

Analysis of Power Distribution Wiring and Cable Operation Techniques

Chao Ma*, Qin-Wu Zhang

State Grid Xinjiang Electric Power Co., Ltd. Changji Power Supply Company, Changji, Xinjiang 831100, China

*Correspondence to: Chao Ma, State Grid Xinjiang Electric Power Co., Ltd. Changji Power Supply Company, Changji, Xinjiang 831100, China, E-mail: 57419799@qq.com

Abstract: With the increasing demand for electricity, distribution lines and cables, as crucial components of the power system, play a vital role in ensuring the continuity and safety of power supply. This paper aims to explore the operational techniques of distribution lines and cables, without involving case studies or empirical validations, but rather analyzing and summarizing relevant technologies from a theoretical perspective.

Keywords: Distribution Lines; Distribution Cables; Operational Techniques; Power System

Introduction

Distribution lines and cables are essential components of the power system, responsible for transmitting electrical energy from substations to end-users. In this process, ensuring the safe and efficient operation of the lines and cables is a critical concern for power workers. This paper will analyze and discuss the operation of distribution lines and cables from a technical perspective.

1. Basic Characteristics of Distribution Lines and Cables

Distribution lines and cables, as two important components of the power system, each have their own unique characteristics. Firstly, distribution lines are mostly constructed as overhead lines. This construction method has relatively low costs because it does not require complex engineering such as underground excavation and burial. At the same time, maintenance and inspection of overhead lines are

relatively convenient, as workers can visually inspect the line status and promptly identify and address issues. However, overhead lines also have some obvious drawbacks. They are susceptible to external environmental influences, such as strong winds, rain, snow, lightning, etc., which may lead to line failures. Additionally, overhead lines are also prone to interference from natural factors like tree growth and bird nesting, thereby increasing the probability of faults.

In comparison to distribution lines, distribution cables are mainly installed underground. Although this method entails higher construction and maintenance costs, it has significant advantages. Underground cables are not affected by surface environmental conditions, making it difficult for adverse weather or other natural factors to directly damage them. Therefore, underground cables have higher operational stability. Additionally, underground cable installation is beneficial for urban aesthetics and the rational



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, sharing, adaptation, distribution and reproduction in any medium or format, for any purpose, even commercially, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

utilization of land resources. However, maintenance and inspection of underground cables are relatively challenging, as it requires complex operations such as excavation and detection. Moreover, once a fault occurs, locating and repairing it can be difficult^[1].

2. Key Points of Operation Techniques for Distribution Lines and Cables

2.1 Inspection and Examination

To ensure the normal operation of distribution lines and cables in the power system, providing continuous and stable power supply to various users, regular inspection and examination are crucial. This process not only concerns the continuity of power supply but also directly relates to public safety and social stability. The core of inspection and examination work lies in the comprehensive, meticulous, and thorough examination of all aspects of the lines and cables. Firstly, visual inspection is the most intuitive part. Inspectors carefully observe whether there are obvious damages, deformations, corrosion, or aging phenomena on the lines and cables. These visual changes often manifest external problems and timely detection and handling can effectively prevent faults. Secondly, inspection of connection points is also critical. In power systems, connection points of lines and cables are the most vulnerable to faults. Loose connections, corrosion, poor contact, etc., in these connection points may lead to heating, arcing, or even short circuits. Therefore, inspectors focus on checking these areas to ensure tightness, cleanliness, no oxidation, and maintain good contact. Furthermore, inspection of insulation conditions is also an important part of inspection work. Aging, damage, or contamination of insulation materials can reduce their insulation performance, thereby increasing the risk of leakage and breakdown. Inspectors use professional insulation testing tools to test the insulation performance of lines and cables, ensuring compliance with safety standards. Through such comprehensive and meticulous inspection and examination work, potential safety hazards can be detected and addressed promptly. Whether it is external damage, loose connection points, or decreased insulation performance, they could develop into serious faults in a short time. Therefore, the timeliness and effectiveness of inspection and examination work are crucial for ensuring the safe operation of lines and cables.

