The Design Analysis of Emergency Communication System of Short-wave Communication Technology

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Abstract: In the circumstances of various emergencies and natural disasters, the communication network or communication device of affected area are damaged to different extent. The obstructed communication system brings many difficulties to follow-up disaster-relief work. In this way, disaster cannot be comprehensively and effectively controlled in a short period of time. Therefore, it is necessary to set up emergency communication system to ensure the timely transmission of information in affected area and the execution of command issued by superior department. The short-wave communication technology, advantageous in stable signal transmission, strong anti-interference capability, simple equipment assembly, rapid construction speed and low costs, is conductive to recovering communication of affected area, which deserves to be promoted.

In recent years, short-wave communication technology is gradually widely applied in meterology, government, military affairs, diplomacy and so on. It can break the limitations of active relaying and network hub, with its strong independent communication ability and anti-inference capability. It, with low investment, simple convenience, rapid construction speed and significant application advantage, can realize effective communication in area such as gobi, mountainous area and ocean, where ultrashort wave cannot cover. China has a vast territory, a variety of natural disasters frequently happen. If there is a lack of effective communication method in affected area, it will have a serious impact on disaster-relief work. The emergency communication system build by short-wave communication technology can solve this problem and ensure the smooth communication, promoting the disaster-relief work.

1. Introduction to Emergency Communication

When emergencies or natural disasters caused by human factor occur, various communication resources are required to meet the requirement for communication in affected area, so as to ensure the transmission of command from superior department and lay a solid foundation for follow-up work. In the process, it is necessary to set up emergency communication system. It shall combine with actual situation, and integrate various different communication technologies, however, the core requirement is to ensure the smooth communication in affected area. In practical construction, it is necessary to ensure a variety of equipment, guarantee the reliability of network system, strengthen the management of emergency communication system and build disaster warning and response mechanism [1].

China has a vast territory and complex address structure, so natural disasters occur frequently, bringing serious loss for local economy and threat for people’s life security. In order to reduce the impact by disaster, improved emergency communication system shall be built up to decrease property loss and guarantee people’s life security. Due to uncertain scale, time and place of emergencies, there is uncertainness in the period for constructing emergency communication system and required equipment. Thus, it needs to expand the application range and enhance technologies to ensure its due function in various disasters.

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2. Short-wave Communication Technology

2.1 Basic principle

The propagation of radio wave can meet the needs of radar, satellite, radio communication, radio broadcasting, etc. The wavelength range of radio waves is 100000m-0.75mm, which is a kind of electromagnetic wave. According to its specific propagation characteristics, it can be divided into ultrashort wave, short wave, medium wave, long wave and ultralong wave, the short wave has a wavelength range of 100m-10m and the frequency range is 1.6-30MHz. Sky wave and ground wave are the main transmission routes. Ground wave is the secondary propagation path of short wave. The propagation is along the ground. The condition of the surface medium is directly related to the distance of propagation. The medium capable of conducting electricity such as sea level is most conducive to the propagation of short waves. Usually the distance of short wave propagation in sea level can be 1000km [2]. Due to poor conductivity, the surface of the land will cause loss of electric waves. The loss of short-wave waves on the dry sandstone ground is especially obvious. Therefore, the short-wave propagation distance on the ground surface is about 50km, and the surface of the wet ground propagates slightly longer. In the process of ground wave propagation, it is necessary to fully consider the case of blocking substances, but it is not necessary to change the operating frequency.

Sky wave is the most important transmission route of short-wave communication. Sky wave is the radio wave formed by the atmospheric electricion layer returning to the ground after encountering the electromagnetic wave radiated by the antenna. The ionosphere belongs to the high-altitude atmosphere of the ionized state, and the distance from the ground is about 60-2000km. The ionosphere is only capable of reflecting the short-wave radiation. In general, the ionosphere consists of four different layers of F1, F2, D, and E. The two layers of F1 and F2 have the most significant reflection effect. The F2 layer will act on short waves at any time to promote the propagation of short-wave. F1 layer can only function during the daytime, and its height is smaller than F2 layer. E layer has a small reflection effect on short waves, and D layer can reflect short wave of 2-9 MHz [3].

The propagation of short-wave communication needs to be reflected back to the ion layer after the antenna is transmitted. After many times, it can realize long-distance propagation, and it is not necessary to establish relay station during the propagation process. The specific operating frequency of the short wave is affected by the ionospheric concentration. The ionospheric concentration is mainly determined by the electrical density (number of free ions per unit volume). The ionosphere concentration is low, the reflection frequency is low, the concentration is high, and the reflection frequency is high. Different seasons, different regions, and differences in sunspot activity will also affect the concentration and height of the ionosphere. In order to ensure the effect of short-wave communication, advanced equipment support is needed, and a reasonable frequency needs to be selected. The sky wave is not affected by the ground object blocking, but the time in the propagation process is long, the path will cause a certain loss to the short wave, and the ionospheric fading, multipath effect, atmospheric noise, etc. will cause short-wave signal changes, which will have a certain impact communication quality.

