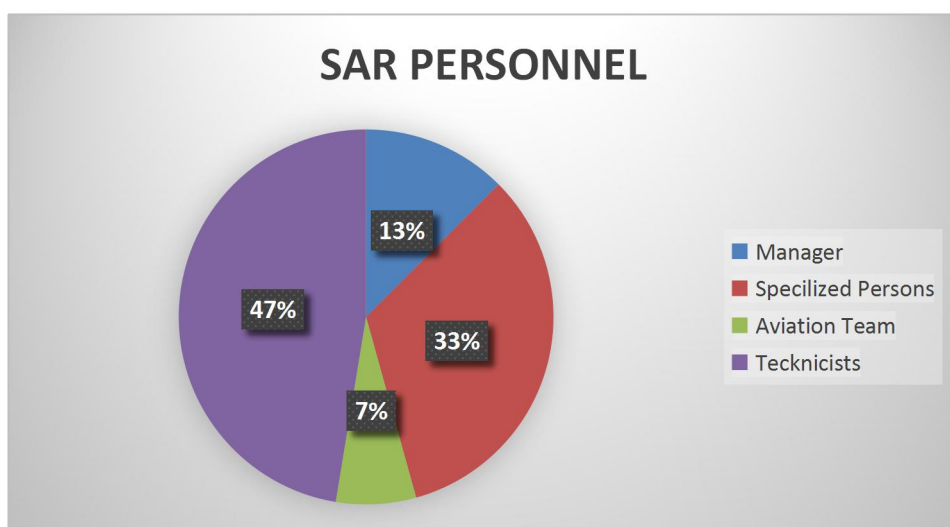


Figure 2.2: China's salvage department staff

Source: Compiled by author

US Coast Guard is the main body of the US rescue industry, the team is huge, the existing 36,000 officers and recruiting staff. It is also equipped with 8,000 reserves, 34,000 Coast Guard Auxiliary, which is made up of volunteers. Coast Guard has more than 5,000 non-military personnel. At present, 90% of the UK's maritime search and rescue operations are carried out by social forces. Sea life rescue mainly relies on social organizations. The Royal Lifeboat Association is responsible for the implementation of the Maritime and Coast Guard Auxiliary (MCA). Japan Maritime Security Department mainly to maritime rescue, traffic safety, disaster prevention and environmental protection, security and security for the task, the ship rescue business by the police rescue department, including maritime relief, marine environmental protection and marine disaster prevention and other three parts. The rescue staff can be divided into three categories: divers, mobile rescue workers, special rescue teams, three types of personnel responsibilities, sources, training content, etc. have different requirements, and taking into account the age, health status, physical strength, swimming ability Conditions, to be selected.

Through the above summary, we found that China's professional maritime rescue force is the main force and the backbone of the implementation of the maritime search and rescue mission, but compared with the huge professional rescue team in the United States, there is a clear gap in China's professional maritime rescue team.

2.3 Search and rescue equipment

2.3.1 Professional rescue ship

As the end of June 2016, This paper statistics China and the United States, Japan, the number of professional rescue ships as shown in Table 2.1. At present, China's

salvage system has a total of 71 types of professional rescue ships, respectively, deployed in China's more than 18,000 km long coastline of the 83 sea dynamic duty points, including: 22 large rescue ship, 8 medium rescue ships, 9 offshore rapid rescue boat, 32 coastal rescue ships (including river rescue tugs), initially formed a large, medium and small ships combined coastal rescue network new pattern. In the United States, the Coast Guard, part of the US Department of Homeland Security, is the main maritime search and rescue force, equipped with professional equipment, facilities and personnel. According to incomplete statistics, the US Coast Guard now has more than 2,000 ships of various sizes, located in the country's 191 search and rescue stations, mainly including large and medium-sized ships about 250 ships, about 1850 small ships. Another example is Japan, the under the sea security office has all kinds of patrol ship more than 50 kinds of a total of more than 700 ships, including 13 cruise ships that can carry helicopters, 40 large-scale patrol ships, 46 medium-sized patrol ships, 20 small patrol ships, 5 fire-fighting ships, more than 200 other patrol ships, in addition to, there are still including measuring ships, set the standard ship, beacon maintenance boats and education trains and so on.

Table 2.1: The comparison of rescue ship amount

Country	Ship Type	Large	Medium	Small	Others	Total
China		22	8	21	20	71
USA		250		1850		2100
JAPAN		53	46	20	205	324

Source: Compiled by author

2.3.2 Search and rescue aviation

After more than 10 years of development and growth, China's air rescue force has begun to take shape, now has four rescue fleet, 16 rescue aircraft. However,

compared with the developed countries, China's air rescue equipment size has yet to be further expanded and expanded, the specific data can be seen in Table 2.2. In addition, there are no bases in the 24 rescue bases in China's coastal areas with helicopter dispatching, landing, oil supply, water supply and other logistics support services, and the existing search and rescue aviation base (including landing point) only 11, seriously hampered the aircraft for long-range search and rescue capabilities. In the United States and Japan and other developed countries, has been established along the coast for the aircraft landing service base, to ensure that the air force on the search and rescue the integrity of the waters.(Coleshaw, S.K. 2002)

Table 2.2: The comparison of rescue plane amount

Country \ Type	Helicopter	Fixed-Wing	Total
China	15	1	16
USA	136	68	204
Japan	46	25	79

Source: Compiled by author

2.4 Search and rescue technology

During the daytime SAR in China, the main means to visual-based, supplemented by telescopes and radar and other equipment; night and visibility under adverse circumstances, the use of visual plus infrared night vision, sweeping lights, fog, Systems and radar equipment search. The following search for the sea scan is mainly equipped with underwater robots as shown in Figure 2.3 (dive depth of 300 meters to 600 meters range), black box locator (up to 5000 meters), multi-beam scanning sonar (Measuring width of 400 meters, vertical detection of 250 meters), magnetometer (detection range underwater 1000 meters), underwater acoustic positioning and scanning sonar system. Compared with the United States and other developed countries in the United States, China's satellite search resolution technology,

deep-sea scanning and imaging graphics technology there is a clear gap. In the search process of the *MASH flight MH370* in 2014, China's high-resolution satellite is only 2 meters wide, while the US keyhole reconnaissance satellite resolution of up to 0.1 meters, imaging clarity ahead (Day, E 2010). In addition, the latest P-8A multidisciplinary anti-submarine patrol aircraft (equipped with advanced acoustic sensors and maritime radar systems, with synthetic aperture mode, capable of searching for water targets and high-precision imaging), advanced towing sonar The cutting edge device, which is capable of detecting underwater depths of more than 6,000 meters deep (Davis, ME. 2011), and "*Bluefin-21 (bluefin tuna)*" (25 hours to sneak into the seabed for 45 hours) is even more impressive.



Figure 2.3: AUV (Autonomous Underwater Vehicle)

Source: Baidu Encyclopedia index keyword "AUV"

In addition, in the development of search decision support system, China Oceanic Environment Forecast Center(COEFC) established the "China Offshore Maritime Search and Rescue Emergency Assistance Decision System" by the end of 2013. Through the sea of spring, summer, autumn and winter in *Zhuhai* and *Zhoushan* Drift test, obtained the drift trajectory of the simulated man, no power boat,

multi-parameter drift buoy and the data of the current and wind on the trajectory. Based on the above-mentioned data of sea drift, the parameters of marine dynamic environmental forecasting model and maritime search and rescue forecast model are optimized to further improve the numerical prediction accuracy of maritime search and rescue drift. In addition, the UK SARIS system can predict the search area of missing persons, ships and objects in the sea, and effectively distribute the search and rescue forces to search the target area systematically. SARIS contains two subsystems, a search area definition tool (SAD), and a search area coverage tool (SAC). The SAD tool is able to predict the trajectory of the target under the combined action of wind, tide and tidal current to determine the best search and rescue area. Once the SAD tool is set up to search and rescue the area, the SAC tool can provide users with a range of tools to quickly optimize the allocation of search and rescue forces (Hall-Arber. 2008).

2.5 Search and rescue regulations and guidelines

In recent years, China has vigorously supported the development of the strategy of "marine power", the promulgation of the "*Emergency Response Law*", "*National Maritime Search and Rescue Emergency Plan*" and "*National Water Emergency Command System*" have provided authority for maritime search and rescue work in China the basis and reference. In addition, China has established three authoritative guidance on maritime bailouts in the light of the International Maritime Organization (IMO) Guidelines on the Prevention and Treatment of Emergency Clauses (MSC.1 / Circ.1183) by the search and rescue organizations and other relevant organizations: Guidance on Ships Relief, Guide to Marine Fire Relief, and Emergency Relief Guide. In accordance with the concept of ship safety management (Canadian Coast Guard. 2012), China has also established a complete set of ship safety management system documents (Finland SAR Manual. 2010), including ship handling documents and

safety management manual, which on the rescue of the action guidelines are: "general relief operations", "bad weather relief instructions", "Special rescue operation instructions", "fire hazard relief operations instructions "and so on (Canadian Coast Guard. 2014).

