



Research on Aviation Emergency Rescue Operation Mechanism Based on Equipment Coordination

Zhiming Lv*, Dongxu Di, Hengzhu Song, Gengjun Chen, Min Li

Shenzhen Xingbiao Technology Co., LTD., Shenzhen 518000, Guangdong, China.

How to cite this paper: Zhiming Lv, Dongxu Di, Hengzhu Song, Gengjun Chen, Min Li. (2025). Research on Aviation Emergency Rescue Operation Mechanism Based on Equipment Coordination, *Aerospace and Aeronautical Engineering*, 1(1), 13-17.

DOI: 10.26855/aae.2025.07.004

Received: May 23, 2025

Accepted: May 26, 2025

Published: July 24, 2025

***Corresponding author:** Zhiming Lv, Shenzhen Xingbiao Technology Co., LTD., Shenzhen 518000, Guangdong, China.

Abstract

The occurrence of emergencies and disasters is completely random, and it is difficult to accurately grasp the law of their sudden occurrence, which brings great objective difficulties for the emergency medical relief management of natural disasters. Aviation emergency air rescue technology also has a variety of characteristics of rapid response, effective and convenient rescue and not limited by the area of flight space. China's aviation emergency rescue is still faced with problems such as lack of equipment and imperfect operation mechanism. From the perspective of improving aircraft emergency rescue weapons and equipment and improving the quality of operation mechanism, this paper studies the characteristics and application scope of various aircraft missions, puts forward the basic concept of coordination of emergency equipment and forces, and based on the comparative analysis of its elements.

Keywords

Aviation emergency rescue; Equipment coordination; Operation mechanism

1. Introduction

China has a vast territory and a high population density. The recurring natural disasters have brought huge losses to our country. In addition to natural disasters, various emergencies also occur frequently. These sudden disasters have extremely strong uncertainty. It is impossible to grasp the law of their occurrence, which is very difficult for rescue operations. The concept of "golden 72 hours rescue" points out that the earlier the trapped people are rescued in an emergency, the higher the possibility of their survival. Beyond the golden rescue time, the possibility of survival is only negligible. Therefore, how to save the lives and property of the masses in the shortest time is the most valuable and important issue to solve the rescue situation. Aviation emergency rescue has the characteristics of fast speed, high efficiency, and small regional space restrictions. In actual emergency rescue, aviation emergency rescue is increasingly used in rescue missions and plays an important role.

2. Current Research Status at Home and Abroad

2.1 Aviation emergency rescue

The aviation emergency support and rescue command system is also an indispensable part of establishing an emergency transportation and rescue organization system. When organizing rescue, coordination with relevant departments is required. After development, the aviation emergency rescue system in most countries has actually reached a certain scale, which not only meets domestic development conditions, but also has relatively excellent professional rescue and emergency response capabilities. The handling and rescue of various emergencies are divided into different systems. When a disaster occurs, aviation emergency rescue usually requires the support of air and land forces. However, disaster relief is not the primary task of the military after all, and the military cannot focus its main energy

on disaster prevention exercises and disaster relief organization and coordination [1].

2.2 Aviation emergency rescue equipment

Today, the foreign aviation emergency rescue equipment system is relatively mature. In real rescue situations, equipment is the material basis for disaster relief. According to the function of the equipment, it can perform disaster information collection, transportation, equipment hoisting, communication, medical rescue and other support. At present, my country's aviation emergency rescue equipment is in a growth period. Domestic research on aviation emergency rescue equipment mainly focuses on the number of helicopters and rescue teams. my country should strengthen the comprehensive independent research and development of aviation emergency rescue-related equipment, improve the performance requirements and flight quality of civil aircraft, and strengthen technical support for the research and development and independent research and development of aviation airborne complete sets of equipment.

3. Aviation Emergency Rescue Operation Mechanism and Equipment Coordination Configuration

3.1 Concept of aviation emergency rescue operation mechanism

The overall emergency rescue operation guarantee mechanism mainly refers to the whole process of comprehensive command, mobilization and effective coordination of the operation of various organizations, rescue participants, rescue equipment, emergency rescue materials and personnel within each emergency rescue system, so as to ultimately ensure the unity of various emergency rescue systems, quickly coordinate and effectively organize and implement the unified action of overall emergency rescue, and reduce the losses of major emergencies that may occur.

Aerial emergency rescue is essentially a special rescue method that requires the use of special airborne rescue equipment and air services and facilities, including airport ground services, air traffic services and other air means for emergency rescue [2]. The biggest difference from other rescue is the management, coordination, control and use of methods and facilities. Based on the characteristics of aviation emergency rescue, its operation mechanism can be defined as the process of using aircraft and airborne equipment to carry out search and rescue, placement and transfer of the wounded, material transportation and other rescue tasks, so as to reasonably and effectively reduce the scope of new life loss and casualties caused by emergencies to the greatest extent possible.

