Key Technology of Fault Self-healing Strategy Based on Distribution Automation System

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Abstract: As a lifeline supporting the development of the whole country, electric energy has been highly valued by all parties in the society and the state. In some coastal developed cities and political core cities, there are many users and the power load is large. At present, traditional power distribution systems have problems in the quality, reliability, and operation level of urban power grids. Therefore, this paper first briefly describes the concept of distribution automation system and the self-healing strategy. Secondly, comprehensive analysis of the problems existing in the development of distribution automation systems. Finally, the intelligent distributed feeder automation and centralized feeder automation are analyzed to improve the power supply reliability of the distribution automation system and optimize the operation and management mode of the distribution network.

1. Research Background

1.1 Literature review

Dong, Liu and He believe that it is the key to measure whether a distribution automation system is strong. The online rate of terminal units is the key point. They take DTU offline faults and communication network interruption as the starting point, and perform functional expansion and secondary development of DTU kernel software. Reduced DTU offline troubleshooting time (Dong et al, 2017). Yang, Dong and Qu et al. believe that a smart distribution network with self-healing function can reduce the power outage time of the distribution network. At the same time, the application of the distribution automation system provides the possibility of self-healing of the distribution network (Yang et al, 2014). Based on the development status of single-phase ground fault self-healing technology, Peng, Xiong and Wu compared the transient zero-sequence current similarity coefficient between adjacent FTUs of faulty lines, and proposed the application of neutral point ungrounded or arc-suppressed coil grounding system. Current ground fault location method (Peng et al, 2013). Zhou, Zhang and Yuan et al. described the organization structure and diagnostic process of the wind turbine generator self-healing system based on immune agent, and considered the system to have the advantages of scalability, reusability and autonomy (Zhou et al, 2012). . Wu, Gao and Xu believe that the phase difference current and the fault current amplitude are used as the fault segment positioning principle, which can be adapted to the active distribution network with multiple DG types and different DG permeability (Wu et al, 2019).). Huang, Zhang and Gong proposed that the fault indicator is an important part of the distribution automation system, but there are many kinds of fault indicators in the market, and the technical indicators of the equipment of each manufacturer are uneven (Huang et al, 2018).

1.2 Purposes of research

As a national lifeline, electric energy is well known to all kinds of users, especially in some first-line, core or coastal cities. Due to the large number of users and high power load density, it has the power supply quality, power supply reliability and power supply system operation level of urban power grids. Higher requirements. At present, the traditional power distribution system can no longer meet the power supply requirements that people change with the advancement of science and

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technology. Especially when the circuit fails, the cable network equipment and line faults cannot be remedied in time due to the backwardness of the traditional distribution network management system. Affects the rapid recovery of the fault area. The fault self-healing function of the distribution automation system can solve problems such as power restoration, fault isolation, and power supply network failure. Therefore, this paper expounds the concept of distribution automation system, and then comprehensively analyzes the problems existing in the development of distribution automation system. Finally, it analyzes the key technologies of the self-healing strategy of distribution automation system. It is hoped that this study can meet the needs of users for the reliability of power distribution automation system, optimize the operation and management mode of distribution network, and provide reference materials for the research of fault self-healing strategies of other distribution automation systems.

2. The concept of distribution automation system

Distribution automation systems are a combination of multiple technologies, including computing, communications, electronics, and automation. (Chen and Ye, 2016) The distribution automation system can realize the fault location and intelligent supervision of the power distribution system to improve the safety, efficiency and reliability of the distribution network system (Zhang et al, 2018). The use of the distribution automation system in the power supply network enables the power supply management to shorten the fault location time of the distribution network in a city with a high cable failure rate, realizing the daily management and maintenance of the power distribution equipment, and reducing the maximum range of users. Power outage time. On the other hand, the distribution automation system can be used in the power supply network to establish a state tracking database of the power distribution equipment, monitor the power distribution equipment in real time, and query the status of the equipment through the database to prevent equipment failure and when the fault occurs. Handle in time. As the core function of the distribution automation system, the feeder automation function directly affects the practicality of this function in the distribution automation system. Whether the feeder automation function can be applied efficiently is related to the distribution network structure of the distribution function, and also directly related to the state of the distribution equipment. The feeder automation function is implemented in three steps. First, the information in the database is collected for failure analysis. Secondly, according to the feedback information of the database, the current conditions of each power distribution terminal are analyzed, and the current fault area is divided in turn. Thirdly, a treatment plan is established for the fault location, and the fault self-healing function of the distribution automation system is realized through regulation of the power distribution terminal. Through the realization of the feeder automation function in the distribution automation system, the fault finding time and the fault recovery time are suddenly reduced, the power grid loss is also reduced, and the grid power and power supply quality and reliability are improved. In the current distribution management process, the distribution automation system has been highly valued. Common feeder automation functions nowadays generally include centralized, local feeder automation and fault location systems. Centralized feeder automation mainly includes power distribution switches, terminals, substations, and so on. A simplified version of centralized feeder automation is the fault location system. It upgrades the fault location system, and the working process is as follows: the information is collected by the fault information terminal, and the fault information is analyzed and processed by the power distribution automatic master station, and the execution plan is issued to the terminal. The fault location system works in a relatively simple process, and only uses the fault addresser for fault location. The local feeder automation is different from the above two modes. This mode mainly relies on the information interaction between the distribution terminals to realize the line fault judgment, so as to realize the troubleshooting and processing of the circuit fault point.