2.2 Load Monitoring and Management

Load monitoring and management play an irreplaceable role in the stable operation of distribution lines and cables, aiming to grasp the real-time load conditions of lines and cables, prevent overload issues, and ensure the normal operation of the power system. In terms of load monitoring, modern power systems have introduced various advanced monitoring devices and technologies. These monitoring tools can collect real-time load data of lines and cables, including current, voltage, power factor, and other key parameters. Through continuous monitoring and analysis of this data, operators can accurately grasp the real-time load status of lines and cables, promptly identify trends of load anomalies or overloads. Load management involves optimizing adjustments to lines and cables based on monitored load data. When heavy loads are detected in a certain area or on a certain line, operators can reduce the load and avoid overload phenomena by adjusting load distribution and optimizing operation methods. This flexible load management approach can not only improve the operational efficiency of lines and cables but also extend their service life, reducing the probability of faults. Additionally, load monitoring and management can provide important references for the planning and expansion of the power system. Through the analysis of historical load data, future load growth trends can be predicted, enabling early planning of grid planning and equipment expansion to ensure that the power system's supply capacity always meets social demands. Load monitoring and management are crucial for ensuring the stable operation of distribution lines and cables. It can grasp the real-time load conditions of lines and cables, prevent overload issues, optimize load distribution, improve operational efficiency, and provide important references for the planning and expansion of the power system. Therefore, in the daily operation of the power system, load monitoring and management work must be highly valued to ensure its effective implementation^[2].

2.3 Fault Diagnosis and Prevention

Fault diagnosis and prevention, as important guarantees for the stable operation of the power system, involve timely detection of potential problems, rapid handling of existing faults, and reasonable avoidance of future risks. In terms of fault diagnosis, modern power systems use a series of advanced technical means. For

example, technologies such as infrared temperature measurement and partial discharge detection can monitor the operation status of lines and cables in real-time, promptly detecting abnormal phenomena. The application of these technologies greatly improves the accuracy and efficiency of fault diagnosis, enabling operators to grasp fault information at the first time and respond promptly. The formulation of prevention measures is based on in-depth analysis of fault types and causes. By analyzing and summarizing historical fault data, targeted preventive measures can be formulated. For example, for common insulation aging issues, insulation material testing and replacement can be strengthened; for accidental situations such as external damage, line inspection and protection can be enhanced. The implementation of these preventive measures can effectively reduce the probability of faults and improve the operational stability of the power system. When faults inevitably occur, it is particularly important to diagnose the causes of faults quickly and accurately. This requires operators to have rich practical experience and professional knowledge, be proficient in using various diagnostic tools and technical means. At the same time, a sound fault handling process should be established to ensure that faults can be properly handled in the shortest time and minimize losses. Fault diagnosis and prevention are crucial links in the operation technology of distribution lines and cables. It requires us to remain vigilant at all times, promptly detect and address problems, and ensure the safe and stable operation of the power system. In future developments, we need to continuously explore and innovate, apply more advanced technologies to fault diagnosis and prevention work, and provide stronger guarantees for reliable power supply in the power system^[3].

3. Measures to Enhance the Stability of Distribution Lines and Cables

3.1 Strengthening Equipment Maintenance and Upgrades

The primary task of enhancing the stability of distribution lines and cables is to strengthen equipment maintenance and upgrades. As important channels for the transmission of electrical energy, the condition of distribution lines and cables directly affects the stability and safety of the power system. To ensure the

continuous and stable operation of equipment, regular maintenance and repairs are essential. This includes visually inspecting the equipment for damages, aging, and other issues; tightening connections to prevent poor contacts or arcing due to loosening; and testing the insulation performance to ensure compliance with safety standards. Additionally, an assessment of the operating environment such as temperature, humidity, and corrosion is necessary to prevent external environmental damage to the equipment. Simultaneously, based on equipment usage and technological trends, timely upgrades are also required. During operation, power equipment inevitably experiences wear and aging. Failure to update these devices promptly may lead to decreased operational efficiency or even faults. Therefore, power departments need to develop scientific equipment upgrade plans, gradually phasing out old equipment and replacing them with newer models with better performance and efficiency. Furthermore, with technological advancements, new equipment often boasts higher energy efficiency, lower failure rates, and longer lifespans. Timely introduction of these new devices not only enhances the operational stability of the power system but also reduces operational costs, achieving both economic and environmental benefits. Strengthening equipment maintenance and upgrades is a key measure to enhance the stability of distribution lines and cables. Only by ensuring proper equipment maintenance and upgrades can the stable operation of the power system be guaranteed, providing reliable power support for social prosperity and development.

