Influence of Lightning Disaster on Cities and Lightning Defense Measures

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Abstract Under the influence of special terrain and climatic conditions, lightning weather in Ulanqab City is more frequent from June to August, and lightning disaster has become one of the important tasks of disaster prevention and mitigation. In this paper, based on the characteristics of lightning weather in Ulanqab City, the impact of lightning disaster on the city was analyzed, and lightning protection measures, such as strengthening supervision of lightning protection safety, establishing a long-term lightning protection mechanism, doing a good job in lightning protection construction and detection in key places, and further improving public awareness of lightning protection, were put forward to reduce and avoid urban lightning disasters as much as possible and ensure urban safety.

Key words Lightning characteristics; Disaster impact; City; Lightning protection measures

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Lightning is a weather phenomenon of electrical discharge accompanied by lightning and thunder. After lightning strikes people or things on the ground, it instantly releases huge energy, and the generated lightning electromagnetic pulse can cause casualties, damage to objects, power supply failures, *etc.*, even causing fire and explosion accidents and other derivative disasters, and bringing serious social and economic consequences. According to statistics, about 0.53 people per million people are killed by lightning every year, and can also cause permanent damage such as heart disease, memory loss, sleep disorders, epilepsy and so on. With the rapid development of information technology, microelectronic technology has been widely used in cities, penetrating into all walks of life and fields. Microelectronic devices are extremely sensitive, so they are easy to be invaded by omnipresent lightning electromagnetic pulse, resulting in loss of control or damage to equipment, network interruption, *etc.*, which will bring immeasurable economic losses.

1 Analysis of lightning characteristics in Ulanqab City

Inner Mongolia Autonomous Region is located in the northern frontier of China as well as the interior of Eurasia continent, and stretched from northeast to southwest, with high terrain and an average altitude of about 1 000 m. It has a temperate continental monsoon climate. Under the influence of special geographical position and diversified climate, lightning weather is frequent throughout the region[1]. Ulanqab City is located in the middle of Inner Mongolia Autonomous Region, and the Daqing Mountain stretches across the middle to divided it into the front and back mountain. The front mountain is warm and rainy, while the back mountain is windy. It has a continental monsoon climate, with four distinct seasons and short frost-free period. It is one of the high incidence of lightning in the Inner Mongolia Autonomous Region.

In Ulanqab City, lightning is mainly concentrated from June to August. In the period, under the influence of the summer monsoon, the climate is hot and humid, and the atmospheric convection is strong, so lightning is frequent. During a day, thunderstorms occur mostly in the afternoon and at night. The spatial distribution of lightning activity in Ulanqab City is affected by terrain, climate and other conditions. Lightning prone areas can be divided into extremely high, high, higher, moderate and general lightning prone areas. In Ulanqab City, Liangcheng County, Fengzhen City, Zhuozi County, Chahar Right Wing Front Banner, Xinghe County, Jining District, Chahar Left Wing Back Banner, as well as the south of Chahar Right Wing Middle Banner, the south of Siziwang Banner, Shangdu County and Hude County belong to extreme high lightning prone areas. The north of Chahar Right Wing Middle Banner, the south of Siziwang Banner, Shangdu County, Huade County, Liangcheng County, Fengzhen City, Zhuozi County, Chahar Right Wing Front Banner, Xinghe County, Jining District and a small part of Chahar Left Wing Back Banner are high lightning prone areas. The northwest of Siziwang Banner belongs to a higher lightning prone area.

2 Impact of lightning disaster on a city

With the continuous expansion of urban construction scale,

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high-rise intelligent buildings are increasing day by day, and modern communication, computers and elevators, and other modern equipment with weak disturbance resistance are all over the buildings, making them more susceptible to lightning damage[2]. Compared with rural areas, once lightning strikes occur in cities, the harm and impact are greater, and the economic loss is immeasurable.

