Research on the Construction of Aviation Distress and Maritime Search and Rescue System

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Abstract: Aiming at the characteristics of aviation search and maritime rescue, this paper means to study the mode of standardized aviation search and maritime rescue. Through the analysis of the capabilities and problems of aviation search and maritime rescue in China, we study the research and construction of ‘ maritime - aerial - aerospace ’ all - round three - dimensional aviation search and maritime rescue system. By using this system, our intention is to build a platform for the central command and deployment. Meanwhile, by utilizing the advantage of all-round three-dimensional characteristic, we can maximize the search and rescue capability, extend the search and rescue scope, save the rescue time and improve the search and rescue effect. Aiming at the existing problems and characteristics of maritime search and rescue in China, this paper puts forward the construction planning route of the aviation search and maritime rescue system, and systematically improves the capability of maritime search and rescue in China through the comprehensive development of system optimization, equipment construction, education and training.

1. Introduction

In recent years, with the constant aviation accidents occurring frequently, like Malaysia Airlines flight MH370 losing contact, AirAsia QZ8501 flight crashed into the sea and so on, which result in an immeasurable loss of human casualties and their properties. Because of the complex marine environment, inaccurate accident location, far rescue scene away from the mainland and other characteristics, aviation search and maritime rescue missions become more difficult than that in the ground. Thus, researching the construction of aviation distress and maritime search and rescue system, improving the aviation distress and maritime search and rescue effectiveness, carrying out the rescue works rapidly and validly after the crash are of great importance to the salvation of life and the reduction of property damage.

2. Characteristics of aviation distress and maritime search & rescue

2.1. Timeliness and effectiveness of maritime search and rescue

Due to equipment failure, complex weather condition, operational errors and other reasons, aircrafts or air vehicles may be led to happen the accidents of sea crash or forced landing. After the occurrence of marine risk, it’s extremely urgent and important to rescue trapped people. As the distress position is far away from the mainland, it’s necessary for search and rescue forces to take a lot of time in the period of confirming the accident, making search and rescue preparation and taking off. Especially in the high latitudes of the sea in autumn and winter, people will be subjected to coma and death soon caused by drowning after falling into the water, so the top task of the maritime search and rescue is being flexible and rapid[1].

2.2 The professionalism of the rescuers

Maritime search and rescue works are influences by the limitation of weather, sea condition and other effects, for example, the scene of incident was located in territorial waters with high waves and many reefs, under this circumstances, search and rescue ships and aircrafts are difficult to carry out rescue and easy to catch in jeopardy, and even cause rescue workers in danger. Above all are severe tests for those search and rescue workers. Solving those problems requires them with strong psychological qualities, solid business skills, rich practical experiences and noble professional characters.

2.3 News and media attention

With the development of the Internet and mobile media, public accessing to news and information is increasingly fast and abundant, and they pay more and more attention to those large events, such as aircraft crash, ship distress, etc. With regard to the incident of MH370, the search and rescue news reported by various countries triggered a great cause of social concern, and Chinese operation of sending a large-scale, high-tech search and rescue forces became a hot topic at that time. It can be said that the maritime search and rescue operations is not only representing the strength of a country, but also reflecting the image of a country.

3. China's aviation maritime search and rescue ability analysis and existing problems

On the basis of establishing a joint conference system and being led by the center of Ministry of Transport and Maritime Search and Rescue, our country has established a sea search and rescue system in 2005, which makes China's maritime professional emergency rescue force suffered a rapid and healthy development. China's coastal has established three bailouts, three salvage bureaus, four sea rescue fleets, and the distribution is shown in Figure 1. And it includes the professional rescue salvage vessels for more than 190 ships, 21 rescue bases, 18 emergency rescue squads; 12 professional rescue aircrafts, 7 duty places, and 38 takeoff and landing spots, which form an aid, salvage, flight three-dimensional team institution and have the comprehensive ability of the air three-dimensional salvage, rapid water response, underwater diving salvage trinity.

