

The Introspection about System Construction of Emergency Equipment in China

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Abstract

The fierce fight for the COVID-19 causing more than 825000 deaths worldwide is ongoing. The challenges of COVID-19 pandemic have been emerging, one of which is the incompleteness of emergency equipment system. The necessity of system construction is discussed firstly in our work by analyzing the exposed problems caused by shortage of emergency equipment, inappropriate deployment of resource, etc. Based on the introspection of the current status of emergency equipment system in China, a relatively complete system structure and its construction method are proposed. The reserve system and corresponding standard system of emergency equipment are discussed as well. The construction principles, design methods, main tasks are indicated in sequence. The significance of financial support in the system construction of emergency equipment is also discussed in paper.

Keywords: Emergency equipment, System construction, Main tasks

Introduction

China is currently in a critical period of reform and development. Factors affecting public safety have increased. Various public emergencies have occurred from time to time, especially natural disasters and public health emergencies. In recent years, the natural disasters in China appear concurrent, costly and have far-reaching effect on people's lives and property [1]. Emergency equipment is an important material basis for handling emergencies and taking actions to emergency rescue. Advanced and reliable emergency equipment, as an important carrier of scientific and technological support capabilities, plays an irreplaceable role in disaster relief in particular disasters, particular environments, and particular time periods. However, China has not yet formed a complete emergency equipment system, and there are still many unsolved problems such as the lack of emergency equipment supporting standards. The inadequacy of the emergency equipment system poses huge challenges to international cooperation in major natural disasters, management and control of major crisis, emergency supplies reserves, continuous support capabilities, rapid production and transformation of emergency equipment, as well as emergency scientific research. In the COVID-19 epidemic that broke out in 2020, although China performed well in the fight, a series of problems in the fight have been exposed. For example, the shortage of emergency supplies such as personal protective equipment and

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medical equipment, indicated that the reserve of emergency materials was insufficient and the capacity for production transformation of emergency equipment was still lacking. And the basic reason is the structure of emergency equipment system is unreasonable. These problems further highlighted the importance of constructing a system for emergency equipment.

Developed countries such as the United States, Germany, and Japan are all paying great attention to the construction of emergency equipment systems. For instance, the United States has established five mission areas of prevention, protection, disaster reduction, response, and recovery in accordance with national security requirements for emergency preparedness capabilities and national emergency preparedness goals. The 31 core capabilities that the U.S. government should have are determined (there are 37 target capabilities defined in the Target Capabilities List (TCL) version 2.0 released in 2007). Based on 31 core capabilities, the United States Department of Homeland Security (DHS) and its subordinate Federal Emergency Management Agency (FEMA) have constructed an authorized emergency equipment list (AEL) [2-4]. The list is a compulsory license list, and the equipment involved in the various funding programs of the Federal Emergency Management Agency must be found in the AEL. The list includes personal protective equipment, explosive device disposal equipment, detection equipment, terrorist incident prevention equipment, etc. The data released in 2015 are 21 lists, 84 medium lists, and 709 sub lists. According to the AEL, the United States further developed the Standardized Equipment List (SEL). In addition to the same content as the AEL, it also developed separate equipment sub list for some critical tasks such as EOD, law enforcement, and diving. It is more detailed than the authorized equipment list, has richer functions and stronger operability [5]. The list comprehensively regulates the construction of emergency equipment system, implementation standards, scientific research support, testing and evaluation, financial support, government procurement, reserve management, training and exercises, application environment, etc. The system guarantee capability has been greatly improved, ensuring that when a major crisis occurs, it can provide effective professional equipment, professionals, technical institutions, and government financial support. The list also puts forward a list of annual priority research and development projects, releases information on preparation standards, adopted standards or reference standards, and equipment training requirements, which can provide technical support for first responders.

The Inter-agency Coordination Committee cooperated with the Canadian Police Research Center to appropriately tailor the SEL to form the Canadian Recommended Equipment List (REL).