2.2 Main characteristics of short-wave communication

Compared with ground microwave communication and satellite communication, short-wave communication can realize long-distance communication. The whole process does not require the support of the relay station, the operation cost is low, the construction and maintenance are simple, the fixed-point communication can be realized through the fixed base station, and the vehicle carried by mobile device. The communication and networking process is extremely flexible, the device is small, and has strong anti-interference ability, which can be operated in different environments. At the same time, the short-wave communication capacity is small, the frequency is narrow, and it can only transmit pictures, voices, and low-speed data. The variable-parameter channel transmission such as sky wave is not stable enough, and the operation of the radio station is

invulnerable to industrial radio and atmospheric noise, requiring technicians to have certain experience [4].

3. The Design Analysis of Short-wave Communication System

3.1 Constituent

The short-wave emergency communication system mainly includes rear command center and front emergency system. The rear command center belongs to a fixed node in the system. The front emergency system includes a number of nodes that can be moved at any time. The short-wave communication channel can connect each mobile node and fix it. The front emergency system can be used to know the actual situation on the site and timely transmit relevant information to the command center, so as to make reasonable scheduling and decision-making in combination with specific disaster situations [5].

3.2 Basic structure of system

The rear command center mainly includes computer terminal, language terminal, and high-power short-wave radio. The high-power short-wave radio is the core equipment, mainly including antenna system, receiver, and high-power transmitter. The wired IP network can be directly connected to the rear command system, and directly connected to the computer terminal through the network routing device. The IP wireless system short wireless wave of the rear command center and the emergency field system in front are effectively connected to the mobile node.

The front emergency command communication system mainly includes electronic information, comprehensive support, and vehicle platform. The terminal and communication system together constitute an electronic information system. The function of transmitting and receiving voice is completed by the voice terminal. In the actual operation process, the control function for conveniently controlling the short-wave radio can be used to send the receiver, or the ordinary handset can be used. The data terminal needs to have the ability to adapt to the complex environment in the field, used to receive data information and short messages. Short-wave transmission and reception and modulation and demodulation are performed by the vehicle short wave. The antennas used in the front emergency command communication system are mainly dipole antennas, cable-stayed antennas, whip antennas, etc. In the actual selection process, technicians are required to determine it according to actual terrain conditions, radiation direction and communication distance on site [6].

If the geological condition in the affected area is complex and the emergency communication vehicle cannot reach, emergency single-person system, dragon whip antenna, voice terminal, knapsack low-power short-wave radio station, a knapsack-mounted fixed frame, PDA data terminal and rear command center or the emergency command communication vehicle system are adopted to contact. The short-wave radio stations currently used is mainly 3G short-wave adaptive communication technology, equipped with short-wave networking capability and anti-interference capability. At present, with the improvement of the technical level, short-wave radio station has significant advantages in signal digitization, short-wave networking, automatic tuning, human-machine interface, short-wave networking, etc., and strong communication performance and handling performance [7].

4. Key Technologies of Emergency Communication System of Short-wave Communication Technology

4.1 Data transmission technology

The latest short-wave communication network can provide different data transmission protocols, including high-speed data transmission protocol and low-speed data transmission protocol. Different types of transmission protocols can be adopted to realize high-frequency channel transmission under harsh environmental conditions, as well as large-scale data transmission in

high-quality environmental conditions. In order to improve the data transmission speed, high-speed frequency hopping data transmission technology and high-speed fixed-frequency data transmission technology are needed. The algorithm used by the high-speed frequency hopping transmission data technology is a differential frequency hopping algorithm. In the application, it is necessary to combine the actual requirements, select a reasonable hopping speed, avoid interference caused by various factors, and improve the data transmission speed. In addition, in order to meet the low-speed data transmission under harsh conditions, extreme low-speed technology and automatic link establishment technology are required to improve the anti-interference and continuous wave resistance in the transmission process [8].

4.2 Real-time channel estimation

Short-wave communication is a time-varying channel, and the overall stability is relatively poor. Therefore, in the application, the communication quality needs to be evaluated in real time. The short-wave communication quality real-time evaluation technology used currently is based on Viterbi decoding, and the short-wave channel data quality resources are obtained by accumulating the error information generated. It does not need to increase the data overhead, and can randomly acquire the channel quality. At the same time, the evaluation process has a large dynamic range, and there is no excessively high requirements for the data volume, and the analysis result has statistical characteristics. The real-time channel estimation technology can detect noise interference and ionospheric transmission anomaly in time, realize the optimized independent selection of the working frequency, and ensure that the communication quality of the emergency communication system meets the requirements for use.