Figure 1 Distribution of China's civilian search and rescue forces

Due to multistage, such as national, provincial, municipal, multi-sector coordination problems, there is a large gap between the level of professional facilities and equipment and the scale of professional personnel in the maritime search and rescue, coordination and command system, which can not meet the requirements of China's shipping rapid economic development. The current state of China's aviation search and maritime rescue development has the following problems:

3.1 System and command process need to be further strengthened

Maritime search and rescue is a high risk, high command of the work, at present, China has not established and equipment to adapt to the use of marine aviation search and rescue system, the lack of standardized system command procedures and various contingency plans. Site real-time command and trend release ability is weak, once the rescue force dispatched, search and rescue command center according to changes in the situation to dynamically adjust the rescue program resources support will become a serious shortage. Although there are some mature search equipment, but did not form a joint effort to maximize the effectiveness of the lack of aviation rescue equipment in the implementation of maritime distress rescue operations in the disposal methods and action plans.

3.2 Technical equipment lags behind the world's developed countries

China's search and rescue work started late, the overall technical equipment lags behind the world's developed countries. As for search and rescue work of MH370, China dispatched amphibious landing ship, destroyers, integrated supply ships, lifeboats for more than 20 ships to do sea search at that time; dispatched helicopters, transport -8, Il-76 transport aircrafts nearly 10 frame to do aerial search. In that joint search and rescue operation, though China had sent a lot of search and rescue equipment, comparing with the world advanced countries' equipment, there is still a large gap in the aspects of search efficiency, life time, program planning and professional equipment.

For example, China's air forces mainly focus on transport aircraft, and Il -76 transport aircraft is not a dedicated remote water patrol aircraft[2]. The transport aircraft lacks of dedicated maritime search equipment, and it mainly relies on the use of simple optical equipment (such as telescope etc.) to observe, so there are some disadvantages like small range of search, low actual efficiency, high rate of human error defects and so on. In contrast, the P-8, P-3 maritime patrol aircraft used by the United States, Australia and other countries, with advanced electronic detection platform, equipped with a wealth of electronic reconnaissance and detection search equipment, can achieve all-weather independent search and accurate reconnaissance.

3.3 Lack of professional search and rescue force

Professional search and rescue forces contain two meanings, one refers to 'search' and the second refers to 'save'. 'Search' refers to the action to find the target object, and 'save' is to implement medical assistance after finding the target. As modern emergency rescue professional norms and management technology have not yet been fully popular, it seems to be particularly deficient in organizing professional medical rescue team, and the mainly prominent for the following three aspects: First, because of the uneven distribution of medical resources in China, Urban medical resources is better than rural[3], and the unbalanced medical resource layout affect the implementation of the rescue progress and effect. Second, the technical level of rescue workers is uneven. Some staffs have not received professional training, lacking of professional search and rescue knowledge and skills, and we also lack the uniform standards for the rescue staff. Third, the public have an indifferent and vigilance awareness of disaster prevention. They often suffer the psychological panic after distress, which easily lead to the secondary casualties. So it's very necessary to enhance people's awareness of prevention and self-help ability and carry out search and rescue knowledge popularization and promotion work.

4. Model of standardized aviation search and maritime rescue

The working process of aviation and maritime search and rescue can be divided into three parts: ‘alarm, rescue and end’. The detailed implementation process is shown in figure 2.

