Safety Design in Electrical Design of High-rise Building in Low Voltage Distribution System

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Abstract. With the continuous improvement of intelligent and automatic level of electrical system in high-rise buildings, the structure of electrical equipment in high-rise buildings is becoming more and more complex, and the total load is also increasing. Higher requirements are put forward for the safety design of its power distribution system. The safety design of low-voltage power distribution system is more and more important for the reliability and safety of the electrical system in high-rise buildings. Based on this, this paper first introduces the high-rise building power transformation and distribution system, including the reliability analysis of high-rise building power distribution system, power supply solutions, etc. Secondly, it analyses the design of low-voltage distribution system in the electrical design of high-rise buildings, and finally studies the safety optimization of low-voltage distribution system in the electrical design of high-rise buildings.

Keywords: Low Voltage Distribution System, High-Rise Buildings, Electrical Design, Safety

1. Introduction
With the rapid development of social economy and the construction of smart city, more and more high-rise buildings are put into use. Energy consumption, lighting, fire protection, security, management and other intelligent systems of high-rise buildings are all connected with urban smart city center. The intelligent high-rise buildings are increasingly inseparable from the support and guarantee of safe and reliable electrical system. As an important part of the electrical design of high-rise buildings, low-voltage distribution system plays an increasingly prominent role. Because the voltage of high-rise buildings is generally large, the safety design of low-voltage distribution system is very important for the reliability and safety of high-rise building electrical system. With the increasing number and complexity of electrical equipment in high-rise buildings, it is very important to take effective low-voltage distribution system optimization design for the power supply safety and electrical safety of high-rise buildings, and then to ensure the overall quality level of high-rise buildings. Therefore, it is of great practical significance to study the safety of low-voltage distribution system in the electrical design of high-rise buildings.

2. Power transformation and distribution system of high-rise building
2.1. Reliability analysis of power distribution in high-rise buildings
Reliable distribution system for power supply and distribution of high-rise buildings, not only related to the normal work and life of high-rise building users, but also related to the safety of buildings and users. The main influencing factors of power failure mainly include the number of connected power supply and the wiring mode of distribution system. The safety and reliability of the distribution system in the electrical design of high-rise buildings can be improved by reasonable optimization design. The power supply and distribution system of high-rise buildings mainly uses ring network connection mode, which can minimize the influence scope of troubleshooting, that is, ring network power supply at high-voltage side and radial power supply at low-voltage side, as shown in Figure 1 below [1].

![Figure 1](image)

**Figure 1.** Several commonly used ring network connection modes

2.2. Power supply solution for super high rise buildings
First of all, the transformer selection should be determined according to the load level of high-rise buildings. The emergency power supply is distributed with important load. Generally speaking, the load level of high-rise buildings has one, two and three levels. Therefore, the appropriate transformer and emergency power supply and other electrical facilities should be selected based on the load level.
Secondly, as for the power supply and distribution mode, for example, the wiring of low-voltage distribution system should adopt the single bus section connection mode. Low voltage contact switch shall also be set to ensure emergency and normal operation of important load during troubleshooting. For high-power electrical equipment, its power supply path should reduce the impact of other electrical equipment, and use the finished integrated motor start controller [2].

2.3. Low voltage distribution system
For the large load circuit, the dense bus duct is suitable for the transmission of electric energy of high-rise buildings, and the cross-linked power cable is used for the small load circuit. The low-voltage distribution system can divide the transmission main line into high area, the line meets the dynamic stability, and the voltage loss is within the controllable range. First, the low-voltage switch should be set with a reduced distribution level to ensure the reliability of the system. The distribution circuit should be set with fault protection, so that the setting has selectivity. Secondly, in the design of elevator power supply and distribution, it should attach great importance to the safety and reliability of power distribution. In terms of line laying, the main power distribution cable is laid along the bridge or exposed in the electrical shaft, while the conductor is laid in a pipe. The most important indicator of intelligent operation and maintenance of distribution is high reliability. In the low-voltage distribution system, all equipment are equipped with sub energy consumption data measuring instrument with standard communication port, so as to collect the data of the power transformation and distribution system [3].

2.4. Characteristics of electrical equipment in high-rise buildings
Due to the large building area and the large number and complexity of electrical equipment in high-rise buildings, the electrical equipment in high-rise buildings has its unique characteristics, such as
many types of electrical equipment, large power consumption, high reliability requirements, complex electrical system, scattered power transformation and distribution system, high fire protection requirements of equipment and lines, as shown in Figure 2 below.