3.2 Reinforcing Personnel Training and Management

To enhance the stability of distribution lines and cables, personnel training and management are crucial aspects that cannot be overlooked. After all, even the most advanced equipment and sophisticated technologies require highly skilled personnel for operation and maintenance. Therefore, strengthening personnel training and management is vital to ensuring the stable operation of the power system. Regarding personnel training, emphasis should be placed on a combination of theory and practice. Organizing regular professional skill training sessions, safety knowledge lectures, and other activities can help employees acquire the latest knowledge and operational skills in the field of power. Additionally, conducting on-site practical

exercises enables employees to operate in simulated real-world environments, enhancing their ability to handle emergencies. Such training not only improves the professionalism of employees but also enhances their safety awareness, providing strong support for the stable operation of the power system. In terms of personnel management, it is essential to establish sound systems and processes. Firstly, clarifying the responsibilities and authorities of each position ensures that all tasks are assigned and followed in an orderly manner. Secondly, developing comprehensive workflow and operational standards guides employees to operate according to the standards, reducing the possibility of human error. Additionally, establishing strict assessment and reward mechanisms, commending and rewarding outstanding employees, and imposing serious consequences on individuals engaging in violations or causing accidents, all contribute to enhancing the enthusiasm and sense of responsibility of the workforce. Therefore, power departments should attach great importance to personnel training and management, providing strong talent support for the sustainable development of the power system^[4].

3.3 Introducing Intelligent Technologies and Management Methods

To enhance the stability of distribution lines and cables, introducing intelligent technologies and management methods is a forward-looking measure. Driven by modern technology, power systems are gradually moving towards intelligent and automated development, providing innovative solutions for improving the stability of distribution lines and cables. The introduction of intelligent technology enables more accurate and real-time monitoring of distribution lines and cables. For example, installing intelligent monitoring systems allows continuous collection of operational data, including current, voltage, temperature, etc., which can be analyzed and processed in real-time to detect anomalies and prevent potential faults. Furthermore, the application of intelligent fault diagnosis systems greatly improves the efficiency

of fault handling. Through remote control, real-time adjustments to the operational status of lines and cables can be made to ensure optimal performance. This management approach not only enhances efficiency but also reduces the risk of human error. Introducing intelligent technologies and management methods is a crucial approach to improving the stability of distribution lines and cables. Leveraging the power of modern technology provides robust technical support for the stable operation of the power system.

Conclusion

This paper has conducted an in-depth exploration and analysis of the operation technology of distribution lines and cables, proposing corresponding measures and suggestions. With the continuous growth of electricity demand and the continuous expansion of the scale of power systems, the operation of distribution lines and cables will face more challenges and opportunities. In the future, it is necessary to further strengthen the research and application of relevant technologies, enhance the operational stability and safety of lines and cables, and provide strong guarantees for the sustainable development of the power system.

References

- [1] Deng,S. Research on operation technology of distribution lines and cables based on power cable [J]. *Science and Technology Innovation Guide*, 2019, 16(18): 53+55.
- [2] Lian,C. Research on operation technology of distribution lines and cables based on power cable [J]. *Science and Technology Information*, 2018, 16(30): 39+41.
- [3] Sun,N, Xu,K. Key points of operation technology of 10kV distribution lines and cables [J]. *Electronic Technology and Software Engineering*, 2021(18): 213-214.
- [4] Ning X. Research on operation technology of overhead distribution lines and cables [J]. *Heilongjiang Science and Technology Information*, 2016(24): 5.