In addition, the German Federal Agency for Technical Relief (THW) has also released a list of more than 40 commonly used emergency rescue equipment, and has established a certification system and standard system for emergency rescue vehicle equipment.

In these years, China has attached great importance to the research and development of emergency equipment and the cultivation of emergency industry. It has issued a series of development plans and supporting policies, clarified development goals, key areas, main tasks, and safeguard measures, and promoted the scientific research and production of emergency equipment, reserve management, and development of equipment and drill training. However, it should also be noted that there are many unsolved problems existing in the system of emergency equipment. It is necessary to further strengthen the top-level design, make up for shortcomings, and form a disaster rescue capability with Chinese characteristics as soon as possible to meet emergency management needs and to adapt to the emergency management system. Based on the current situation of China's emergency equipment, this article reflects on emergency equipment system, and puts forward the principles and specific implementation tasks of the emergency equipment system construction.

The necessity of the construction of emergency equipment system

The so-called emergency equipment system refers to the combination of general and specialized systems and system support under the leadership of the national authority to effectively prevent and deal with various natural disasters and emergencies. The system is in accordance with the country's requirements for emergency preparedness within the framework of national laws and policies. The emergency equipment is a function-focused, capable and efficient technical equipment system.

By constructing an emergency equipment system, it is conducive to enhancing the pertinence of equipment research and development, gathering scientific research resources, breaking through

technical bottlenecks, and improving the overall technological level of emergency equipment. The construction of emergency equipment system contributes to establish an independent emergency equipment standard system and improve the standardization and generalization of emergency equipment. The quality of scientific research and production will be optimized by building a complete and suitable emergency equipment system. Therefore, the life-span management of emergency equipment will be standardized and the capacity building of emergency equipment reserves will be improved. The construction of emergency equipment system can also ensure the quality of equipment in storage, and improve the continuous support ability to deal with major disasters. Besides, it is beneficial to help guide governments at all levels to increase fiscal and tax support to cultivate the rapid development of the emergency industry. The construction of emergency equipment system is also conducive for professional emergency teams and private emergency forces to carry out targeted training and improve the level of integrated use of rescue forces.

Design principles and methods of emergency equipment system

The design principles of emergency equipment system are illustrated as following:

- The design of emergency equipment system should be pulled by actual needs, and the major points should be emphasized. Emergency equipment covers a wide range of areas, and the transition boundary of equipment between normal and emergency is not clear. The design of emergency equipment system is supposed to lean close to the actual situation of emergency, strengthen the construction of key needs, core capabilities and special equipment. It is noted that system expansion should be avoided, conciseness and efficiency should be highlighted.
- Function connection and system matching are the second principle. Aiming at the three important stages of prevention and protection, monitoring and early warning, and disposal and rescue. The relationship between rescue equipment and support equipment, general equipment and special equipment, equipment and mobilization equipment are coordinated to realize the mutual matching of rescue and support functions and support the echelon connection of forces.
- The construction of emergency equipment system should be guided by standards and regulations. Adhere to standards guidance and standardized development, carry out the whole chain design in accordance with the ideas of standardization, generalization, combination and modularization, and realize standardization of design inspection, standardization of reserve management, and modularization of system application.
- Adapt to demand and update dynamically during the process of construction. To adapt to needs for changing emergencies and technology development, it is necessary to adjust the system composition in a timely manner to achieve a virtuous circle of dynamic update of the equipment system and "intergenerational" development.