The specific operation and management mechanism of aviation natural disaster emergency rescue plan is mainly divided into four stages: prevention and control and on-site emergency plan preparation, monitoring and forecasting, information warning, emergency rescue disposal mechanism and accident rescue, and environmental post-recovery and organizational reconstruction. Among them, the emergency disposal mechanism and emergency rescue process are the three most important and complex key stages, which refers to the emergency organization management agency taking various effective emergency response and preparation measures in a timely manner through command coordination, linkage coordination, etc. Organize and guide the implementation of the whole process of emergency rescue support actions. How to ensure the fastest mobilization of rescue resources and reduce risks after the disaster accident is an important part of the disaster emergency preparation link. To strengthen the rescue efficiency in the aviation emergency preparation stage, it is necessary to give full play to the advantages of modern aviation and the limited power of ordinary ground rescue equipment, and make adequate emergency rescue preparations in advance.

3.2 Introduction to aviation emergency rescue equipment

Aviation emergency rescue generally includes two types: one is conventional rescue equipment, including helicopters, transport aircraft and ordinary aircraft. At present, most of these equipment are concentrated in military, aviation and navigation enterprises. The second is special aircraft, various special airborne systems, most of which are concentrated in troops or organizations performing special tasks. In emergency rescue, these two types of equipment generally play different roles in disaster relief, thus achieving mutual cooperation. According to their equipment, they can be divided into aircraft and airborne rescue equipment, among which aircraft can be divided into helicopters, fixed-wing aircraft and drones. Each type of aircraft has different characteristics and also plays its own role in the mission. Its types and characteristics are shown in Table 1.

Table 1. Aircraft types and equipment features

Type		Features		
Helicopter	Flexible	Vertical take-off and landing	Can be suspended	Low environmental requirements
Fixed-wing aircraft	Fast speed	High maneuverability	Easy to transport	Relatively high requirements on weather conditions and landing and take-off location
UAV	Small size	Low cost	Maneuverability	Can be used in special environments and conditions

The scope of use of airborne rescue equipment is still very wide, and it has its unique military characteristics. For aviation flight rescue missions in different regions, the equipment is also different, as shown in Table 2 below.

Table 2. Rescue equipment for different aviation emergency rescue missions

Rescue mission	Equipment
Medical rescue	Oxygen cylinders, electrocardiographs, ventilators, stretchers, medical cabinets, medical staff chairs and other equipment
Search and rescue aircraft	Visual observation, infrared forward vision, radar, digital map generator, marker pen, flares, etc.
Fire extinguishing	Fire detection system, fire box, high-definition infrared camera, rescue winch, etc.

3.3 Concept of equipment coordination

The strength of emergency aviation rescue support equipment is the necessary technical and material basis for the efficient implementation of various special rescue operations. In particular, for emergency aviation and emergency flight rescue organizations, the strength of large-scale professional air rescue equipment such as rescue machinery and equipment is a strong basic premise and technical equipment support for the formation of rapid and effective emergency rescue operations. In my country's actual disaster relief operations, serious disasters often have the significant characteristics of wide impact and strong destructive power [3]. At the same time, due to the extremely limited number of small aircraft available for professional rescue and the number of various types of airborne emergency professional rescue equipment in my country, how to deal with the take-off and landing of small and medium-sized aircraft and the loading of various equipment, the unified and reasonable configuration of professional emergency rescue equipment, and the organization and dispatch require special attention, which is very important in emergency rescue. According to the different application fields of collaboration, there are three main angles to define the concept of collaboration.

(1) Mainly aimed at system science theory. Specifically, the system can complete the integration within the system through self-organizing behavior without specific external intervention. It is the overall state effect from "disorder" to "order" to achieve a certain "emergence" behavior. The overall effect of the system is better than the sum of all subsystem effects, which can be simply expressed as "1+1>2".

(2) Computer-supported collaboration refers to the process of computer-assisted decision-making.

(3) Military organization collaboration theory focuses on the study of complex system collaboration within military organizations, including complex human-computer interaction and coordination systems, command and coordination organizations, combat effectiveness collaboration, etc. It can be directly studied through model simulation design methods, analysis and prediction methods, etc.

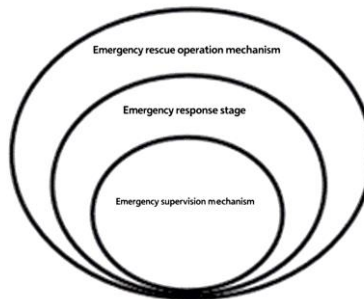


Figure 1. Emergency rescue relationship diagram.

