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Research on Distribution Network Feeder Automation Technology

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Abstract: With the continuous improvement of socio-economic level, the current level of science and technology is also constantly developing. At the same time, China's power industry is also developing at a relatively fast pace. The rapid development of the power industry has made vital contributions to the development of our national economy and the improvement of people's living standards. In the development of the power industry, the automation technology of distribution network feeders is an important part of the development of power system automation. Therefore, the research and analysis of distribution network feeder automation technology must be carried out to improve the application level of distribution network feeder automation technology, so as to promote the modern development of China's power industry.

1. Introduction

In the current development process of the power industry, China attaches more importance to the modernization of the distribution network, and has invested a lot of money in the construction and transformation of urban distribution networks. And the construction of distribution network automation engineering has made great progress in scale and technology. Distribution network feeder automation technology is an important part of the development process of distribution network automation, and is the main function of the distribution network automation system. The rapid development and wide application of feeder automation technology are important contents of the current development of distribution network automation systems. Feeder automation technology has become the main development trend of multiple power loops and backup power sources. With the development and application of new feeder automation technology, the complexity of the primary wiring network structure of the distribution network is also increasing, and the requirements of users are more diverse and rich. Therefore, it is necessary to increase the research on distribution network feeder automation technology to ensure that the feeder automation technology meets the actual development needs of the power industry.

2. Composition of Distribution Network Feeder Automation System

Feeder automation system is based on the development of modern communication technology and technology. It is from scratch and has developed a distribution network feeder automation system based on FTU and communication networks. Its structure is shown in Figure 1. This distribution network feeder automation system mainly includes the main station, SCADA system, communication lines, FTU composite switches, advanced application equipment for power distribution and other parts. The main function of the main station in the system is the main structure of the feeder automation system, including modules such as SCADA monitoring, fault isolation scheme calculation, geographic information system and power distribution management information. The operation of fault handling and network reconfiguration in the system can only be realized by the main station system. If the



power distribution network fails, the FTU can use the communication network to transmit the fault information and switching conditions to the master station system. The master station system can perform such operations according to the fault status and system operation mode, feeder and degree, and power supply compound conditions Calculate accurately. Then, based on the calculation results, the best fault solution can be provided. The fault can be solved automatically or manually by the system, and after confirming that there is no error, the corresponding operation instructions can be issued, and the equipment can be remotely controlled by using the communication network. The calculation method of fault processing is not single. Generally, it includes power supply recovery algorithms such as unified matrix, expert system, and fuzzy technology. For some large-scale distribution networks, it is necessary to set up a substation system feeder substation in the feeder automation system. In addition to being able to control and transmit all terminal equipment and corresponding data in the area where the substation is located, it can also isolate and calculate from the main station's faults, calculate, recover, and diagnose. Feeder automation. And when the master station fails, the slave station temporarily replaces the master station to complete the functional requirements of communication, remote control, isolation, and power recovery [1].

