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Electricity emergency management in the UK and Australia: exploring the enlightenments for China

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Abstract. With the deepening of human society's dependence on power, power emergency caused by natural, technological, social and management factors, especially the large-scale power failure accidents, are expanding in scale and degree. In this regard, the electricity emergency management systems in Britain and Australia have their own characteristics and certain reference value. On the basis of introducing the electricity emergency management systems of Britain and Australia, this paper puts forward four suggestions to improve the emergency management system for addressing electricity emergency management in UK and Australia: exploring the enlightenments for China.

1. Introduction

Whether in developed or developing countries, the frequent occurrence of electricity system accidents has caused serious social and economic losses, affected social stability and endangered people's normal life and safety of property. The occurrence of power system accidents reflects the inherent vulnerability of power system. Vulnerability is a kind of attribute that makes the structure and function of the system easy to change because of the sensitivity of the system to the disturbance inside and outside the system and the lack of coping ability [1]. Vulnerability is inherent in the system and must be dealt with through appropriate management mechanisms to prevent and mitigate the damage caused by this vulnerability. The vulnerability of power system determines that it is necessary to establish an appropriate emergency management system to effectively deal with power emergencies [2]. In response to power accidents, the emergency management systems of Britain and Australia have their own characteristics, which also provide useful experience for the establishment of China's power accident emergency management system [3].

2. The electricity emergency management of the UK

In terms of its general emergency disposal, the central government divides the emergencies into three levels: (a) widespread, catastrophic and has spread trend of unexpected public emergency events need the establishment of emergency response committee; (b) for emergencies with broad impacts and requiring coordination at the central level, relevant departments of the central government shall be responsible for cross-departmental coordination; (c) for emergencies that are beyond the local response and disposal capacity but do not require cross-departmental coordination, the relevant central departments shall handle them as the leading departments [4].

2.1. Emergency management organizations

As to deal with electricity emergencies with different influence, there are three layers of related organizations.



2.1.1. National permanent institutions. As a national emergency management agency, the national emergency secretariat established by the Cabinet Office is mainly responsible for coordinating emergency management and rescue across departments and agencies in emergency situations. The specific responsibilities of the national emergency secretariat include emergency management planning, risk assessment, organization, coordination, etc.

2.1.2. National non-permanent institutions. As the UK's top emergency management, coordination and decision-making body, the Emergency Response Team is a non-permanent national body. The national emergency secretariat will decide to activate the team in the event of a major crisis requiring cross-departmental coordination. In addition, depending on the nature of the emergency and its severity, officials at the appropriate levels will participate. In the event of an emergency, the team will be responsible for obtaining timely and accurate information and determine the specific measures to be taken in response to the emergency [5].

2.1.3. Regional institutions. The British government divided the country into nine regional administrations. All bureaus set up golden emergency command organs, formulated regional emergency plans and implementation rules in accordance with the civil emergency law, and organized regional emergency management and training. Depending on the severity and nature of public emergencies, the UK has different levels of emergency response. Local governments are responsible for handling general (e.g., traffic accidents) and public emergencies (e.g., regional power outages) that affect local areas but do not affect the whole country, as well as reporting the disposition of the latter category of cases to the central government.

2.2. Emergency management measures

The Electricity Supply Emergency Code (ESEC) stipulates the national grid emergency response plan. Emergency of Electricity supply is referred to the definition provided in the article 3(1)(b) of 1976 Energy Act and article 96(7) of the 1989 Electricity Act, namely, electricity supply emergency means a state that the system cannot transfer electricity to users due to natural reasons (such as bad weather conditions and other natural disasters) or human and technical reasons (such as inadequate investment in the power grid, the equipment aging, system network congestion, lack of network operating margin).

2.2.1. Variable Rota Disconnection Plan (VRDP). The ESEC stipulates relevant technical and management matters concerning emergency state of power, including the government's emergency power under emergency state of power, the operation rules of each department under emergency. According to the Electricity Supply Emergency Code, the VRDP divides non-protected sites in a Network Operator's licence area into 18 groups (Load Blocks) of near equal demand. It sets out the nominal three-hour disconnection periods, i.e. eight periods in any 24-hour day (See Figure 1). The rota level and level of disconnection will be based on the shortage of supply.