2.1 Damage to electronic equipment Household appliances have long become a necessity in people's lives, and electronic intelligent equipment has been widely applied. The daily work of urban residents is inseparable from computers and mobile phones. Electronic equipment is prone to be struck by lightning. Lightning electromagnetic pulse is very easy to invade and damage these extremely sensitive microelectronic devices, resulting in serious direct economic losses and indirect losses that are difficult to estimate.

2.2 Failures of power supply system Lightning is the primary cause of power grid failures, and seriously threatens the safe operation of power grid. Unlike indoor electronic equipment, parts of the outdoor power grid face the threat of direct and induced thunder. When power supply devices are attacked by lightning, a power outage will appear in different ranges and times. China's power grid is struck by lightning more than 350 000 times every year, and the number of tripping of transmission system caused by lightning stroke accounts for more than 50% of the total number of tripping. Although the number of lightning strokes on power systems is only one-third of the number of lightning damage incidents on electronic equipment, the impact is huge. The interruption of electricity consumption in urban production and life will trigger a series of social chain reactions. When lightning occurs frequently in Ulanqab City, electricity consumption also peaks, so it is difficult to avoid the harm caused by lightning to the power grid and power system[3]. For example, Wulan Cement Plant in Ulanqab City was hit by a thunderstorm on July 30, 2005, and a large area of power supply lines in the plant was tripped, leading to power failures, equipment operation stop, production interruption. Besides, a 355 kW kiln head induced draught fan and other equipment were damaged.

2.3 Lightning hazards in inflammable and explosive places With the needs of society, storage places of some dangerous goods, flammable and explosive goods have further expanded. Due to the special nature of these goods, once a fire or explosion occurs, it will cause great harm to society. If gas stations, liquefied gas stations, natural gas stations, oil pipelines, oil storage tanks (pools), oil wells, ammunition depots and other flammable and explosive places lack necessary lightning protection facilities, lightning will cause heavy casualties and property losses.

2.4 Lightning hazards in crowded public places The purpose of installing lightning protection facilities is to quickly divert lightning current to the ground after buildings or public facilities are struck by lightning, so as to reduce and avoid lightning damage to buildings, personnel and equipment. In crowded public places, if lightning protection facilities fail, lightning strokes will not only damage buildings and facilities in buildings and affect the personal safety of personnel, but also may cause adverse events such as fighting and stampede due to crowd panic. Bus platforms closely related to the lives of urban residents are usually the preferred place for public shelter in thunderstorm weather. Most of these platforms have metal frames, so they are highly conductive. Moreover, most of the bus stops are not equipped with effective lightning protection facilities, so there is a certain lightning hazard if citizens take shelter from a thunderstorm at an empty bus stop. In parks, playgrounds and other densely populated places, ferris wheels, most roller coasters and other amusement facilities have steel structure. Open scenic spots near the water and large sports venues are easy to be struck by lightning, and the personal safety of tourists face great risks in strong lightning weather.

2.5 Lightning hazards in schools Most school buildings in a city usually have 2 – 5 floors, and the corresponding lightning protection devices are installed in teaching buildings and other building groups. However, more or less some problems are found in lightning protection devices during the annual inspection. In some schools, due to inadequate maintenance of lightning protection devices, lightning rods (zones) installed outside buildings suffered corrosion, fracture and so on, so that they can not play a due role in lightning protection when lightning weather occurs, and even lead to lightning. If schools do not install multimedia systems, monitoring systems, broadcasting equipment, computers, *etc.*, in strict accordance with the lightning protection standards, these devices are vulnerable to lightning induction and lightning waves during thunderstorms, threatening the personal safety of indoor teachers and students.