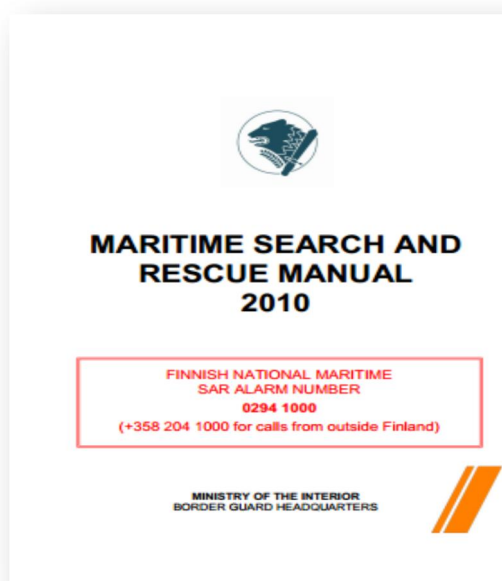


Figure 2.4: MARITIME SEARCH AND RESCUE MANUAL
Source: MINISTRY OF THE INTERIOR BORDER GUARD HEADQUARTERS

There are also a number of search and rescue laws and regulations abroad, such as the International Air and Sea Search Salvage Manual (IAMSAR) in the search and rescue operations conducted a textbook summary (Hart, D. 2006). US Navy finishing "NAVY SEARCH AND RESCUE MANUAL" (US SAR Manual) on the different conditions of the maritime search and rescue equipment, technical details of the finishing, the Finnish Coast Guard on the finishing release of the "MARITIME SEARCH AND RESCUE MANUAL" cover shown in Figure 2.4, It provides a detailed analysis of all the details of the maritime search and rescue process(Hawkes. 1997),

including the designation of the search and rescue plan. In addition, North *ATLANTIC TREATY ORGANIS* released "Survival at Sea for Mariners, Aviators and Search and Rescue Personnel" in the HFM-12 course, which is a question of how to survive in a maritime accident, including the role of a flooding suit, various frostbite, drowning Emergency treatment, etc. were summarized. In September 2016, ICAO published the White Paper "ASIA / PACIFIC SEARCH AND RESCUE (SAR) PLAN", a search program for Asia and the Pacific, which analyzed the characteristics of maritime search and rescue in the region in recent years and made specific Maritime search and rescue planning (ASIA SAR PLAN. 2016).

CHAPTER 3

Safeguard measures for maritime search and rescue personnel

3.1 The status of maritime rescue in nowadays

According to the 2016 annual report of the Ministry of Transport of the People's Republic of China, we can have a basic understanding of the current status of China's maritime rescue. 2016 annual rescue of the East China Sea rescue a total of 670 people in various types of distress, with 2015 year-on-year decline of 12.30%; rescue 31 various types of ship in distress, compared with the same period in 2015 rose 34.78%, but the direct rescue property value of only about 1.3038 billion yuan, down 38.13% year on year, have a certain degree of decline, mainly in 2016 rescued ships to small ships mainly.

In addition to the statistics on the number of bailouts in the last decade of 2016 (see Figure 3.1), we can see that the basic trend of the number of reliefs is upward, which means that future maritime rescue operations will be more frequent and search and rescue risk for maritime search and rescue personnel Probability increases, which also need to give maritime search and rescue personnel more attention to security.

In the rescue force deployed, the East China Sea rescue bureau issued a total of 847 various rescue forces, an increase of 3.93%, accounting for the total number of rescue system dispatched 43.5% (of which: 190 ships, up 46.15%; rescue boat 95

And the 2015 helicopter 230 units, down 3.36%; emergency teams dispatched 352 times, down 5.68%). 2016 more prominent is the ship launched a substantial increase in the number of the total reached 190 times, A significant increase over last year, which shows that maritime search and rescue operations when the professional rescue ship gradually developed into a new force, so the search and rescue personnel at sea to study the safety measures should focus on the professional rescue ship driver and rescue personnel, because they are becoming the main body of the rescue.

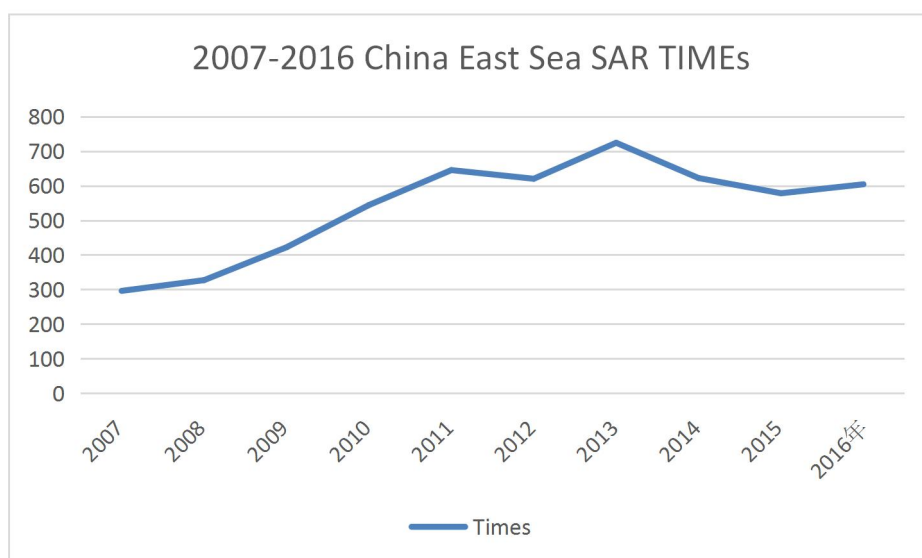


Figure 3.1: 2007-2016 China East sea SAR Times

Source: Compiled by author

In addition, there were 111 injuries (Figure 3.2), accounting for 27.75%, and showed a gradual upward trend. Ship underwater wreckage 121, accounting for 30.25%, both of which are the main dangerous situation of the ship. Fishermen, merchant ship and wounded rescue personnel and emergency transport needs in recent years continue to remain high, but in the harsh sea conditions, the ship turned sinking, mechanical failure and personnel fell into the water and other accidents also reached 100, accounting for 25.0% These are worthy of our attention. In addition, the traditional

sea sick and wounded rescue continued high demand at the same time, land island rescue and cruise personnel medical assistance than in previous years have been a breakthrough. Through the statistics of the proportion of different search and rescue types can know the types of rescue operations of maritime search and rescue personnel to carry out the frequency of action, so the safety and protection of search and rescue personnel should also be combined with data focus analysis.

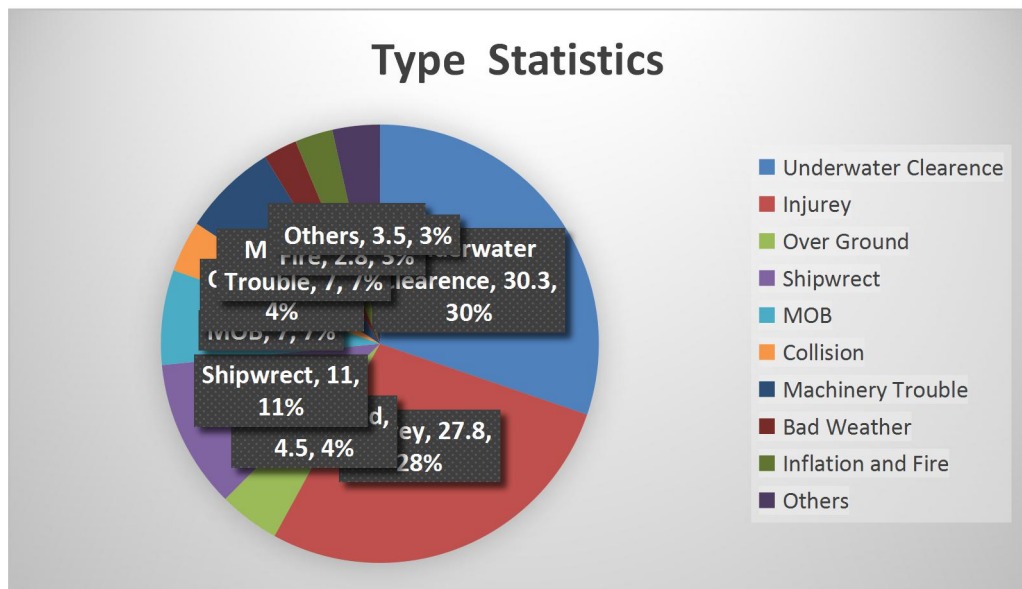


Figure 3.2: 2016 China East sea SAR Types

Source: Compiled by author

In addition, during the maritime SAR operations, the search and rescue personnel distress situation also occurs. October 20, 2016 morning, Qinhuangdao City Maritime Search and Rescue Center, "Jiaqing oil 6" round of distress calls that the return from the Jingtang Port Qinhuangdao process, affected by storm surge, nacelle water, steering gear failure, ship Out of control, on board 8 people are facing life-threatening. Professional rescue ship "North Sea rescue 113" arrived at the rescue site, but affected by bad weather conditions, the rescue ship repeatedly tried to cable

failure, and found that once the cable rescue ship itself in the harsh sea conditions difficult to maintain their own manipulation, affecting the safety of SAR personnel, so the rescue ship decided to take safety and protection measures to the tanker, to be allowed to carry out the conditions of permission to carry out towing rescue operations, and ultimately the crew successfully rescued. July 13, 2015 at about 20:20, Zhoushan City Maritime Search and Rescue Center received "Wanli 8" round report: "Wanli 8" round and "Hengrun" round in the small plate near the sea area collision, "Hengrun" Rounds immediately sank, people abandoned the ship to escape, the number is unknown," Wanli 8 "round has been lifted lifeboat rescue staff. 1:45 am, "sea patrol 0732" boat arrived at the scene of the accident. Due to the typhoon "Can Cheong" just leave, search and rescue scene waves high, sea patrol swing range of more than 20 degrees, rescue boats swaying up and down (Figure 3.3), rescue boats hope to use the cable But the rescue failed to break off a cable, and finally search and rescue personnel can only take the risk, climbed to the top of the rescue boat to explore most of the body of the lifeboat crew towed to the rescue boat, this mode of operation so that the rescue boat People scared. There are a lot of dangerous situations, even including many search and rescue personnel in distress occurred when the situation occurred, so the safety of maritime search and rescue personnel research is even more important.