At present, two methods are generally adopted for equipment system design. One is the group decision-making method. It refers to the method of carrying out the equipment system design through the appropriate technical form, concentrating the knowledge, experience, and wisdom of experts in various fields. This is also the most traditional and most used method of equipment system design. The technical forms adopted include expert survey method, Delphi method, collective voting method and conference discussion method, etc. The participating experts should cover management, technology, use, evaluation, and other fields. The group decision method has a large amount of data and complex information collection and analysis and processing. At present, in the system demonstration of some industry-specific equipment, the development and application of computer-aided group decision support systems have been carried out, which is helpful for improving the efficiency of the demonstration and the scientific nature of the system design. The second is the mapping analysis method. It refers to the method of carrying out analysis and establishing a system through the correspondence between task-ability-equipment-technology. The emergency mission requirements are mapped and analyzed to obtain the emergency capability requirements, the emergency capability requirements are remapped and analyzed to obtain the emergency equipment requirements, and finally the emergency equipment requirements are mapped and analyzed to obtain the technical development requirements. This is also the basic idea of the construction of the US emergency equipment system. The mapping analysis method can be realized by engineering through software assistance, but in the specific analysis process, many experts are still required to participate.

Main tasks in the construction of emergency equipment system

The construction of the emergency equipment system is not only to build an authorized equipment catalogue, but also should include the following key tasks.

The first one is to put forward requirements for core capabilities. Considering the characteristic of the response to natural disasters, accident calamity, public hygiene event and welfare event in China, the classification of emergencies is firstly accomplished according to disaster treatment procedures or industry fields. The classification should be completed under the guidance of the overall goal of the national disaster prevention and reduction as well as emergency response system. Requirements for core capabilities tend to be proposed afterwards based on the study and reference of foreign emergency capability methods. To deal with the core capacity requirements of emergencies, build public capacity and special capacity requirements for disaster treatment procedures or industry fields, and carry out equipment system demonstration based on actual demand.

The second is to build an equipment system. According to the two main lines of general equipment system and special equipment system, the general equipment system is constructed uniformly, and the special equipment system can be constructed according to the industry field. The so-called general equipment system refers to the equipment series that meet the public emergency needs of different disasters and different industries, such as emergency communications, emergency medical treatment, emergency diet, emergency camping, emergency power supply, other logistics and survival support equipment, and urban firefighting equipment. The so-called special equipment system refers to a series of equipment that meet the emergency needs of a specific industry field and special disaster types, such as forest firefighting equipment, mine emergency rescue equipment, marine emergency rescue equipment, hazardous chemical rescue equipment, etc. In the construction of the system, it is necessary to clarify the equipment objects and application scenarios, put forward the main functions, technical indicators, standardization and supporting requirements. It is also noted that clarifying the technical form of the equipment and standardizing the scientific research and production, detection and evaluation of equipment from the system level are significant as well.

The third is to build a supporting standard system. To promote the healthy and orderly development of the emergency equipment system, there must be corresponding standards for regulation and guidance. The United States has set up an emergency equipment standard coordination subgroup (SCSG) in the inter-agency committee. Its main task is to study and put forward the requirements for standard setting, and cooperate with the internal members of the inter-agency committee, external agencies and first responders to participate in relevant development and revision activities of standards. Maintaining the standards that should be implemented and referenced in the list of standardized equipment is also one of their tasks. For example, 236 standards were released in 2013. There are 79 standards directly adopted by the standardized equipment catalogue, and 137 are included as reference standards. There are 7 standard committees in the German Standards Institute DIN related to emergency equipment, and more than 6,000 standards have been formulated, of which more than 80% are adopted by the European Union and the world. There are 31 technical committees (TC) related to emergency equipment in the European Commission for Standards (CEN), and more than 240 published standards are closely related to emergency equipment.

Emergency equipment is an industrial product or system platform used in emergency situations. It is closely related to life rescue and safety guarantee. The application environment of emergency equipment is special and of frequent. Therefore, the reliability requirements for emergency equipment is more strict than general industrial products. Some sorts of emergency equipment can be stored in normal times and be invoked in emergencies., which is necessary to maintain a good state of reserve technology to ensure that it can be pulled and used well at critical moments. Some emergency equipment selected through the market also need to be restricted by setting access thresholds. The establishment of emergency equipment standard system in China can standardize emergency equipment system design, scientific research and production, inspection and evaluation, reserve management, and use and maintenance. Additionally, the benign development of the emergency industry can be promoted by published good qualities.