According to the development needs of emergency rescue tasks in the modern aviation field, reasonable configuration of equipment is conducive to the advance preparation of aviation equipment and auxiliary forces, and the realization of collaborative participation in rescue. The operating mechanism of the emergency rescue system, the progress stage of emergency disposal, and the coordination relationship with the support equipment are shown in Figure 1.

In the implementation stage of emergency accident disposal, the comprehensive coordination mechanism of equipment is the key to ensure the full and reasonable dispatch and use of existing equipment and give full play to the efficiency level of existing equipment. It is of equal importance to comprehensively improve the operating efficiency and implementation quality of the overall operating mechanism of aviation disaster emergency rescue.

3.4 Analysis of the components of equipment coordination

The effective coordination or configuration method of the aviation professional emergency air rescue system equipment system is to make two or more special aircraft cooperate with each other within the optimal emergency rescue response time radius to achieve mutual safety cooperation. Perform various emergency flight and rescue tasks, including organizing and using two rescue aircraft and various professional emergency rescue system equipment and onboard rescue service personnel, and be responsible for the rapid delivery of relevant disaster relief materials to the disaster area. In other words, once an emergency occurs, on the basis of establishing the equipment supply and demand relationship, some aircraft and airborne equipment will appear [4]. Under the premise of meeting the constraints, the equipment is transported from the rescue point to the disaster site, and the equipment configuration is optimized to achieve the best rescue effect.

The high configuration and decision-making of aviation disaster emergency rescue equipment have the outstanding characteristics of irreversible coordination. When implementing other aircraft rescue, special attention should be paid to the coordination of various equipment configurations and the optimization of the configuration and disposal of airborne equipment. However, the important basic elements of the careful and serious analysis of the coordinated performance characteristics of various equipment configurations have been scientifically recognized to formulate the suboptimal, efficient and fast coordinated configuration investment strategy for disaster rescue emergency equipment, which can timely combine the strength advantages of aviation rescue special equipment. Then, the overall efficiency of the configuration of various types of aviation rescue equipment can be improved to the greatest extent possible, and the excessive consumption of its configuration manufacturing cost can be reduced. The configuration processing solutions of its equipment coordination capability are concentrated in the following contents:

(1) Rescue materials; Material transportation is also one of the most important parts of emergency rescue in the modern aviation industry. Emergency rescue equipment and materials are transported to rescue points other than airports or emergency resource demand points. They can be regarded as the same batch of transported goods. Their parameters mainly include weight, volume, and whether batch delivery of aircraft is allowed. Because the main demand target of aviation equipment supported by emergency rescue material distribution is aircraft, it can only be measured by the number of flights.

(2) Aircraft; Aircraft is the most important equipment for carrying out aviation emergency rescue operations. It can not only replace vehicles as a tool for transporting goods, but also carry professional rescue equipment to help communications, personnel rescue, etc.

(3) Rescue point; It is an important gathering place for rescue material information and rescue equipment, and is the center point for the configuration and distribution of disaster relief equipment.

(4) Demand material point; Establish a material point that needs to be rescued at the disaster location, including the location, equipment and satisfaction of needs.

(5) Transportation network: It is a network connection between the departure location and the location of disaster demand materials, where the parameters include distance, transportation time, etc.

(6) Goals and constraints: The coordinated configuration of aviation emergency rescue system equipment generally requires the technical constraints and conditions of the distance length limit of the distribution area, the number of rescue points, the ratio limit of the number of demand point equipment, and the time limit of the distribution area to be met in advance.

4. Conclusion

In summary, the professional rescue and mission environment requirements in different regions have many equipment characteristics in their respective important aspects, such as plateau mountains, cities, and water environments.

This article summarizes the professional equipment requirements for different types of aviation missions, explores the establishment of professional aviation rescue emergency support rescue equipment standards for emergency rescue support tasks of different professional aviation missions in the region, and further improves various specialized emergency rescue technical equipment systems, which can effectively enhance the ability of our military to respond to aviation emergencies and natural disasters in a timely and effective manner. The most important aspect in the military is to improve the emergency rescue efficiency and capabilities of the military aviation system and improve the disaster reduction effect. For the country, it is particularly important to protect the health and safety of people's lives, property, life safety, and economic environment construction.

References

- [1] Gao XQ, Zhang ZY. Current status and development of aviation rescue in my country. *Mod Manag Sci.* 2010;(6):86-7,90.
- [2] Yu G, Zong SN, Lu SY, et al. *Aviation emergency rescue.* Beijing: Aviation Industry Press; 2009.
- [3] Liu N, Ge HL. *Theory, method and application of emergency resource allocation decision-making.* Beijing: Science Press; 2015.
- [4] *Research on aviation emergency rescue operation mechanism based on equipment coordination [dissertation].* Tianjin: Civil Aviation University of China; 2018.