Figure 3.3: “Sea patrol 0732” rescue scene

Source:http://www.cnzjmsa.gov.cn/hsyw/tpjj/201409/t20140919_281226.html

3.2 Classification and duties of search and rescue personnel

According to the difference of the nature and the working environment in the maritime search and rescue personnel, the search and rescue personnel can be divided into the following three parts (Barnes.2011 pp.169–180) (architecture shown in Figure 3.4): rescue personnel on aircraft (including aircraft pilots and aircraft lifeguards), rescue personnel on ship (including the professional rescue ship crew and rescue boats on the search and rescue personnel) (Ministry of Communications 2005), emergency teams (including water rescue, boarding rescue, diving rescue professional search and rescue personnel).



Figure 3.4: The structure of SAR personnel

Source: Compiled by author

1. **Rescue personnel on aircraft.** Maritime search and rescue aircraft are mainly divided into fixed-wing aircraft and helicopters, including fixed-wing aircraft are mainly used for maritime search work, which is often said that "sweeping sea"; rescue helicopters because of its fast, flexible, wide field of vision, search radius , Hovering operations affected by the sea and other characteristics of small, is the implementation of the sea life rescue the fastest and most effective means of rescue is one of the main components of the maritime search and rescue aircraft. With the continuous development and improvement of China's search and rescue system, the number and demand of future maritime search and rescue aircraft will be further increased, through the search and rescue aircraft for maritime search and rescue will be further developed, so search and rescue aircraft search and rescue personnel is an important component of search and rescue system Part of one. Collecting aircraft rescue personnel, including aircraft pilots and lifeguards, the driver needs to determine the location of distress based on distress information to find the location of distress, but also pay attention to the sea of the weather conditions, because the search and rescue helicopters often need to hover, The weather will be dangerous to the flight safety of the aircraft; aircraft also need to be equipped with professional lifeguards, lifeguards often need to fall through the rope to the ship in distress or above the water, found the distress, and the applicable lifeblood (Rescue Net) Or the Rescue Seat (Figure 3.5) is tied to the person in charge or property, and the rope is raised by the pulley with the help of the lifeguard, bringing the distress to the plane and coming out of danger.

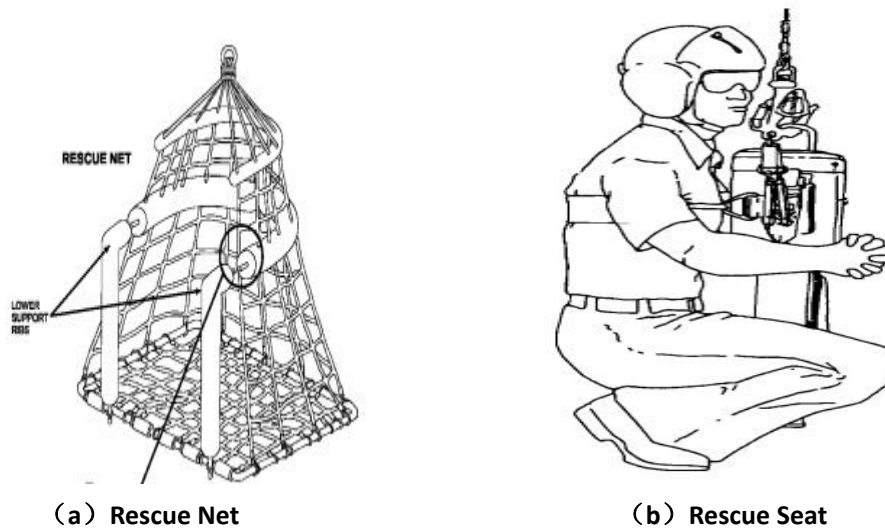


Figure 3.5: Rescue Net & Rescue Seat

Source: NTT

2. **Rescue personnel on ship.** According to the specific needs of the rescue boat can be divided into large-scale rescue for the sea and the professional rescue boats and mobility, flexible operation of the rescue boat. Professional rescue ship crew also need first of all according to the distress alarm to confirm the location of the accident occurred, after the ship sailing to the rescue area, the general accident is often accompanied by bad weather, so the rescue boat driver needs to have a wealth of navigation experience, the ship In addition to the ship in distress, it should also carefully analyze the wind, wave, flow conditions at this time, choose the appropriate close to the direction; professional rescue ship because the ship is larger, usually equipped with the above There are hooks and other rescue equipment (shown in Figure 3.6), which requires the ship staff to master the use of hanging devices and fixed methods; in some cases, professional rescue boats or fire engines, the ship personnel to perform marine fire Work, which requires search and rescue personnel with a certain degree of fire knowledge; general distress often need to rescue the ship for towing operation, which requires rescue personnel with cable business skill. In addition to rescue boats, rescue boats on

the rescue workers are also the third category of emergency personnel, usually in the coastal search and rescue or far from the rescue boat as a mother ship for search and rescue, rescue boats flexible operation, easy to provide assistance to the water, such as Figure 3.7 shows.

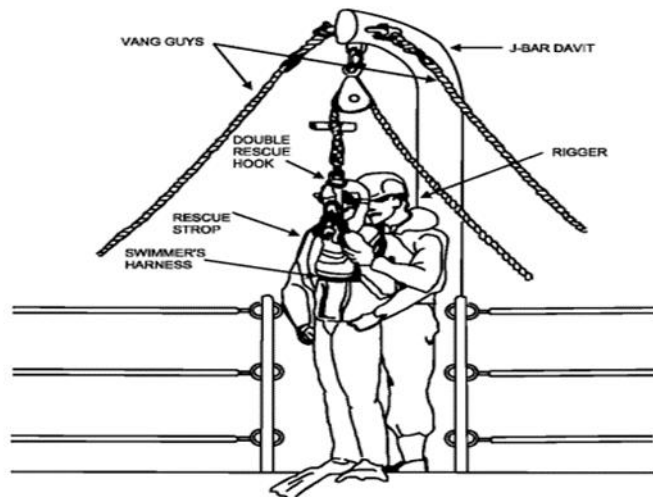


Figure 3.6: Rescue ship hanging device

Source: NTPP

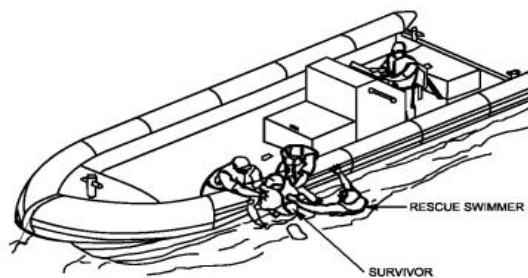


Figure 3.7: Rescue ship in working

Source: NTPP

3. **Emergency team.** Emergency teams mainly by the water rescue workers, divers, boarding rescue personnel. Rescue Swimmer. when the rescue ship identified and found the ship or the victims of the victims, the search and rescue decision-makers in the full assessment of the risk of the water environment, the confirmation can be assigned to the surface of the water rescue workers in accordance with the requirements of wearing protective clothing near the victims Point, this approach is usually used to rescue the sea staff fell into the water, or serious after the sea crash occurred in the search work, the international water rescue workers have strict norms, including the use of rescue equipment when the rescue requirements, close to the distress after how The risk of the person in distress from the dangerous surface and other specific requirements, on the surface of the concept of rescue workers as shown in Figure 3.8. ②Diver. when the shipwreck, especially some serious shipwreck, such as the ship overturned, the ship buckle and other accidents, the crew will be trapped in the watertight chamber can not compete against the powerful water pressure, and then due to prolonged hypoxia, No food and fresh water supplies lead to death, and divers as an important part of the emergency team, in this case will play a vital role. The divers, with the aid of specialized equipment, can carry the defective equipment, search equipment and various rescue equipment into the submarine part of the ship, and seek the distress personnel. In addition, when the ship is controlled by the propeller or the bottom of the ship because of the entanglement, Time limit, but also need the rescue of divers. ③ Boarding salvage personnel (Onboard Rescue). Boarding the rescue for the following reasons: At first, to help people with limited capacity to wear protective equipment, to protect the escape; the second is to provide emergency medical assistance to the ship; third as a fire Players, boarding fire, firefighting work.