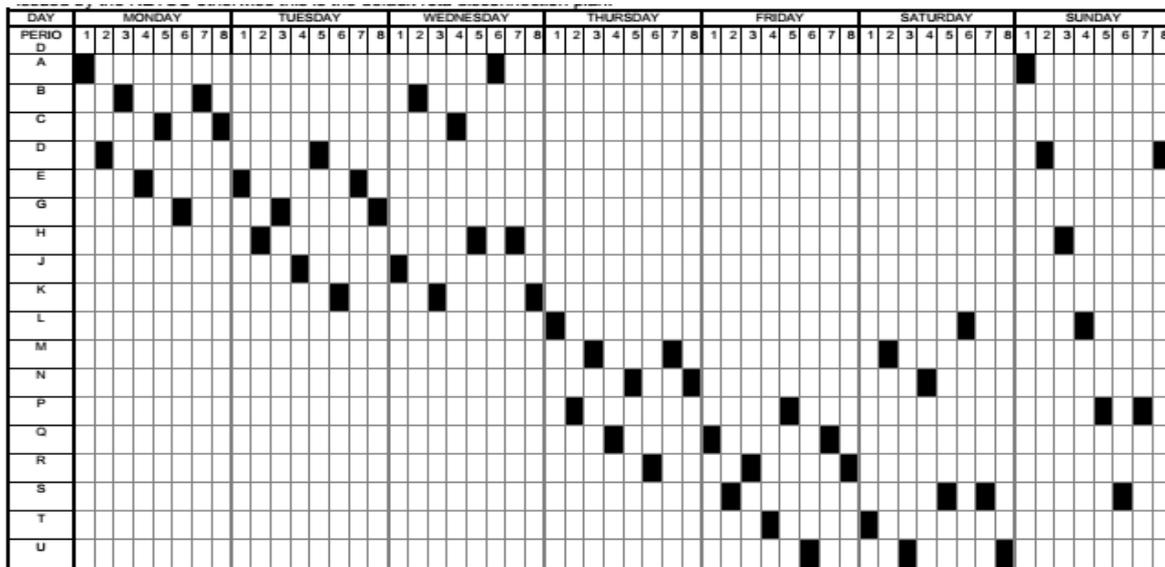


Figure 1. Variable Rota Disconnection Plan (Level 1)

2.2.2. *Black start management.* According to the requirements of the access condition of British power system, the national grid must have the ability of black start. State Grid Corporation has selected auxiliary service agreements with power plants that have been declared to have black start capacity and signed with them with a term of validity of 12-15 years or the entire operating cycle of the power plant (black start belongs to auxiliary service). According to the ancillary service agreement, the plant will be compensated if it has a black start capability or if it conducts black start or black start tests. If state grid requires power plants to use expensive backup fuels, state grid is responsible for compensating for the increased costs. The black startup strategy of state grid corporation is as follows: firstly, the power supply inside the power plant is used to start the unit to form a "power island". Secondly, each "power island" is gradually synchronized, and then the "power island" is connected to form a more stable subsystem. Each power grid company notifies each region to start the black start unit. These generators must be started within 2 hours of receipt of the notification [6].

3. The electricity emergency management of Australia

3.1. Emergency management mechanism

Emergency Management Australia is the largest disaster management agency in the country and its main responsibilities include the development of national disaster response plans, assisting national governments in their disaster prevention and reduction work in coordination with national governments, overseas rescue work on behalf of the government. In addition, Australia also has a special emergency management committee. The federal government, state and local governments have set up corresponding emergency management committees. To save costs, some local emergency management committees have been set up by two or more governments to carry out cross-regional disaster prevention and reduction work. At the national level, emergency management is to provide guidance, carry out cross-sectoral coordination and develop technical standards; Below the national (regional) level, specific emergency plans shall be formulated and implemented under the guidance of the state emergency departments [7].