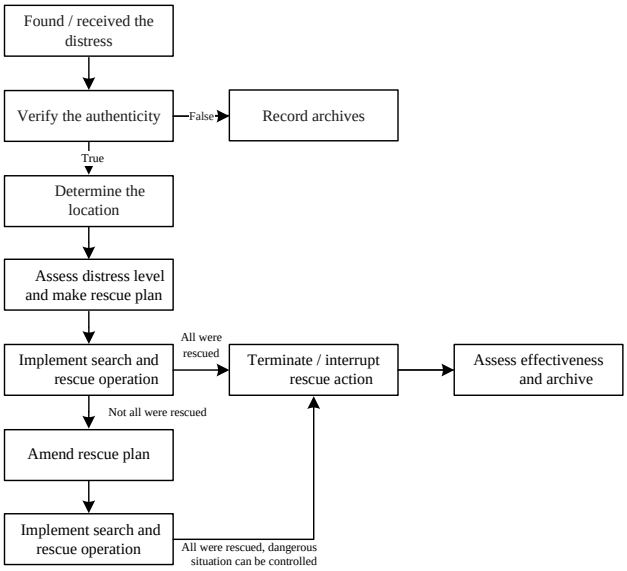

Figure 2 Flow chart of maritime search and rescue

When the staffs in maritime search and rescue center received distress alarm or found distress situation through the monitoring, the first thing the attendant should do is to verify the authenticity of the accident by using of professional knowledge. If it is true, then the attendant should communicate with the person in distress quickly, and inform whom that the police have already known and is preparing to start the rescue operation. Meanwhile, the attendant should determine the location of the accident, which needs to consider the location of beacons and seawater mobility comprehensively, and the information can be a coordinate point, a line or an area. The related personnel in search and rescue center organization should assess the distress level, carry out the search and rescue programs and implement the search and rescue operation according to the initial location of the distress, and refine and amend the search and rescue programs in accordance with the actual situation. When all rescued or dangerous situations are controlled, with no further harm, the principal of the search and rescue center issued a direction to end the rescue operation, which means this operation is up to termination, and the relevant personnel need to assess the effectiveness and organize archives.

Maritime search and rescue is in the race with the time, survivals sounds are with the relevance of the time in the water, water temperature and weather conditions, life-saving equipment, etc. [4]. Ordinary people soaking in the water temperature of 20 ℃ in the sea, the longest survival can live for 16 hours and 20 minutes; while water temperature is 10 ℃, the longest survival can live for 2 hours and 40 minutes; while water temperature is 0 ℃, the longest survival can live for 12 minutes. ‘Rapid and efficient’ is the key point of sea search and rescue work. This paper studies a kind of ‘maritime - aerial – aerospace’ all - round three - dimensional aviation search and maritime rescue system, namely, it’s a synergetic operations combing the help of sea search force (ship), aerial search force (aircraft) with aerospace search force (Beidou / GPS satellite) to carry out the search and rescue operations (Figure 3), these processes are unified commanded by the maritime search and rescue command center.

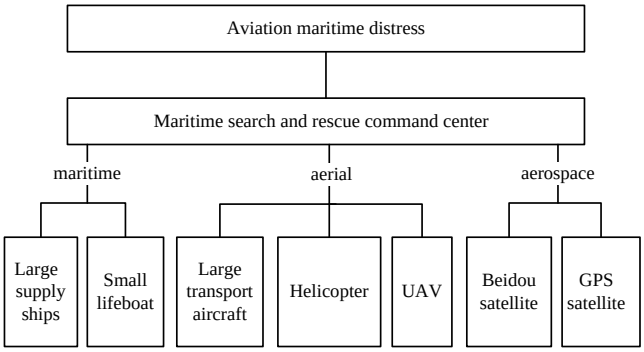

Figure 3 Aviation distress and maritime search and rescue system

4.1 The surface search endurance force is strong

Rescue ships need advanced detection and rescue equipment and can provide a platform for helicopters, such as large ships, amphibious landing craft (for helicopter landing), ocean lifeboats and so on, to meet the large area of the maritime search work. Meanwhile they also need to be equipped with small lifeboats and speedboats with the features of strong mobility and high flexibility to inspect the key areas. Sea ships are suitable for long-term search operations, but the speed is low, and the typical maximum speed of it is 55 km / h. If the incident area from the rescue base is not far, the ship can arrive in time; but if the incident area from the rescue base is far away, then the ship can not reach quickly to do the search and rescue operation.