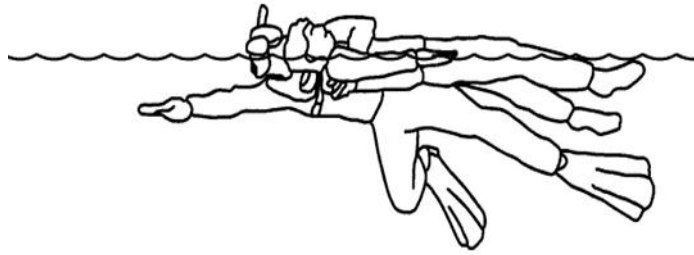


Figure 3.8: Rescue Swimmer

Source: NTPP

According to the above classification of search and rescue personnel, the third section of this chapter will detail the various search and rescue personnel in the search and rescue operations required security facilities.

3.3 The safety protection facilities for search and rescue personnel

3.3.1 Search and rescue personnel on aircraft

The pilot life jacket. At present the aircraft pilots commonly used life jackets for the vest inflatable life jackets, as shown in Figure 3.9, the appearance of vest style, front and hem are adjustable jack, can be tight. Inflated before wearing a lightweight; inflatable balloon will be tightly wrapped around the upper body, a reasonable distribution of the air can be automatically turned upside down tilted on the surface of the water, the head is 120 mm above the water surface.



Figure 3.9: Pilot life jackets

Source: http://bbs.tiexue.net/post2_6586940_1.html

Hoisting Vest. When rescue helicopters hover, rescuers on the search and rescue aircraft often need to descend along the rope to the vessel or personnel near the rescue (Brooks, C.J. & Tipton, M.J. 2001), to help the distressed to wear rescue equipment or emergency personnel to provide medical and other emergency relief in the lifeguards need to wear along the rope Suspension protective clothing as shown in Figure 3.10, to ensure that protective clothing and safety hook firmly connected to prevent the emergence of broken search and rescue personnel to fall.



Figure 3.10: Hoisting Vest

Source: <http://www.lifesupportintl.com/products/aircrew/hoistoperator/aircrew-vest-the-osprey-system/>

Hoist Cable. When the lifeguard descends along the rope, it may be because the rope stuck (Jammed) to cause the lifeguard to hover in the air can not act, which is extremely dangerous, so need to have a professional elastic switch life rope as shown in Figure 3.11, When the rope is stuck, the lifeguard can adjust the *SafetyStrap* (NTTP 3-50.1 2009) to adjust the rope tightness, reduce the force of the rope stuck, easier to lift the rope stuck phenomenon.

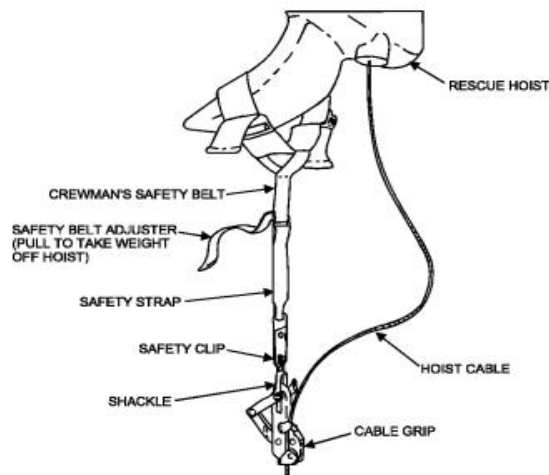


Figure 3.11: The structure of life saving rope

Source: NTP

Special safety helmet. Helmet (Figure 3.12) as a protective device not only for the search and rescue of individual personnel on the search and rescue personnel, rescue crew on board, including boarding rescue personnel should wear safety helmets, safety helmets should also wear searchlight peripherals, Night to carry out the sea rescue. The safety helmet is particularly important for the lifeguard of the search and rescue aircraft because of the particularity of the work along the rope.



Figure 3.12: Special safety helmet

Source: Baidu Picture index word "Special helmet"

3.3.2 Search and rescue personnel on ship

Marine non-slip facilities. Maritime search and rescue often accompanied by bad weather, rescue boat shaking a larger range, and the wind and waves are likely to lead to waves on the deck, coupled with the thunderstorm weather so that the deck of the water, and rescue ship crew in search and rescue time often need to stand The ship's side, the slippery deck is very easy to make the search and rescue personnel accident, slip to the injured or even fall into the sea; In addition, the cold winter deck will condense a layer of frost, which will increase the risk of rescue, so the marine anti- , Which to anti-skid shoes (Figure 3.13) as a typical representative, can play the role of protection of search and rescue personnel (Fu, Y., Zhu, Y. Zh. 2010).



Figure 3.13: Special Non-slip shoes onboard

Source: <http://www.114pifa.com/tagsc/%B3%DD%C2%D68%B3%DD>

Deck handrail rope and safety rope. In order to prevent the escort of the crew from slipping into the sea, the rescue deck should be fitted with a handrail rope and, if necessary, a safety rope (see Figure 3.14). When the rescue boat crew in the cable operation, you can connect yourself with the lifeline, to avoid slipping and other accidents.



Figure 3.14: Safety rope

Source: http://b2b.hc360.com/viewPics/supplyself_pics/139923234.html

Climbing and lifesaving harnesses. When the lifeboat is released in large storms and assisting the distress to board the salvage vessel, set up the climbing net and put on the life jackets and life jackets to prevent danger of falling into the water.

3.3.3 Emergency team

1. Rescue swimmer

Mainly: ① Immersion suit (Immersion suit) as shown in Figure 3.15, is to reduce the cold water in the body heat loss of the protective clothing, it was also called life-saving service. In the process of rescue the sea, the water search and rescue personnel are often in the sea for a long time search and rescue work (X, W. 2012), and low water temperature, warm water immersion service can effectively cut off the loss of heat for water rescue work escort. ② rescue swimsuit as shown in Figure 3.16, when the water rescue personnel found in the rescue boat in distress, the need for immediate water will be brought back to the ship, in the process of diving, due to towing the distress, so the water rescue staff should have a Set of special swimming equipment, rescue swimsuit allows rescue personnel can easily breathe, plus the fins can speed up the procession, GPS transponder can always convey the location, to avoid accidents.



Figure 3.15: Life-saving Suit

Source: Fig.3.15. <http://b2b.hc360.com/supplyself/412752670.html>

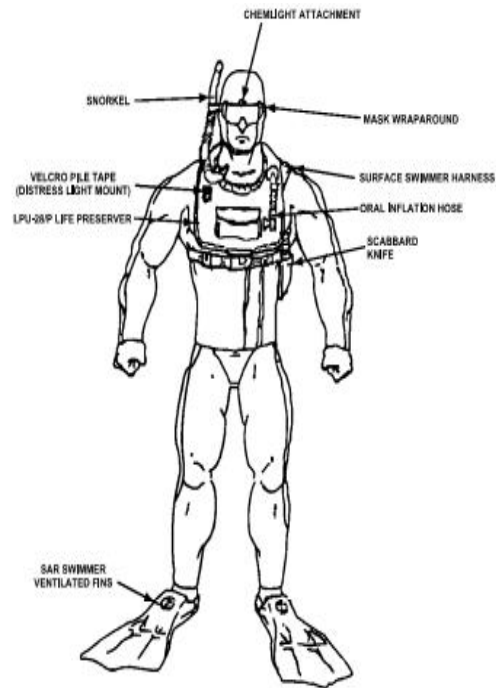


Figure 3.16: SAR Swimmer Suit

Fig.3.16. NTTP

2. Boarding rescue personnel
3. The main task of boarding the rescue workers is to transfer the victims of the rescue and firefighting. The main protective measures are ① protective clothing (Figure 3.17): in the fire extinguishing, the material can protect the skin of rescue workers from the flame of heat radiation and burns and steam burns, the appearance should be waterproof; ② safety lights (Figure 3.18) : In the night of the rescue work or into the lighting interruption of the enclosed cabin, you need to carry a safety light to understand the surrounding situation, the use of dangerous areas should be safe explosion-proof type; ③ self-contained compressed air respirator (Figure 3.19): self- Compressed air respirator is mainly composed of high-pressure air bottle, full face mask and control valve, residual pressure alarm, etc., in the fire detection or sealed cabin rescue, the

rescue personnel in order to ensure their own oxygen needs to be equipped with the equipment; (Figure 3.20): In the rescue personnel to perform a higher risk of rescue tasks, often in the body fasting life rope to prevent falling or other accidents occur, in the fire detection fire, often need a fire-resistant life-saving rope , It has two roles, one is the reality of the channel path, the second should be timely as a search or rescue or contact tools.