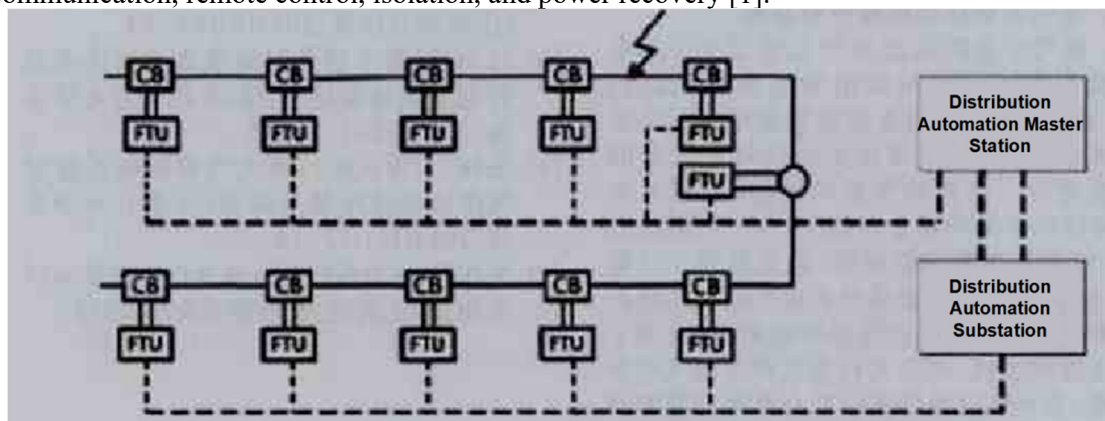


Figure 1 Composition of Feeder Automation System

3. Automation Technology of Distribution Network Feeder

3.1 Basic Functions

Feeder automation technology mainly locates feeder lines, performs fault detection, solution calculation, and restores power supply. Feeder automation can show modern intelligent technology, which can quickly handle faults in the form of switching operations, thereby reducing damage to the grid operation during fault processing. Because feeder automation technology can complete fault isolation within seconds or tens of seconds, and can restore power supply within minutes. It is especially suitable for application in the urban area distribution network where the electricity is intensive. However, the investment in the construction of the communication network in the system is relatively large, and if there is a problem such as network failure or hacking, the entire feeder automation system will be paralyzed. With the continuous development and improvement of modern science and technology such as optical fiber technology and GPRS, the new FTU feeder system based on optical fiber and GPRS technology can greatly reduce the input cost and expand the scope. At present, the feeder automation systems commonly used in China mainly include optical fiber Ethernet, optical fiber double-loop self-healing, wireless, and dedicated lines. Because fiber Ethernet has a strong advantage between the input cost and the use efficiency [2]. Therefore, the optical fiber Ethernet method is widely used in the current distribution network feeder automation system. Mainly based on optical fiber feeder automation technology, the main station, sub-station and FTU are effectively connected in the form of Ethernet. At the same time, it fully integrates the advantages of high-speed and long-distance communication of optical fiber. According to the TCP / IP address selection and IEC-870-5-104 communication mind, it can use the communication transmission

function between the main network and the subnet to perform packet exchange. This can realize fast and real-time transmission of data in the feeder automation system, thereby improving the efficiency of system operation. Based on the Ethernet structure, you can also use a bridge or router to complete the device information routing based on the IP layer. At the same time, it can not only complete the data exchange function by using the substations according to the router, ensure that the substations promote data sharing on the basis of network interconnection, but also greatly improve the efficiency of feeder automation operation of the entire distribution network.

3.2 Troubleshooting

The main function of feeder automation technology in the application process is the function of fault handling. In the system process, a combination of intelligent centralization and intelligent distribution is used to implement the fault handling process. Compared with the traditional reclosing mode, this type of fault processing has higher reliability and flexibility. It can diagnose faults online according to the parameters of the power grid and the actual situation of the structure. At the same time, it can accurately grasp the change of the fault, including online processing of various forms of faults such as transient or permanent failure of a loop, multiple lines, etc., which can prevent the vibration of the fault processing mode on the line during the traditional reclosing operation. And impact damage. The process in the fault diagnosis process is mainly based on the distribution network terminal as a basis to detect the fault, and then uses the substation as the regional control center and the centralized management center to use the feeder fault in the area where the substation is located for query and analysis. It can determine the location of the fault, complete the reporting and timely isolate the fault, which can reduce the impact of the fault. In the process of fault diagnosis, it is still necessary to use calculation analysis to provide accurate and reliable power supply solutions for non-faulty areas to ensure the power supply stability of the entire system. If the substation fails to successfully isolate the faulty part, the fault content needs to be reported to the master station system in time, and then the master station is responsible for coordinating and calculating the processing scheme [3].

In general, it is mainly divided into the following feeder automation implementation processes: First, the substation sends out fault information and the processing result of the fault. After transmitting this information to the master we can use the multi-substation linkage mechanism to handle the fault. Third, in the process of troubleshooting, the best intervention method must be selected according to the specific situation of the fault. For some small-scale power distribution network faults, the system can be completely automated to troubleshoot. If the type of fault is more complicated, it needs to adopt joint manual and automated processing methods for intervention. Fourth, in the process of automatic and manual joint intervention, it is necessary to calculate the fault handling plan according to the fault diagnosis, provide multiple troubleshooting plans, and then the operator selects the best troubleshooting plan based on the actual situation of the fault and completes Isolate the fault and restore power.