4.2 The speed of aerial search is fast

If the rescue ship is not in the incident area, whether air rescue forces can quickly maneuver and with the shortest time to reach the scene of the accident or not, is directly related to the success or failure of this search and rescue operations. If the plane is forced to land in the sea after crash, under the influences of the ocean currents, sea breeze, the role of waves, the life rafts will drift in the sea. With time passing by, passengers will become farther and farther from the accident site, which resulting in the search range continues to expanding. In case of serious accidents, such as plane disintegration of sea drowning, and the body remains after a period of drift (e.g. MH370 aircraft wreckage drift at a speed of 40-100 - km per day), may spread in the tens of thousands, hundreds of thousands of square kilometers area, as the sea surface ship alone can not meet the requirement of the search and rescue, it needs the help of ‘aerial – aerospace’ cooperation.

First of all, let the large transport plane quickly arrive at the scene of the accident (this can reduce the necessary time from receiving the distress signal to landing the scene to search and rescue), then feedback the latest information about the incident spot to the search and rescue center for them to adjust the next search and rescue program. At the same time, it can comfort the feelings of those lost-controlled people. But it is difficult for the fixed-wing aircraft to implement salvage assistance to the people and floating things directly, thus the role of search and rescue helicopter is particularly important. Especially in the complex sea condition like storms, it is difficult to drive lifeboats, helicopters can hover in the state, retracts the cable or life-saving basket to rescue the sufferers. At the same time, the helicopter can also serve as a means of transport between the rescue site and the rear of the land, to deliver life-saving supplies, emergency equipment, medical personnel, sick and wounded people to the scene of the accident.

Flying activities are prone to be affected by meteorological conditions, such as thunderstorms and low visibility of complex weather, which will be dangerous to keep flight safety. While fixed-wing aircraft and helicopter battery life are limited, so you can consider the use of long battery life, less man-made unmanned aerial vehicles to do search and rescue work. There are some reasons: first, unmanned aerial vehicles are not equipped with flight personnel, free from fatigue driving, casualties and other factors, and have an excellent endurance (such as American RQ-4B ‘Global Hawk’ UAV life lasted 36 hours, with the maximum range of 22,780 km[5]), the second is the unmanned aerial vehicles can fly hoveringly in a certain target sea, which is difficult to achieve for those driver's fixed-wing aircraft, helicopters or satellites under orbit control. Third, he flight

height of the machine is relatively low, and the target can be observed closely. The target data and image information can be quickly transmitted back to the search and rescue center through the satellite system.

4.3 Space search force works around the clock

The Global Satellite Search and Rescue System (COSPAS-SARSAT) is a satellite search and rescue system jointly developed by four countries: United States, Russia, France and Canada. The system consists of user coordinates, ground handling system and space segment of the three major components of the satellite, which can provide global search and rescue services

In recent years, with the rapid development of China's satellite industry, the construction of Beidou satellite navigation system has been successfully covered throughout China and the Asia-Pacific region. The system can not only provide the functions of high-precision timing, navigation, positioning, but also have a short message communication function, which can be applied to Aviation distress and maritime search and rescue works. Comparing with the foreign COSPAS-SARSAT system, China's Beidou satellite navigation system has the following advantages: independent research and development, security and stability, less influenced by the sea environment, wide coverage, high timeliness. Beidou satellite navigation system mainly is formed by space satellite, ground receiving station, search and rescue command center and user equipment, as shown in Figure 4. When the plane in danger at sea, the sufferers can automatically or manually send distress signals, and distress signals forward to the ground receiving station through the satellite, after the ground receiving station receive the signal of processing, it can access the location of the sufferers information, and then through the ground communication network, the information can be sent to the search and rescue center. Thus, search and rescue center can integrate sea, air and satellite tripartite information to command and dispatch rescue ship, aircraft to carry out search and rescue operation [6].