Figure 3.17: Protective Suit



Figure 3.18: Safety Flashlight



Figure 3.19: compressed air respirator



Figure 3.20: Life-saving rope

Source: Fig.3.17. http://b2b.hc360.com/viewPics/supplyself_pics/139923234.html

Fig.3.18. <http://www.c-c.com/ctrl/pic-17800866.html>

Fig.3.19. & Fig.3.20. <http://www.chinajvzb.com.cn/haishangsoujiu/>

4. Diver

Underwater wireless communication systems, such as the US AquaSeNT

system (Figure 3.21), the system can provide underwater emergency wireless communications services, when the divers in the underwater search and rescue communication is one of the important security.



Figure 3.21: “AquaSeNT”

Source: <http://www.aquasent.com/>

Full dry diving suit (Figure 3.22). In the diving operation when the submarine temperature is low, professional diving suits can be human body insulation, while in the diving operation when the sea and the hull environment is not yet understood, the need for special materials, diving suits to protect the human body to avoid injury.



Figure 3.22: Full dry diving suit

Source: http://b2b.hc360.com/viewPics/supplyself_pics/249362430.html

③Diving with a knife and flashlight. In view of the particularity of the subsea operation, the submarine light is weak, the divers in the search and rescue need corrosion-resistant, compact and lightweight, water pressure, underwater penetration of the strong flashlight (Figure 3.23) for their own navigation, Because the ship environment is complex, divers likely to be hindered, or even be obstructed or stuck, which need to carry a knife (Figure 3.24) and other demolition equipment to protect their own safety.



Figure 3.23: Diving flashlight



Figure 3.24: Diving knife

Source: Both from <http://www.chinajzb.com.cn/haishangsoujiu/>

④ Diving breathing equipment. Including oxygen cylinders and respirators. Oxygen cylinders should be based on specific work tasks, in accordance with the provisions to ensure adequate air pressure and oxygen; the current respirator is mainly used with two head pressure valve diving respirator (Figure 3.25), the general principle of this respirator is open Cylinder valve, high pressure air in turn through the cylinder valve, pressure reducer, a first decompression, the output of about 0.7MPa of medium pressure gas, and then through the medium pressure air pipe to the supply valve, the valve will pressure The gas in accordance with the wearer's intake, the second decompression, decompression of the gas into the mask for the wearer breathing use, the human exhaled turbidity through the mask on the exhalation valve to the atmosphere, so the gas is always along Flow in one direction without going backwards.



Figure 3.25: Secondary head pressure relief valve Diving respirator

Source: <http://www.chinajvzb.com.cn/haishangsoujiu/>

CHAPTER 4

Risk Analysis of Maritime Search and Rescue

4.1 Characteristics of maritime search and rescue risk

Before the analysis of the characteristics of maritime collection risk, we must understand the characteristics of maritime search and rescue activities at first. According to the analysis and induction of the previous search and rescue cases, maritime search and rescue features include the following (Wu, Sh. 2012):

1. Particularity. The maritime search and rescue process itself is determined by many factors, including weather conditions and search and rescue objects, etc., its specific search and rescue environment led to the unique search and rescue scene, so different search and rescue operations to specific circumstances specific analysis.
2. The clarity of the target. Maritime search and rescue is the most important life rescue, in addition, the rescue of the victims of the ship, as well as the control of the marine environment are the objectives of maritime search and rescue activities.
3. The urgency of time. The sea environment is changing, the general location of the ship in distress and the actual rescue team arrived after the location is very different, on the other hand, the sea is different from the land, if the staff fell into the water, the time to soak in water is limited, so These are the speed of search

and rescue made a strict request, the time is very urgent.

4. The uncertainty in search and rescue process. Maritime search and rescue process often has many uncertainties, including the specific scene of search and rescue and search and rescue information changes, sea conditions and weather changes, in addition, in the process of maritime search and rescue will occur many unexpected events, so the maritime search and rescue with very high uncertainty.
5. Limited resources. The search and rescue sub-centers have developed a detailed search power scheduling program, and in the actual situation, the scheduling of resources often do not like the same plan in a short time to reach the designated location, so according to the location of distress led to the distribution of search and rescue resources Limited, on the other hand also increased the risk of search and rescue.
6. The team's temporary. After the shipwreck, the search and rescue center first to the available search and rescue resources to mobilize, so often rushed to the scene are around the convenience of the ship, this temporary construction team did not like a professional rescue team before the same system training , Lack of understanding between people, so the search and rescue activities need to run.
7. Search and rescue openness. Maritime search and rescue involved in the administration, management is very extensive, in addition to the official professional search and rescue forces, in recent years, maritime search volunteer team is gradually increasing, becoming the maritime search and rescue in the emerging forces.

It is precisely because the maritime search and rescue with some of the above characteristics, making the search and rescue activities at sea and is different from the traditional search and rescue mission, its own complexity and special nature determines the high risk of maritime search and rescue.

4.2 Classification of maritime search and rescue risks

According to the source of maritime search and rescue risks, the risk of maritime search and rescue can be divided into five categories: resources, environment, technology, information and organization.

Resource risk. After the shipwreck, the search and rescue center most need to know is in the incident area and the surrounding areas which can be used to mobilize the search and rescue resources. These resources include maritime patrol boats, professional salvage vessels, professional salvage vessels, rescue helicopters, past merchant ships and fishing vessels, fireboats, cleaners, oil recovery vessels, other vessels, islands and coastal personnel, medical ambulances and facilities Wait. As the shipwreck occurred in the vast sea, to carry out search and rescue operations can get the resources are very limited, which is a lot of accidents can not get the main reason for timely relief.

Environmental risk. The sea where the shipwreck occurred was mostly in the harsh areas of the traffic environment, such as winds, evil waves, reefs, shoals and so on. This harsh environment has caused a shipwreck, but also to the rescue ship caused a great danger. The so-called environmental risk, refers to the search for the waters of the wind, waves, tide, temperature and other hydrological meteorological factors, and water depth, reefs, islands and other geographical elements, the smooth implementation of search and rescue operations brought about by the adverse effects.

Technical risk. Technical risk refers to whether the technical equipment and methods used in search and rescue are safe and effective. The limitations of search and rescue equipment, the lack of dedicated life-saving equipment, search and rescue programs

such as technical defects may cause search and rescue failure. However, due to the rapid changes in the scene, requiring rescue ships can only be based on existing conditions and their own characteristics, creative relief.

Information risk. There are two main aspects, on the one hand is the urgent need for search and rescue the lack of critical information; the other is a lot of spam congestion.

Organizational management risk. This includes the maritime search and rescue laws and regulations are not perfect, around the emergency management system is not unified, search and rescue contingency plans are not perfect, search and rescue project team coordination and communication risks.

4.3 Risk analysis of search and rescue in different stages

Maritime search and rescue according to the time can be divided into three search and rescue stages as shown in Figure 4.1, each search and rescue phase has a corresponding search and rescue tasks (Zhu, B. Zh. & Zhu, Y. Z. (2003).), Each stage has a corresponding risk of search and rescue, the following detailed explanation of the risk, focusing on the implementation of the search and rescue stage of the risk analysis.



Figure 4.1: Three SAR Phase

Source: Compiled by author

4.3.1 Search and rescue start phase

This stage includes the maritime search and rescue center received distress alarm, after the search and rescue center according to the alarm risk level to determine the validity of the alarm information, the location of the accident, type, after the release of navigation warning, start the search and rescue contingency plans. In the search start phase, the most important point is the search and rescue information to master, which directly determines the next step in the development of the search and rescue plan, so the correctness and effectiveness of distress information is the basis of search and rescue operations (Wang, Y. N. 2013), search and rescue start-up stage how to effectively obtain Such information, and to ensure the availability of information is very important (Deltamarin 2006). The main risks at this stage include the study of the search and rescue program, the clear search and rescue mission, the mobilization of all maritime relief and social forces that can participate in maritime search and rescue (patrol boats, salvage vessels, salvage vessels, rescue helicopters, merchant ships, fishing vessels, fire Boats, cleaners, etc.), the formation of search and rescue team, the distribution of search and rescue roles and responsibilities, designated on-site command ship. Search and rescue program is perfect, search and rescue resources are available, communication links are smooth. If the initial search and rescue coordination is not smooth, search and rescue plan to make mistakes, will directly lead to the next stage of search and rescue to carry out the situation.

4.3.2 Search and rescue implementation phase

The search and rescue implementation phase is the most important part of the whole

search and rescue operation (He, Y. X. 2008). According to the third chapter, the classification of the search and rescue personnel in the sea will be described in this section. This section will elaborate the search and rescue risks that different types of search and rescue personnel will face when performing different search and rescue tasks. Search and rescue risk to lay the foundation.

4.3.2.1 Search and rescue personnel on aircraft

1. Aircraft pilot

- **Weather and sea risk.** Whether it is driving fixed-wing aircraft or search and rescue helicopters, from the shore search and rescue center sailing to the accident site of the flight process is risky. Most of the maritime distress accompanied by bad weather, so in the rescue process of sea conditions and weather conditions should focus on. Pilots encountered heavy winds during the flight, which threatened the flight safety of the aircraft and threatened the safety of the pilot.
- **Attention dispersion risk.** Because during the search and rescue operation at sea, the pilot not only to fly the aircraft, but also on the sea of the situation looked through the visual or GPS to find and determine the location of the distress, which makes the pilots attention dispersed, affecting driving safety.
- **Approaching risk.** Because of the special handling of the aircraft, when you find the ship in distress and choose to approach, due to consider the situation at the time of the atmosphere to choose the appropriate angle and approach to close, if close to the method of improper selection, will lead to near failure, not only affect the smooth work of the rescue Will also affect the safety of the pilot.