3. Problems in the development of distribution automation systems

3.1 Distribution automation system features less

China's current distribution automation system development is still lagging behind compared to developed countries. The function of the distribution automation system cannot meet the actual needs, and it lacks in functions, controllability, and viewing. Therefore, the distribution automation system needs to further expand the safety protection function, enrich the types of communication methods, increase the power quality detection function, and improve the system power consumption structure. This plays an important role in the practicality, economic improvement and safety protection measures of the distribution automation system. In order to keep up with the pace of the times and accelerate the use of advanced science and technology, feeder automation and distribution automation systems need to be further self-improved to achieve a higher level and higher level of feeders and distribution. Combined with the characteristics of the power grids of developed coastal cities and political core cities, the distribution automation system should be linked to the environment and adapted to local conditions. Using more advanced communication means and computer software technology, we will deeply study various new methods that can quickly find fault locations and better handle faults, making the distribution automation system more mature and more practical.

3.2 Distribution automation system does not meet the new requirements of the distribution network

Under the new power system reform, the global energy revolution has put forward new requirements, and the distribution automation system is facing severe challenges. The distribution automation system improvement has a clear direction, that is, more efficient and safer circuit maintenance management. At this stage, the distribution automation system mainly needs to be improved and improved in two aspects of substation and feeder automation system. In order to ensure the stability of the circuit when the user is using electricity, reduce the probability of power outage, while improving and improving the substation and feeder automation system, the power distribution equipment should be upgraded, reducing the loss of labor costs and improving the operating efficiency of the equipment. Reduce the circuit failure rate. At the same time, according to the charge load degree of different circuits, the circuit can be hierarchically managed, and the distribution automation system can be upgraded to have the ability to identify and distinguish between important and non-critical lines, and prioritize important lines. The power supply line management department should further upgrade the functions of the distribution automation system, because in the context of the global energy revolution, the situation of the power market will change, and a new pattern of multi-buyer and multi-sellers will gradually take shape. In order to occupy an important position in the situation of competition between buyers and sellers, and to seize the opportunity, the distribution automation management system should have more intelligent functions. While meeting the fault detection of the basic circuit of the distribution network, it has other functions required by users and grid companies. At the same time, the functions of the distribution automation system can be extended and extended to achieve the purpose of docking with other power distribution related systems, so as to meet the wide range of use of energy storage equipment.

4. Key technical analysis of fault self-healing strategy in distribution automation system

The distribution automation fault self-healing scheme is mainly divided into intelligent distributed feeder automation and centralized feeder automation. In the function of distribution automation system, the power distribution automation fault self-healing function plays an important role, and the operation status of this function directly affects the final effect of power distribution management. Intelligent distributed feeder automation and centralized feeder automation use different methods to achieve automatic recovery of different fault lines.

4.1 Intelligent Distributed Feeder Automation

The intelligent distributed feeder automation can complete the information transmission between the terminals, realize the rapid positioning of the circuit fault location, isolate the fault area, and recover the circuit fault by itself. Intelligent distributed feeder automation can perform data analysis through data intersection between terminals to realize automatic processing of faults. In the process of processing, the intelligent distributed feeder automation system is linked with the power distribution main station and the substation. When the intelligent distributed feeder automation system operates, the power distribution main station generates linkage action to drive the substation operation. The advantage of the intelligent distributed feeder automation system is that the response is quick and the action is rapid. The fault is isolated and processed at the first time of the fault, and the positioning is fast and accurate. However, there are certain deficiencies. For example, the capital investment for intelligent distributed feeder automation is about 4-6 times that of ordinary terminals, and the capital consumption is huge; the scope of application is small, and it is often applied to simple distribution lines on complex lines. The application is prone to significant loopholes; the device function is simple, remote control cannot be realized, and related parameters need to be set in advance. If the situation changes, manual data adjustment is required; the operation does not have flexibility and adjustability, and if the action fails, the fault self-healing Features will not be implemented.

4.2 Centralized feeder automation

The centralized feeder automation system implements feeder automation and terminal control through the primary station. The workflow mainly identifies the fault type of the roadblock circuit through the terminal device, and transmits the analysis result information to the host, and the host analyzes the cause of the fault, and finally processes the fault, and the remote control terminal of the system issues a command to complete the switch action, and finally Complete fail-safe isolation and circuit recovery and normal operation. In the process of self-healing of faults, the centralized feeder automation and the substation master station are in a dominant position, and the two cooperate with each other to issue complete remote control commands and deliver accurate information. When the device performs fault analysis, if there are multiple fault points in the faulty line, the system will change the fault self-healing mode from two aspects. On the one hand, considering the real-time load ratio of the faulty line, in order to ensure the stability of the system operation, the best solution is selected for fault self-healing. On the other hand, according to the user's demand for power supply, it is classified, that is, a hierarchical power supply strategy is adopted for different users. When all users use electricity at the same time, it can avoid the lack of power supply due to the selection of the same route, and some users have power failure. The advantage of a centralized feeder automation system is that multiple strategies can be selected. Since the main station has data storage and data processing functions, the advantage of the feeder automation system can integrate multi-party information resources and analyze the optimal line self-healing recovery solution. The shortcomings are also very obvious, that is, the system takes a long time to deal with the fault, and generally can be analyzed and processed after thorough and complete fault analysis, and the action is slow compared with the intelligent distributed feeder automation.

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