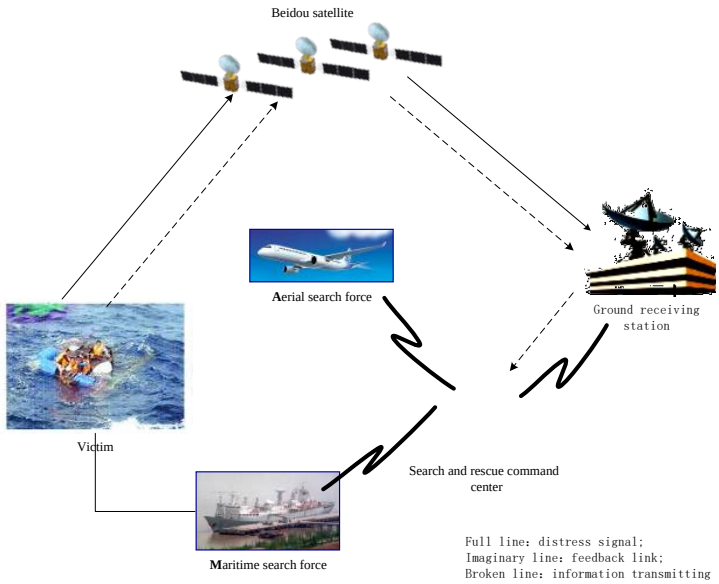

Figure 4 A maritime search and rescue map based on the Beidou satellite

5. The aviation maritime search and rescue development proposal

5.1 The foundation is the unified distress maritime search and rescue system

Maritime search and rescue system is a complex integrated system, it needs the close cooperation with the relevant agencies in order to maximize the effectiveness. According to the European maritime search and rescue data analysis of 2015 results, it shows that the primary task of improvement of the global search and rescue system is to promote the coordination and cooperation between search and rescue agencies[7]. Developed countries search and rescue system is that the

search and rescue center directly command the professional rescue forces, which can greatly guarantee and improve the efficiency of search and rescue operations, thus it can achieve the purpose of enhancing the effectiveness of rescue. However, China's current maritime search and rescue command system is composed of professional rescue organizations, maritime departments, military armed police, volunteer groups and other common participation, numerous but not unified, and the departments are relatively independent, which lead to the result that each department does not understand each other, restricting the coordination and reunification of search and rescue operations and affecting the improvement of search and rescue efficiency in China. Therefore, speeding up the establishment of a unified and efficient maritime search and rescue system is the basic task to enhance the search and rescue capabilities.

5.2 The key is the long-term equipment improvement plan

Aviation and maritime distress place is mostly far away from the land, and the sea condition is bad. From the analysis of China's maritime search and rescue case, China's equipment has a space yet to be improved, so the development of long-term equipment improvement plan is the key to maritime search and rescue construction. Equipment improvement can rely on scientific research institutions, local colleges and universities and military research institute together to complete. The aircraft and ships which involved in the search and rescue operations will be installed a dedicated detection and search equipment, and their equipment will be maintained and upgraded regularly, the aircraft's battery life will be enhanced, the Beidou satellite navigation system positioning and communication functions will be strengthened, and thus our overall search and rescue capabilities will have an overall improvement.

5.3 The development need is the professional search and rescue education and training

The professional quality and skills of search and rescue personnel has a great extent influence on the rescue capacity of rescue team. In the case of similar performance of the rescue equipment, personnel search and rescue skills directly affect the effectiveness of the rescue. Therefore, setting up professional maritime search and rescue education and training institutions is very needed, so we can set up search and rescue courses in local colleges and universities, and also can set up a special training and education classes which should be attributed to the maritime distress search and rescue center. In this way, we can improve the personnel search and rescue capabilities based on the continuously updated search and rescue experience .

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