- **Hover risk.** Maritime search and rescue helicopters often need to hover operations, the purpose is to transfer the transport of distress personnel and facilitate rescue personnel boarding to help rescue. In the process of hovering, considering the wind and wave conditions and maintain the relative stability of the aircraft and the ship is a complex task, the complexity of the task will determine the risk of hovering operation, prone to accidents; In addition, Lowering the rope and laying rescue workers or escalating the risk of boarding passengers will make the aircraft stability changes, especially when the lifting of the larger quality of the aircraft itself poses a risk; Moreover, the aircraft hover generally close to the sea (As shown in Figure 4.2), at the bottom of the troposphere, the airflow is severe, which is one of the sources of risk in hovering operations.



Figure 4.2: Helicopter doing the rescue work

Source: http://hnrh.voc.com.cn/hnrh_epaper/html/2009-11/06/content_138014.htm

2. Aircraft lifeguard

- **Weather and sea risk.** Lifeguard in the process of falling along the rope, if the weather conditions are bad, the rope will be violent shaking, lifeguards even in the case of a safety rope, but also due to the sharp swing of the rope to create a security risk, increase the probability of unexpected.
- **Jammed risk.** It is very dangerous for the lifeguard to descend in the air

when the rope falls due to the rope due to the aging of the rope or for other reasons, or if the safety shackle is stuck and the lifeguard is trapped in the air.

- **Rescue and other risks.** When the lifeguard has successfully landed on the ship in distress, it is necessary to bind the distress by the appropriate rescue device, and sometimes even to bind himself to the same life-saving device, such as a life-saving device, and finally to rescue the plane On the completion of the rescue. Of course, this rescue facilities will be very complicated, and the process of rising along the rope is very dangerous, so there is a risk of rescue equipment bandage.

4.3.2.2 Search and rescue personnel on ship

- **Due to the lack of awareness of the situation of the ship in distress.** Before the maritime search and rescue, you should first get the main profile of the ship in distress, including the main scale, tonnage, cargo and other information to monitor the loss of power ship hull, water tightness and stability, observation of the ship is deteriorating trend and overturned Hazard; to ensure that the equipment available on board, including the host, auxiliary equipment, generators, steering, windlass, mooring equipment and towing equipment, if the rescue operation before the start of this information is not enough understanding, will make follow-up Rescue work there are many unexpected problems, increase the risk of relief.
- **Risk of dragging operations.** (Figure 4.3), but in actual action, the towing operation not only to the tugboat, including the rescue ship will have a corresponding rescue risk, such as cable Sudden rupture caused rescue boat violent swing; trapped boat in the process of stranding the process of stranded

ship rescue operations caused by limited; storms due to the impact of dangerous ship towing effect makes the rescue ship difficult to control and so on.



Figure 4.3: SAR ship doing with cable

Source: http://hnrh.voc.com.cn/hnrh_epaper/html/2009-11/06/content_138014.htm

- **Bad weather and sea conditions.** The harsh sea environment will inevitably increase the risk of navigating the ship, the bad weather under the sea rescue will make the psychological pressure of rescue workers, there is a potential risk.
- **There is a risk in the process of releasing a rescue boat / lifeboat.** Due to the uncertainty of the maritime search and rescue environment, the lifeboat may be overturned when the lifeboat is released, which poses serious harm to the rescuers on the rescue boat. It is also important to note that when the waves enter the shallow water area, Shore waves, the threat to the rescue boat / lifeboat is very large, should be highly valued.
- **Lifeboat sailing risk.** In many cases, the rescue boat is required to release the lifeboat to the distress site for rescue. The rescue boat is prone to collide with the mother ship. There will also be a corresponding risk in the release and recovery of the rescue boat. In addition, due to the small size of the rescue boat, The greater the impact, which also exacerbated the risk of maritime salvage. There is a risk in the process of releasing a rescue boat / lifeboat. Due to the uncertainty of the maritime search and rescue environment, the lifeboat may be overturned when the lifeboat is released, which poses serious harm to the rescuers on the

rescue boat. It is also important to note that when the waves enter the shallow water area, Shore waves, the threat to the rescue boat / lifeboat is very large, should be highly valued.

- **Risk of cabling.** Maritime rescue process is a basic work, but if the cable failure, and sometimes will have serious consequences, such as the North Sea rescue in 2010, rescued a ship called "new crown wins" cargo ship, then rescue ship personnel plan But the cable in the cable when the storm is too large lead to cable failure, the cable dropped into the sea after the rescue boat left and right host are wrapped, making the rescue ship lost power.

4.3.2.3 Emergency team

The emergency team is the most risky group in the maritime search and rescue operations. The contingent includes water rescue workers, divers and firemen as firemen. Each type of emergency personnel has a great risk of their search and rescue tasks. The following will analyze the contingent Search and rescue risk.

1. Rescue swimmer

- **Psychological stress poses a risk.** But there are many professional equipment for their escort, but the sea can not be measured, the rescue process will be subject to physical and mental stress; not only that, the water rescue staff is often a lot of time, but the water is still a lot of money, To salvage the victims, salvage the dead also increased their psychological pressure, resulting in rescue risk.
- **The risk from the distress personnel.** Distress personnel will be extremely afraid of falling water, they desperate to first rescued, this is human instinct. Water rescue workers in the vicinity of the distress, it is vulnerable to

distress of the distress, including the life-saving personnel rescue equipment, etc., rescue personnel not only to stabilize the emotional distress, but also to ensure that the right people to wear emergency rescue equipment, which give water Rescuers bring a great risk of search and rescue.

2. Diver

- **Weather and sea risk.** Bad weather under the high risk of diving, the general provisions of Pu Fok's wind reached 4 and waves over 1.5 meters when not suitable for diving operations.
- **Risk of rescue inside the cabin.** There are moving objects in the cabin and the hull, and the diver should beware of inrush or damage to the diving equipment. In addition, the cabin is more and more difficult to move objects, will hinder the rescue work of the divers, in addition to the cabin items may collapse, which are the risk of diving operations.
- **The risk from diving equipment.** Diver diving equipment damage can easily make the diver injured, and divers should ensure that the air supply is sufficient.
- **The risk of suction diving equipment.** This device is sometimes due to the umbilical cord is not long enough to make the breathing machine gas flow is poor.
- **The risk from the sunken ship.** During the dive operation, the ship may be sinking or displacement, this situation to the divers work brings a great risk. Moreover, sudden changes in the floating state of the ship will also bring risks, changes in the floating state will lead to blocked channels, resulting in rescue divers trapped.

3. firefighting personnel

- There are many sources of risk at this stage, mostly at the same risk as the land-based firefighting stage.

4.3.3 Search and rescue end phase

For the maritime search and rescue project, the entire life cycle of the project will be extended to the accident caused by the sunken ship all the salvage clearance, the accident caused by the restoration of the marine environment, accident investigation and maritime disputes, the treatment of the victims (Howard, P. 2010), The risk of this stage mainly from the provision of warning signs, the withdrawal of search and rescue forces, the resumption of maritime traffic order, to carry out maritime investigation and evidence collection, announced the end of search and rescue (Yu, J. 2013).

CHAPTER 5

Measures and suggestions for SAR risk avoidance

5.1 Risk avoidance measures for maritime search and rescue personnel

According to the analysis of the risk of maritime search and rescue personnel in chapter 4, some specific risk aversion methods are discussed according to the classification of maritime search and rescue personnel according to chapter 3.

1. Search and rescue personnel on aircraft

- In response to the risk of search and rescue caused by bad weather and sea conditions, the Salvage Bureau of the Ministry of Transport has a weather requirement for aircraft take-off to participate in the rescue: visual clouds and visibility conditions. The height of the cloud at the airport is no less than 300 Meters, straight line visibility distance of not less than 3000 meters, salvage the sea floor height of not less than 200 meters, straight line visibility distance of not less than 3000 meters. Take off the airport when the wind conditions, is against the wind Pu wind level is not more than 10, the left wind Pu wind level does not exceed 6, the right wind wind level no more than 8.
- for the lifeguard along the rope down the process of the existence of the risk, first, before the fall to check the rope, pulley and other related equipment; the second is to fully do the assessment of the environment, if the

assessment found that the environment is not suitable for relief Homework, should be carefully selected whether the next step in the rescue behavior.