3 Discussion on lightning defense measures

3.1 Establishing a long-term mechanism for lightning disaster prevention Lightning disaster is a natural disaster with great destructive power. Improper emergency treatment will bring a series of secondary disasters and chain reactions. With the warming of the climate, extreme weather and climate events increase, and the development of scientific and technological information age also makes the public more sensitive to lightning disaster. The Ulanqab Meteorological Bureau should implement the social supervision responsibility of lightning protection safety, strengthen the linkage with various departments, establish a cooperation mechanism for lightning protection safety management, incorporate lightning disaster prevention into the supervision system of public safety, strengthen the monitoring, forecasting and early warning of lightning disaster, timely release early warning information of lightning disaster, and provide good services for relevant departments and the public to carry out lightning defense work in advance. The management departments of various industries fully fulfill their

regulatory responsibilities, organize the implementation of lightning disaster prevention work in their own industries, formulate their own lightning protection emergency plans, and regularly carry out emergency drills, actively cooperate with meteorological departments to carry out administrative law enforcement of lightning protection safety and investigation of lightning disaster accidents, and jointly eliminate lightning protection safety hazards.

3.2 Strengthening lightning hazard assessment Ulanqab City is located in the plateau area, where the topography is complex. Lightning disaster, one of the most harmful meteorological disasters in the city, shows an increasing trend in the damage year by year, and poses a great threat to people's life and property safety. In strict accordance with relevant laws, regulations and norms, meteorological departments at all levels must seriously do a good job of lightning risk assessment of large construction projects, key projects, flammable and explosive places, open-air public facilities and other important projects and occasions in the region, especially for new, expanded and reconstructed projects. Governments at all levels and relevant units should provide support and cooperation in accordance with laws to ensure public safety.

3.3 Implementing social supervision responsibility for lightning protection safety To do a good job in lightning protection design and installation of all kinds of buildings, instruments and equipment and carry out regular maintenance and testing is the most effective way and method of lightning protection and disaster reduction. In petroleum, chemical, natural gas and other flammable and explosive materials production and storage sites, electric power, communications, radio and television, medical and health industries, computer systems, communication systems, satellite receiving systems and other facilities, stadiums, theaters, shopping malls, hotels, hospitals, schools, stations, airports and other public service facilities and densely populated places, high-rise buildings, major urban infrastructure, *etc.*, lightning protection devices must be installed in accordance with norms and standards, and lightning protection safety tests must be carried out regularly by institutions with professional testing qualifications to rectify hidden dangers in a timely manner. The municipal meteorological bureau implements the social supervision responsibility of lightning protection safety, performs macro-management functions according to laws, strengthens the technical guidance and supervision inspection of relevant departments, and carries out law enforcement inspection for lightning protection safety. Rectification requirements shall be put forward for enterprises that fail to pass the inspection, and administrative penalties shall be imposed on enterprises that refuse to rectify or fail to rectify according to laws.

3.4 Improving the public's ability to prevent and respond to meteorological disasters To improve the public's awareness and ability of meteorological disaster prevention and reduction, and constantly enhance the knowledge, interactivity and interest of meteorological science popularization, a series of activities are held during key periods such as "3.23" World Meteorological Day on March 23 and Disaster Prevention and Reduction Day on May 12 every year, and experts are invited to give lectures in communities, parks and schools to learn and communicate with the public face to face and at close distance, so as to improve the public's understanding of meteorological disasters and grasp the ability of using meteorological knowledge to seek benefits and avoid hazards. Lightning weather emergency drills for teachers and students are regularly organized every year to enhance the skills of departments to prevent and respond to disastrous weather.

4 Conclusion

With the rapid development of urban modernization and the gradual improvement of public awareness of disaster prevention and reduction, lightning casualties have been reduced, and electronic equipment has become the main target of lightning disaster in a city, indicating that the lightning protection work of meteorological departments is facing new challenges. It is necessary to focus on the lightning protection design and construction of buildings, equipment and other engineering projects, strengthen lightning disaster risk assessment, regularly maintain and test lightning protection facilities, and give full play to the lightning protection role of lightning protection devices. At the same time, the research on lightning protection technology should be strengthened to meet the needs of urban development and construction, further enhance the awareness of lightning protection in the whole society, and promote the smooth development of lightning protection and disaster reduction work.

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