To promote the construction of the emergency equipment standard system, the following tasks need to be focused on. The first one is to establish a special standards committee. To fulfil the task, the practice of the American Inter-agency Committee Standards Coordination Group can be referred to. A special standardization committee composed of emergency management agencies, scientific research institutes, production enterprises and first responders can be established under the guidance of Ministry of Emergency Management of the People's Republic of China. The standardization committee is to responsible for standard preparation requirements demonstration, construction of system, adoption of existing standards, formulation and maintenance of standards, etc. The second is to carry out the framework design of the standard system. The overall framework of the emergency equipment standard system can be constructed by borrowing, compiling and revising and other technical approaches. The process can be completed from the perspective of emergency equipment life-span management. The spotlight should focus on the four major systems of equipment system standards including common technical standards, testing and certification standards, and reserve management standards. The third point is to accelerate the preparation of emergency standards. On account of the frequent occurrence of accidents, disasters and emergencies in recent years, we will accelerate the formulation of a batch of emergency standards to guide and standardize the development, production and testing of a batch of urgently needed emergency equipment, such as hazardous chemical disposal equipment and forest firefighting equipment.

One task of emergency equipment system construction is to carry out pilot construction. In order to promote the orderly implementation of the emergency equipment system, we can choose industries with a good foundation and strong professional rescue force to start the pilot construction. Based on the basic principles and capacity requirements of the system design, through the retention and integration of existing equipment, technological upgrading and new research and transformation to form a special equipment system for a certain industry field, such as mine rescue equipment system, hazardous chemical disposal and rescue equipment system.

The fifth task is to carry out inspection and evaluation. There are three aspects should be concerned about. The first one is the assessment of core competence needs. Adapt to changing risks and support resources, regular assessment and update of core capacity requirements should be performed. It can provide a basis for the construction of the national emergency response preparation system and the update of the equipment system. The second aspect is the assessment of equipment system support capability. The emergency equipment system covers a wide range aiming at different rescue scene. Designing the equipment system rationally and scientifically directly affect the rescue capability and support level. To test the compatibility of the equipment system and system support capabilities, the simulation of emergencies, comprehensive drills, and third-party assessments can be carried out. The goal of assessment is to further improve and revise the equipment system and discover the capability improvements brought about by the system design. The third is single-package certification testing. For emergency equipment involves high-risk and special application environments and is related to the life and safety of rescue personnel, it is necessary to clearly implement standards and conduct mandatory inspection and evaluation. For instance, public early warning systems, personal protective equipment, nuclear, biological and chemical equipment, surface rescue equipment, etc.

In addition, financial and tax support for emergency equipment manufacturing enterprises is an important guarantee for the systematic construction of emergency equipment, and it is also a "propellant" that runs through the entire process of system construction of emergency equipment. Public welfare is a typical feature of the emergency industry. The social and economic benefits of emergency equipment manufacturers cannot be directly reflected in the market. The government needs policy support from finance, taxation, and procurement. The US National Emergency Preparedness System (NPS) has a special National Disaster Preparedness Grant Program (NPGP), which is used by the US Federal Government to provide financial support for emergency preparedness, including equipment procurement, and specifies funding projects. In 2015, there were 24 projects in the national disaster preparedness appropriation plan, including emergency management implementation, public transportation security, port security, and emergency operations centres. The United States promulgated the "Coronavirus Supplementary Appropriation Act" on March 6, approving \$8.3 billion for the hardware construction and upgrading of laboratories related to the COVID-19 epidemic and emergency procurement of national strategic reserve materials, such as medical rescue supplies. On