2. Search and Rescue personnel on ship

- The responsible person on the rescue ship before the start of the rescue must be done risk assessment work, the relevant sea environment, including the state of distress and other important information should be used as an element of risk assessment. Ship rescue personnel should be in accordance with the China Salvage Bureau "rescue operation risk assessment report" and "risk probability list", the completion of the assessment of the risk of relief.
- In the event of a possible accident in the release of the rescue boat, a crawler should be placed on the side of the ship before the release of the lifeboat to prevent the crew from being rescued safely after the rescue boat has made an accident.
- Towing operation need to follow the relevant technical requirements, including cable, then drag and other operations.
- To confirm the ship profile, including the type of ship, the main scale, tonnage and cargo loading;
- To monitor the situation of the ship's hull, watertightness and stability, and whether the observation has deteriorated and the risk of overturning;
- To ensure that the equipment available on board, including the host, auxiliary, generators, steering, anchor, mooring equipment and towing equipment;
- If the steering is not applicable, it can be fixed in the middle of the ship position;
- To determine the location and strength of the power of the ship to lose power, according to the size of the tug, sea conditions, weather conditions and towing distance selection of suitable tug rigging;

- To confirm and maintain a good way of communication, including emergency communications and the full exchange of information;
- To develop appropriate towing voyage plan;
- When considering the route, consider the draught of the steamer to ensure adequate depth of water;
- To develop contingency plans;
- To prepare all equipment, such as towers, cable, cable ties, rigging and deck equipment;
- Work before the coordination meeting, placement, division of labor and safety precautions;
- Monitoring of host, auxiliary, anchor, deck equipment and towing ropes;
- To ensure that emergency equipment available at any time.
- Pay close attention to the depth of water, sea conditions and weather, concerned about the future weather and sea conditions for the development trend of the impact of towing operations;
- Before the flight operation, should be a comprehensive inspection of the tug on the life-saving equipment: ready to transfer personnel at any time;
- Conduct a comprehensive risk assessment before the operation, find the source of risk, develop appropriate security precautions;
- The type of the ship shall be taken into account when selecting towing rigging; for example, oil tankers and dangerous goods ships should be fitted with rigs specially designed for emergency towing;
- To take appropriate emergency towing of the ship on the damaged ship; if the head of the towing point of damage, can take the way the stern drag;
- To confirm the steamer connection;
- If the ship is lost or stranded, the tugboat shall use the simplest cable method to control the dangerous situation: to re-adjust the cable and steamer after

the situation has improved;

- Unmanned drift ship No emergency trailer When drifting on the surface of the water, visual weather and sea conditions Ship or helicopter transporter handling assistance with cable;
- If conditions permit, the tugboat rescue team can board the lost power ship to assist the cable.

3. Emergency team

- When the ship is fixed, the bow of the rescue boat shall be selected to be able to solve the release of the cable in an emergency.
- A comprehensive assessment of the risk to ensure that during the operation of the ship will not sink or displacement occurs under the premise of the diver can enter the cabin.
- The debris in the cabin endangers the safety of the diver and should be carefully cleaned. Under conditions permitting, the rescue diver should act to gently remove the debris to prevent collapsing. If the conditions are not allowed, rescue divers should inform the water, and find the channel. Safety should be ensured to prevent the ship's condition from changing to cause displacement of the object in the cabin and to block the passage again.
- During the rescue operation, at least one set of suction diving equipment should be provided for emergency use.
- Sudden changes in the floating state of the ship caused the channel was blocked, resulting in rescue dive trapped, the emergency diver can help the divers under the aid of the rescue hose to rescue the diver again, but also to find a new path.
- With a self-contained diving equipment need divers lashing signal rope, clear letter sign, easy to escape and emergency rescue operations of divers.

- To assess the impact of heat and heat generated by thermal cutting operations
- Assess the impact of the air spill on the stability of the ship after the hull is opened.
- Horns, hatchways, ocean currents and other movable objects in the hull rupture may endanger the safety of divers.
- Hydrological meteorological conditions may be dangerous for water support operations.
- Pay close attention to the base of the diver, not twisted, damaged.
- In the fire and fire to the environment to fully understand the attention to the analysis of the following: fire, fire boat characteristics of the ship, the ship status of the fire vessel, fire boat personnel, rescue the ship's ability to rescue, to determine whether the fire And should take into account the loading of fire cargo, the nature of the fire, to determine whether the spread of the fire will cause great security risks, such as explosion, and whether the fire measures will have adverse effects on the buoyancy or stability of the ship, such as Lose balance, overturn or wreck.
- To take the side of the fire side of the rescue, especially for the wounded or inhalation of smoke, such as personnel: such as the mentally retarded mental stress, first to appease the stability of the emotional distress, to avoid unnecessary injuries.
- To determine whether the rescue crew has the relevant experience and ability, and whether the rescue ship is equipped with effective fire fighting equipment, especially for the fire ship is a rolling passenger ship, oil tankers, dangerous chemicals and other special vessels.
- To determine whether the site conditions and / or weather conditions are conducive to the safe evacuation and transfer of distress personnel, especially when the number of people in distress.

5.2 Maritime search and rescue risk early warning management

According to the classification of the risk of maritime search and rescue proposed in Chapter 4, this paper puts forward the following suggestions and measures of early warning management according to the five types of risks such as resources, environment, technology, information, organization and management.

1. Resource risk management early warning. Strengthen the maritime professional search and rescue team building, one is to improve the level of technical equipment, to build a number of modern maritime patrol boats and rescue boats. Second, it is necessary to establish a professional flight team to adapt to the air cruise and maritime search and rescue, and gradually improve the coastal waters of China's three-dimensional rescue system, in the key waters to achieve the first sea and air three-dimensional salvage function. Third, the establishment of rescue ships on the sea duty standby system (Kozey, J. 2006), increase the rescue force on standby deployment density, shorten the distance between the ship and the ship in distress.
2. Environmental risk management early warning. Environmental risk management, the need for an integrated monitoring network for the marine environment (Jiang, D. T. 2005), so that maritime management departments to timely grasp the accident-prone areas of environmental changes, to remind those who sail in these waters pay attention to wind and waves, and once the shipwreck occurred, Search and rescue ships to provide first-hand marine environmental information (Hayward, J.S. 1984), early to take measures to cope with adverse weather, reduce the environmental factors on the impact of maritime search and rescue risks.
3. The technical risk of early warning management. For this type of search and

rescue risk, you can carry out search and rescue technology exchange, editing a typical search and rescue cases, the development of search and rescue technical manual (guide), to carry out search and rescue technology training to prevent.

4. Information risk management of early warning. In order to prevent the risk of information search and rescue at sea, China has strengthened the construction of maritime search and rescue information from the aspects of accident alarm and on-site monitoring, including: (1) unified maritime rescue telephone (12395); (2) vessel traffic management system (VTS); (3) the construction of Closed-Circuit Television (CCTV); (4) the construction of ship automatic identification system network (AIS); (5) the construction of electronic chart and ship information inquiry system.
5. The organization and management of the risk of early warning management. In addition to establishing and improving maritime search and rescue laws and regulations, establishing a unified maritime search and rescue command and management agencies, to develop a comprehensive maritime search and rescue plan, to strengthen the maritime search and rescue exercise is also a very important preventive measures.

5.3 Suggestions and thoughts on reducing the risk of search and rescue

5.3.1 Establishment of search and rescue expert knowledge base

Nowadays, artificial intelligence has made many achievements, and expert system (ES) is one of the main applications of artificial intelligence, is a computer program designed to solve the problem of human experts. It is by simulating the results of human experts in the reality of the deduction to make the form of expert opinion and explanation (Huang, Zh. Q. 2014). Therefore, the establishment of maritime search and rescue technology expert knowledge base can be through the computer's efficient

computing power to assist in the relevant search and rescue technology decision-making (Huang, Zh. B. 2015.pp.17–19).

The construction of the knowledge base of the Maritime Search and Rescue Technology, which includes the study of the knowledge and model of environmental information such as maritime meteorology, ocean currents and waves, including the types of distress ships and the nature of distress, various rescue power information, rescue plans and operational procedures. The knowledge base of the maritime search and rescue technician must study the rational knowledge representation model and reasoning knowledge according to the characteristics of the information, such as meteorology, hydrology and salvage power, etc. The knowledge representation should be able to fully express the domain knowledge and Which is conducive to the construction of the knowledge base, and is scalable, understandable, clear, clear and convenient.

"Maritime search and rescue technology experts" the knowledge included in the knowledge: rescue power information, maritime information, search and rescue information, general principles and procedures to rescue and common dangerous emergency rescue professional plans. Rescue force mainly refers to the Ministry of Transport Salvage Bureau at all levels of life-saving rescue ships, other special vessels and rescue aircraft parameters and standby information; maritime information mainly refers to the sea of special geographical information; search and rescue information refers to the ship information The classification of ship information, regional identification and program development and other information; rescue common principles and procedures refers to the basic principles of the rescue process and rescue information processing procedures. The knowledge source of the *"Knowledge Base for Maritime Search and Rescue Technology"* includes: search and

rescue experts, source of hidden knowledge of the rescue salvage professional staff, experienced captain and so on; case records, maritime search and rescue documents, information, salvage units Contingency plans and the International Aeronautical and Maritime Search Relief Handbook and the IMO's access to explicit knowledge such as the "707 Circular" for the manipulation of special ships in storms. "*Expert Consultation on Maritime Rescue Expert Knowledge*" is used to acquire "*interviews with search and rescue experts*", "*direct observation*", "*expert decision*", "*investigation*", "*questionnaire*", "*case study*", "*inspection record*", "*Statistical analysis*" and other methods.