5. Problems in Emergency Short-wave Communication System

5.1 The unreasonable antenna erection, excessively depending on public communication system

The short-wave communication system has strong independence and can play its role in places where emergency communication is required. For this reason, relevant organizations are vigorously promoting short-wave communication system. In the actual application, many regions are affected by traditional thinking modes, and still rely on traditional communication systems. The construction of short-wave communication system lacks substantive measures, and many emergency response structures failed to play their due role. At the same time, for the sky wave short-wave communication mode, a large number of communication dead zones are generated in the area where the reflection is closest, and unreasonable antenna erection will affect the communication quality. In addition, many regions have invested less in short-wave mobile communication system. The systems that have been built lack complete maintenance measures, and security risks cannot be discovered in time, resulting in an inability to adopt an effective response strategy after disaster.

5.2 The low utilization efficiency

The short-wave communication system itself has defects such as ionospheric fading, communication delay, path loss, etc., and the signal quality is not stable enough, which also causes it to fail to play its due role in emergency situations. For areas where there are no emergency events for a long time, technicians lack daily practices for short-wave communication system. Most of the equipment is idle for a long time, aging is serious, and maintenance is difficult.

5.3 The strategies for improvement

In order to improve the efficiency of short-wave communication equipment, technicians should regularly exercise the short-wave communication equipment to clarify the relationship between short-wave communication and seasonal changes, sunspots, etc. In the actual application, a reasonable frequency can be selected for operation, so that short-wave communication can play its role in practical application. At the same time, relevant authorities need to strengthen publicity and education, raise public awareness of short-wave emergency communication system, establish

relevant institutional systems for equipment maintenance, strengthen overhaul, extend equipment life, and ensure that they can be used normally in the event of disaster.

6. The Application of Short-wave Communication in Power Emergency Communication

The power emergency communication system mainly refers to the adoption of emergency communication system to ensure the normal transmission of voice, data and images of the accident site in the event of natural disasters and communication system failures, so that the emergency command center and the power failure site are connected smoothly, which is convenient for the formulation of solution schemes in the first time. The power emergency communication system is less affected by factors such as geographical environment, with low requirement for transmission distance, which requires reliability and mobility [9].

In constructing the communication system on site, it is necessary to combine the portable radio with the mobile vehicle system. The power of the portable radio can be selected to be 20w. The main equipment includes whip antenna and the battery to avoid multipath effect during the application process. The transmission method is ground wave transmission. The selection of communication station can use 125w high-power radio station, the location of the base station can be built in the top of the building or the open unobstructed ground. The communication within the area is mainly completed by mobile vehicle equipment and fixed base stations, and the coverage can be appropriately increased during the construction process to meet the communication needs of different areas.

7. Conclusion

The short-wave communication technology is advantageous in emergency communication system, to enhance communication quality and anti-inference ability and ensure the relief effect in various disasters. In the actual application, relevant institutions shall strengthen studies, improve the practical ability and promote the improvement of China’s emergency communication system construction.

References

[1] Chen Zhuaixia. The Design and Improvement of ViLiN in Power Emergency Communication System [A]. Power Information Professional Committee of Chinese Society for Electrical Engineering. The Symposium for annual meeting of informationization in power industry [C]. Power Information Professional Committee of Chinese Society for Electrical Engineering: Telecommunications Science of Post and Telecom Press, 2017: 4.

[2] Shi Diwei. High-power Microwave Emergency Communication Technology [A]. Chinese Institute of Electronics. The Symposium of 2017 National Conference on Microwave Millimeter Wave (Volume 2) [C]. Chinese Institute of Electronics: Microwave Branch of Chinese Institute of Electronics, 2017: 4.

[3] Hou Yingwu. Research on Foreign Emergency Information System and Main Enlightenment to China’s Construction [A]. Chinese Institute of Command and Control. The Symposium of the 6th Chinese Conference on Command and Control (Volume 1) [C]. Chinese Institute of Command and Control: Chinese Institute of Command and Control, 2018: 3.

[4] Liu Fang, Gao Xuefei, Hu Lizhang. A Power Emergency Heterogeneous Communication System Based on MANET and Satellite Network [J/OL]. Hebei Electric Power, 2018(06): 30-33

[5] Li Huaiyi. On the Application Prospect of UAV Cluster Technology in Fire Emergency Communication Support [J]. China New Telecommunications, 2018, 20(24):38-39.

[6] Yao Qi. The 3rd Conference on CRAC Radio Technology and Amateur Emergency Communication and Radio Direction-finding Manoeuvre in Xi’an [J]. China Radio, 2018(11): 33.

[7] Wang Qun, Li Wei, Yu Hai, Jin Chengming, Tong Xin. Research on the application of evaluation method based on fuzzy analytic hierarchy process in emergency communication plans for power system [J]. Power System Protection and Control, 2018, 46(22): 171-177.

[8] Zhang Guangquan, Ning Bingwen. The Improvement of National Emergency Communication Support Ability by New Technologies and New Equipment [J]. China Emergency Management, 2018(10): 38-39.

[9] Hu Tengfei. The Application and Development of Satellite Communication in Emergency Communication [J]. Digital Communication World, 2018(10): 196.