Australia has developed a series of ideas and models for disaster response: (a) The concept of disaster. No matter what kind of disaster, the task and goal of emergency management are similar; they are to achieve disaster prevention and reduction, to minimize the loss of disaster. Although specific disasters vary slightly in measures and practices, in the context of disasters, universal emergency management arrangements are common. (b) PPRR mode. Emergency management in

Australia consists of four basic elements: Prevention, Preparation, Response, Recovery. Prevention refers to that emergency management departments at all levels in Australia assess the key factors that may lead to the crisis according to the political, social, economic, natural and other conditions within their respective jurisdictions and solve them as soon as possible. Preparation refers to the release and implementation of emergency management plans from the federal government to local governments. Various emergency plans are detailed, specific and operable. The response is that local governments are in charge of directing specific emergency relief efforts in the aftermath of a disaster, and that federal agencies that have not been designated by recipient countries should not direct aid. If a national government requests assistance from the federal government in the event of a need for assistance, the National Emergency Management Coordination Centre (NEMCC) will conduct specific assistance operations with the approval of the federal Department of Justice. The implementation of the recovery is mainly organized by the government of the disaster area.

3.2. Emergency management of electricity systems

According to the requirements of the Australian Electricity Rules (NER) in 2016, Australia has developed the black start guide, which is divided into the power generation company guide and the power supply company guide. The main work of Australian power emergency management is the management of black start. The requirements of Australian power law on black start can be summarized as the following five aspects: (a) Australian Energy Market Operator (AEMO) is responsible for the development of system recovery plan, and the combination and coordination of system recovery; (b) AEMO is responsible for research, development and promulgation of black start work guidelines; (c) power production enterprises and power operators in accordance with the guidelines to develop Black Start Program (BSP); (d) BSP must contain enough information, so that AEMO can determine the situation and the ability of each plant after the power outage, and ensure the effective and safe implementation of the system recovery plan; (e) the BSP for all areas must be approved by AEMO, taking into account the BSP guidelines and related content of the system recovery plan.

4. Enlightenment for China's electricity emergency management

Modern society relies heavily on reliable and stable electricity supply for production and life. With the development of economy and society and the expansion of city scale, the economic loss, social harm and even the life and health damage of residents caused by power accidents caused by natural or man-made reasons become more and more serious. The frequent occurrence of large-scale power accidents and their hazards have prompted the formation of a more mature emergency policies, laws and management systems. The analysis of typical policies and laws on emergency management of power accidents in Britain and Australia reveals the following beneficial enlightenment:

(1) Improve policy and legal system. Policies and laws related to emergency management of power accidents include not only a country's emergency management policy and legal system for various emergencies, but also special emergency management laws and regulations. The emergency code of power accident is one of the main contents of power law or emergency management law. General emergency management policies and laws constitute the overall framework of national emergency management, so that when an emergency occurs, relevant parties can follow a clear framework and standardize the implementation of response. The special emergency policies and laws on power accidents provide concrete and operable guidance for the government, power generation enterprises, transmission enterprises, grid operators and electricity users to take measures in case of power accidents, and also provide legal guarantee for the timely implementation of the decisions made by relevant competent authorities.

(2) Establish hierarchical response. On the one hand, due to the difference in the scope of influence and degree of hazard of different power emergencies, the government level and departments required to deal with related accidents are different. Therefore, according to the nature and severity of power emergency, it is important to adopt different response levels to improve response efficiency. On the

other hand, power accident emergency management involves many departments, and there must be a specific department as the leading department of emergency management, and other departments cooperate with each other and obey the instructions of the leading department, so as to form a unified and coordinated command and operation system in case of emergency.

(3) Guarantee electricity supply for basic demands and the equity of burden distribution [8]. In the event of power accidents and the need to restrict the power use of users, it is necessary to consider that different groups can be treated fairly in terms of adverse effects, and the needs of industries such as food processing that meet people's basic needs and users of critical infrastructure such as railways will be guaranteed as priority as possible.

(4) Integration of prevention and response. The implementation of relevant measures by relevant government departments and important enterprises based on emergency plans is conducive to timely solving power system accidents and restoring power supply and normal production and life as soon as possible. Compared with the codes for emergency handling of power accidents, it is also important to prevent the occurrence of relevant power accidents to the maximum extent. Therefore, many countries have also formulated corresponding technical standards and management regulations in terms of power infrastructure protection, power accident assessment and standby power supply setting. The integrated management system of prevention and response is worthy of reference.

5. Conclusions

The electricity emergency management in the UK and Australia reflects the importance of institutions in dealing with social accidents. The emergency response and prevention institutions should adapt to the scope and degree of an accident. Coordination of different entities and a hierarchical response system are necessary for efficient and effective resolutions. The priority of basic needs of human beings and strategic sectors should be guaranteed and the response system should also pay more attention to equity when dealing with electricity emergency.

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