5.3.2 Developing new maritime search and rescue equipment

At present, China's salvage bureau rescue equipment still exists rescue boat, aircraft and other important equipment, the overall lack of the proportion of old ships, large and special ship shortage and other issues. In response to these problems and difficulties, on the one hand, the State and the Ministry of Transport continue to provide strong support for the construction of maritime search and rescue equipment, and actively purchase and build large rescue helicopters, large advanced rescue ships and tonnage floats (Cheng, C. 2016).

The future of maritime search and rescue equipment needs to integrate into the latest technological development results, such as the bureau in the thirteen five plan " Unmanned Aerial Vehicle (UAV)", "Unmanned Surface Vehicle (USV)", " Autonomous Underwater Vehicle (AUV)" (Song, L. P. 2016) Search and rescue equipment procurement and R & D program, in addition, we also need advanced underwater wireless communication systems and more intelligent lifeguard protective clothing (Wang, H. 2010).

5.3.3 Developing of maritime search and rescue personnel integrated security protection system

In the actual maritime search and rescue activities, the search and rescue personnel may need to board the ship in distress to carry out rescue operations, so the development of a set of specifically applicable to maritime search and rescue personnel personal comprehensive security system is necessary (NORRINGTON, L. 2008), according to the maritime boarding search and rescue operations exist in a variety of security The following security measures are designed to ensure the safety of search and rescue personnel during boarding searches:

1. Anti-fall sub-system (PELOT, R. 2006(02)). Mainly including safe off the round anti-fall insurance device, by an anti-fall life-saving device and vest seat belt with the use. The new anti-fall device anti-fall function through the anti-ratchet double disc brake system, effectively control the body out of control fall, the operation can be free to pull out the rope, easy to use, in the normal ship (less than 2 m / s) Affect the normal operation, but when the body quickly fall, you can quickly lock to prevent the staff continue to fall. V-belt seat belt for the shoulder belt, in the waist can be fastened belt, two legs with a ring buckle. The safety device has the following main functions: to maintain the working position of the sea staff to meet when landing, to prevent the fall; to play a protective or elevated role; fall when pulling the body.
2. Anti-subsidence subsystem: including special life-saving package, the sea dedicated life-saving package with life jackets and lifejacket integrated design, the use of special materials and processes, set security, dullness, comfort, water resistance, durability in use of light-emitting band structure in the dark

environment can facilitate the rescue personnel to identify and determine the location of the person in distress. The use of seawater touch emergency inflatable life jackets, marine workers into the water within 5 seconds of life jackets will automatically inflate, so that the head up and float. Among them, the sea touched inflatable life jacket equipped with a number of airbags, equipped with a salvage zone, in case of emergency, the salvage belt inflatable expansion, outward bulging, so as to facilitate rescue salvage. The whistle function in the lifesaving bag allows the distress to send out distress signals so that the rescuer can find and determine the target.

3. Anti-missing subsystem. Including the sea staff alarm and search and rescue system. The system consists of two parts: alarm terminal and search and rescue platform. When the staff fell into the water, the manual activation or automatic activation of the terminal, the terminal to collect the wearer positioning information, optimized processing, according to the specified transmission frequency, through the AIS link sent distress information, information, including personnel identification number, location Information and so on. When the distress position is within the coverage area of the AIS base station, it can be received by the AIS shore-based system and forwarded to the search and rescue mission control center through the mobile communication network, and the search and rescue mission control center organization search and rescue. When the distress position in the AIS base station coverage, the distress information by the distress location around the sailing and installation of AIS ship's ship to receive, the surrounding ship according to the dangerous search and rescue. At the same time, the installation of the *Beidou* generation terminal to receive the alarm information, but also through the *Beidou* satellite sent a distress signal to the search and rescue mission control center to facilitate the shore command and

rescue operations.

4. Anti-injury subsystem: mainly including gloves, anti-skid shoes. Anti-damage equipment is mainly used in the sea operating personnel in the climb when the anti-slip, anti-stab wounds and so on. Maritime staff because of the special nature of their work environment, requiring gloves, shoes, high non-slip, waterproof, anti-corrosion, anti-static, but also to meet the special requirements of night operations. In view of these characteristics, the design of the sea staff dedicated gloves, anti-skid shoes, gloves and vamps are waterproof soft calfskin, soles imported anti-skid tire materials, armed air force anti-static soles formula. At the same time, add 3 M reflective material suitable for night work on the surface.

5.3.4 Strengthen the training of maritime SAR personnel

Search and rescue personnel as the main search and rescue, a good search and rescue literacy and professional search and rescue technology level is not only important for search and rescue operations, but also on the other hand to protect their own security. Therefore, strengthening the training and training of maritime search and rescue personnel is also an important part of building a safety and security system for search and rescue personnel (Reason, James. 1995).

Maritime risk, once the accident occurred, the implementation of maritime search and rescue is a risky behavior, not only to spend a certain amount of time, costs, and sometimes even cause their own losses and casualties, we can only see the theoretical knowledge is far enough (Wei, Ch. Q. 2012), but also need skilled practice Skills, which requires the daily search and rescue personnel in the process of training and attention to the theory and practice of a high degree of integration, it is necessary to

strengthen the practice of training (Xiao, F. B. 2011). Maritime search and rescue personnel in the internship before the internship and job training in the absolute time is now basically in line with international requirements, but the maritime search and rescue special training time is shorter, requiring search and rescue personnel to accept and digest all the knowledge and skills, it is difficult, Effective docking between education and formal work. Therefore, the employing units and training institutions should create conditions for the maritime search and rescue students to provide adequate maritime internship opportunities, to provide adequate maritime internship positions, the introduction of foreign useful practices, to carry out China's maritime search and rescue professional student internship system to strengthen the national North Sea, the East China Sea, the South China Sea Salvage Bureau and training base in the search and rescue trainees after a certain period of time in accordance with its actual performance issued search and rescue card. If the assessment, however, should be a return to the lack of individual to carry out targeted supplementary learning.

The general principle of carrying out search and rescue training and training for maritime search and rescue is to adhere to the combination of theory and practice. In the induction training, regardless of the daily course training, but also to carry out a rich teaching model, such as inviting some experts with rich search and rescue experience special report, and provide students with these experts the opportunity to try to improve every A student's enthusiasm, not only that, but also innovation and reform of the new assessment training model, the current search and rescue personnel training is still limited to the final on the machine test, the future can try to take a combination of paper research and examination methods for each student Designate a mentor to train and supervise their professionalism and work skills. At present, there are still many problems and difficulties in the training of maritime search and rescue

personnel. In the training content, the international background should be combined with the responsibility and obligation of the search and rescue personnel at sea, keeping up with the latest development of search and rescue technology and equipment. More practical opportunities for students to adapt to job needs in advance. Of course, the induction training should pay attention to the allocation of teaching plans, first of all to do the training content of the refinement, not just a simple theoretical knowledge, it is best to explain the specific case; Sex, to keep up with the pace of the times. Solid theoretical basis of the students at the same time, but also frequent exercises, the process of organizing exercises need to take full account of the rational distribution of personal business and assessment of the weight. At the same time, we should further improve the evaluation system of induction training. We can learn from China's Donghai bureau to take the way, the assessment results included in the evaluation system after the entry into the work, eliminating the students only need to "pass" the idea, really play the training "enlightenment" effect.

CHAPTER 6

SUMMARY and OUTLOOK

This paper first analyzes the background of the topic and puts forward the purpose of the writing and the significance of the study. After that, the status quo of maritime search and rescue personnel in China and developed countries is sorted out by combining the search and rescue system, the size of the search and rescue team, the search and rescue equipment, the search and rescue technology, the search laws and regulations And summary; according to China's current rescue situation, try to search and rescue personnel in accordance with certain standards for classification, and different types of search and rescue personnel personal safety protection facilities were summarized; after the start with the maritime personnel search and rescue risk research, The characteristics and definitions of the risk of maritime search and rescue, and the classification of risk, followed by the search and rescue process may occur in different stages of the search and rescue risk of a detailed analysis; after that, in the previous study on the basis of this paper on the corresponding And puts forward some suggestions and thoughts on reducing the risk of maritime search and rescue in terms of search and rescue equipment, search and rescue technology, search and rescue expert knowledge base, search and rescue training and so on.

Maritime search and rescue because of its own background, the environment is

different from its own has a different from the general search and rescue behavior of the complexity and particularity of the search and rescue personnel in the search and rescue operations in the rescue of the main body, in order to provide search and rescue services at the same time, its own Security should also be protected, the risk of search and rescue may also have a corresponding control method. Based on the above research purpose, this paper constructs the safety and security system of maritime search and rescue personnel, and makes a preliminary analysis on the risk control of maritime search and rescue, but there are still some shortcomings:

1. Maritime search and rescue itself is very practical, the proposed theory can be better combined with the reality to be further research, the future of the bailout and other related relief departments to conduct research on the sea search and rescue personnel on the ground visit.
2. The risk of maritime search and rescue in this paper is only a preliminary analysis, the future can be combined with several specific cases of maritime search and rescue to explore, including the entire process of search and rescue operations, from search and rescue help to rescue the aftermath of the work, combined with examples of analysis to help reflect the theory The application value.

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