April 24, US government promulgated \$484 billion in response COVID-19 epidemic assistance bill, increased funding for small business loan projects, hospitals, and coronavirus testing agencies. In recent years, China has successively issued a series of documents supporting the development of the emergency industry, such as the "Opinions on Accelerating the Development of the Emergency Industry", the "Action Plan for Cultivation and Development of the Emergency Industry (2017-2019)", etc. The documents put forward that the encouragement of emergency products and services in the structural adjustment guidance catalogue should be increased in support of fiscal and taxation policies. Since 2015, Ministry of Industry and Information Technology, National Development and Reform Commission and Ministry of Science and Technology have jointly promoted the construction of three batches of 20 emergency industry demonstration bases. The implementation of these measures has played a very good role in guiding and supporting the development of emergency enterprises, but there is still a lack of specific measures in terms of financial and taxation policy support involving the core interests of enterprises and long-term development.

National fiscal and taxation policies have an important function of embodying the will of the country, realizing national leadership, and implementing national strategies. At present, financial support methods in China are becoming more and more abundant, the effect of tax incentives is gradually showing, and the amount of funds is steadily increasing. These changes create the conditions to provide financial and tax support to emergency equipment manufacturers. By giving full play to the leverage of fiscal and taxation policies, it can play the role of "hematopoietic agent", "weathervane" and "stabilizer", encourage equipment manufacturers to devote themselves to public welfare undertakings, and foster the rapid development of emergency industries. Drawing lessons from the US's fiscal and taxation support for the R&D and production of emergency equipment, and considering the eager expectations of domestic enterprises for fiscal and taxation support policies, it is recommended to incorporate the fiscal and taxation support policies for the R&D and production of emergency equipment into the national fiscal and taxation policy system. Form a fiscal and taxation policy system guided by national fiscal and taxation policies, industry and regional policies as the main line. The system is closely combined with resource features, strategic layout, and development priorities, to achieve synergy with industrial policies, financial policies, and regulatory policies, and effectively lever the participation of multiple social capitals in the national fiscal and taxation policy system. The following tasks should be focus on. The first is to establish a fiscal and taxation policy system for the R&D and production of emergency equipment. Introduced special fiscal and taxation policies for emergency equipment R&D and production under the guidance of the national public security and emergency industry development macro policies. The process could be proceeded in accordance with the regional resource endowment and development plan. The second is to highlight the focus of fiscal and taxation policy support. Implement the national development strategy, combine the development direction and key areas of emergency equipment specified in relevant national documents and policies, and select basic, strategic and new-quality emergency equipment for key support within the scope of the authorized emergency equipment system. Regional fiscal support policies are inclined to emergency equipment companies with comparative advantages in regional development, which fully reflects the radiation and traction role of fiscal and taxation policies. The third is to play the role of tax incentives and support. Follow the principles of tax neutrality and tax fairness, study and adjust the main body, scope and scale of tax policy support, give full play to the incentive role of tax on small and medium-sized emergency equipment R&D and production enterprises, and stimulate small and medium-sized enterprises in motivation and vitality in technological innovation, introduction and transformation. The fourth is to enrich the form of fiscal and taxation support. Promote financial and taxation support methods and methods such as "funding + reward", "pre-event + post-event", and "direct + supporting" formed in practice in some regions, improve the incentive and compensation policy system for emergency equipment production and development enterprises, and stimulate the positivity and initiative of scientific research and production enterprises. The fifth is to form a policy synergy. Research and explore supplementary financing methods for fiscal and taxation policies, combined with the overall layout of the national industrial fund, study the establishment of a national emergency industry special fund, explore the government and social capital cooperative investment model, and effectively guide social funds to participate in the development of the emergency equipment industry.

Conclusion

Combining China's wide geographic scope, high frequency of emergencies, and multiple types of emergencies, it puts forward the principles that should be based on the construction of an emergency equipment system and the specific steps for building an emergency equipment system. The steps to construct an emergency equipment system mainly include: putting forward the core requirements of the equipment system in line with the characteristics of national emergencies, rationally designing the structure of the emergency equipment system based on actual needs, constructing a corresponding standard system for the type of emergency equipment, and conducting a trial of the emergency equipment system Construction and inspection evaluation.

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