![Diagram showing characteristics of electrical equipment in high-rise buildings](image)

**Figure 2.** Characteristics of electrical equipment in high-rise buildings

3. **Design of low voltage distribution system in electrical design of high-rise buildings**

3.1. **Power supply time design**

The management network of electrical system in high-rise building needs independent power supply, so as to realize the load demand of low-voltage distribution system in high-rise building. It should be noted that there are many electrical loads in high-rise buildings due to the large number of electrical equipment. Many of these loads are very important. Therefore, the medium and low voltage distribution system is required to have high reliability. That is to say, independent backup power supply is required to ensure that the switching of power supply in case of single system failure can meet the time requirements and management requirements of electrical design of high-rise buildings [4].

3.2. **Power supply safety design requirements**

The medium and low voltage distribution system in high-rise building is very important in its electrical design, which is reflected in that the medium and low voltage distribution system is related to the normal electrical use of building users. First of all, in the design and planning of the medium and low voltage power distribution system of high-rise buildings, the fire protection and firefighting needs of the buildings should be fully considered. Secondly, the stability of the system should be fully guaranteed during the electrical use of high-rise buildings, so it needs to be equipped with stable power supply. From the above two design requirements, it can be seen that the reliability and safety of the electrical system of high-rise buildings cannot be separated from reasonable and scientific power system design and management [5].

4. **Safety optimization of medium low voltage distribution system in electrical design of high-rise buildings**

4.1. **Reasonable selection of circuit breaker**

As an important electrical safety device of medium and low voltage distribution system in high-rise buildings, leakage circuit breaker plays a very important role. It can reduce the hidden danger of electrical faults, thus reducing the risk of safety accidents. The working principle is shown in Figure 3 below.
Therefore, the leakage circuit breaker should be designed and installed scientifically based on the overall design of the low-voltage distribution system in the electrical system of high-rise buildings, so as to ensure its normal and effective work. In addition, the equipment specification and model of the leakage circuit breaker should be selected scientifically and reasonably based on the rated current range of the leakage circuit breaker to ensure the normal play of the protection function of the leakage circuit breaker.

4.2. Grounding protection design

As an important means to ensure the safety of low-voltage distribution system in the electrical design of high-rise buildings, the grounding protection system plays an important role in protecting the personal safety of social workers and consumers. Therefore, the grounding protection system of high-rise building should be designed based on the electrical characteristics of high-rise building, the form of grounding and the basic requirements of the use of electrical equipment. In addition, in order to reduce the influence of external voltage on the circuit of medium and low voltage distribution system, many kinds of grounding protection forms should be connected by equipotential bonding when designing the grounding protection system [6].

4.3. Design of automatic power cut off device

One of the important functions of the automatic power cut-off device is to cut off the fault facilities automatically, so as to reduce further equipment damage and realize the safe and reasonable use of electricity in high-rise buildings. In addition, in order to protect the circuit, the current protection should be designed in the system to prevent the harm caused by overload and short circuit. TN system is easy to be used at this time. TT system is used to avoid potential conductive hazards caused by external factors, and equipment with metal shell is used to ensure good grounding, so as to ensure timely cut-off of leakage current.

5. Conclusion

With the increasing number of high-rise buildings, as well as the continuous improvement of the intelligent and automatic level of their electrical system, the safety design of low-voltage distribution system in the electrical design of high-rise buildings has become an important measure and guarantee means to improve the safety of high-rise buildings. On the other hand, because of the unique characteristics of high-rise buildings, such as complex structure of electrical equipment, large total load, the security design of its distribution system also puts forward higher requirements. Therefore, in the safety design of low-voltage distribution system in the electrical design of high-rise buildings, scientific and reasonable design and planning should be carried out based on the electrical characteristics of high-rise buildings, grounding forms and the basic requirements of the use of electrical equipment, so as to improve the reliability and safety of the whole low-voltage distribution system.
system from the overall level. Only by carrying out scientific and reasonable safety design of low-voltage distribution system in the electrical design of high-rise buildings, and strict installation and construction specifications, can the safe and reliable operation of low-voltage distribution system in the electrical system of high-rise buildings be guaranteed.

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