3.3 Fault Identification

Using the FTU in the feeder automation system can accurately identify the fault type and signal data, and the current obtained by the FTU can accurately identify the fault using the current facility. If the line is introduced between phases, the FTU will sample the transient and exceed the current limit, so that the fault can be accurately judged. Under normal circumstances, the decision can be made within 30 milliseconds of the occurrence of the fault, which can provide a prerequisite time for calculating the fault handling scheme. If a unidirectional ground fault occurs, the continuity of the ground point and the phase in the normal state will be reversed. In addition, the non-faulty voltage will exceed 1.5 times the fault voltage, and the single-phase ground fault can be judged in time. However, many distribution networks in China adopt a mode in which the negative value of continuous components such as neutral point is not grounded. Using this method will reduce the accuracy of fault identification. According to this situation, the feeder automation system can use the pull-out switch to eliminate such faults. And the main station system can add switching operations, sequence prompts

and other functions, which can improve the accuracy of single ground fault judgment [4].

4. Application of Distribution Network Feeder Automation Control Technology

4.1 Troubleshooting of FTU / DTU

During the fault processing of the FTU / DUT, the terminal of the automation system will accurately determine the limit data signal of the fault by means of real-time analysis and sampling of current and electrical compression, and can use the fault processing operation function of the station to complete the fault information reporting. . That is to say, in the application process of the FA terminal technology, its main function is operation execution. The main station system provides the feeder terminal with the characteristic parameters such as current and voltage when the fault occurs. Then the accessory terminal can analyze the sampled values and characteristics comparative analysis. In this way, the nature and type of the fault can be accurately determined, and effective measures can be taken to deal with the fault according to the result of the determination.

4.2 Overhead Line Troubleshooting

During the fault handling of the overhead line, the FTU coordinated with the sub-stations of the switching system on the column and the master station to complete the automatic fault detection of the overhead line. In this process, the fault detection FTU is responsible for positioning, which is mainly the fault isolation and power restoration work coordinated by the FTU and the substation. It is coordinated and completed by the FTU, the substation, and the master station. During the fault handling of an overhead line in an electric power network, the power supply source of the two overhead lines in the line is a substation. All switches, including segmentation, are monitored and operated by a substation of the distribution network feeder automation system. In this process, the operations of fault isolation and power restoration are also completed by this substation. If these two overhead lines are not powered by a substation, the two overhead lines will be monitored separately by system substation a and substation b, and they will be responsible for monitoring the line's fault handling and power restoration, etc. [5].

4.3 Time Allocation in Applications

The determination time for permanent fault allocation is generally within 3 seconds to 5 seconds. The fault determination of overhead lines is taken as an example to study. If a traffic line fails, the substation will perform protective actions and automatic reclose operations. In the case of success, it can be basically concluded that there is a fault on the main line. In this case, the substation is responsible for collecting protection action information, and collecting and analyzing various fault information including switch trip information. The collection time required by the slave station for direct collection is within 5 to 10 seconds. If the RTU conversion mode is used for collection, the collection time is within 10 to 15 seconds. The substation can use the automatic positioning function to collect fault information. The time required is 1 second, and the time required for fault isolation is 2 to 5 seconds. The time required for the main station to implement power restoration is 3 seconds to 6 second. This is mainly because it takes 2 seconds for each switch to recover before it can work. Generally, restoring 1 or 2 switches can complete the interconnection restoration operation. Using the time distribution of feeder automation technology, it can be researched that faults can be effectively handled in a few seconds to several minutes, and the power supply restoration work can be completed, which can greatly improve the troubleshooting efficiency of the distribution network. For example, in a company's power supply process, the distribution network feeder automation technology transformation and construction is implemented on a large scale. When a switch station branch line fails, the failure processing and power supply restoration process is completed in less than 10 minutes. The time of failure is summer. In the past, when the power distribution network failed, it was necessary to troubleshoot the line and restore the power supply according to the point-by-point inspection method. It took at least one hour to two hours to restore the power supply. After the feeder

automation technology is applied, the fault can be accurately identified and judged in the feeder automation line in the distribution network after a fault occurs. The completion of fault isolation, power failure processing, and power restoration within this period of time can effectively reduce the loss of the power distribution network line to a minimum, greatly improve the maintenance speed, and promote the further development of the power distribution network. positive effects.

5. Conclusion

Using feeder automation technology, we can accurately judge and identify the fault type, fault nature, and fault status of distribution network lines in a very short time. It greatly shortens the fault isolation time of the distribution network lines and can restore power supply in a very short time. In order to promote the widespread application of distribution automation technology, we need to research and improve the current feeder automation technology to ensure that the feeder automation technology can be adapted to the distribution network line reconstruction project. In this way, the stability and safety of the distribution network lines can be further ensured, and the probability of failure of the distribution network lines can be reduced as much as possible. At the same time, we can also improve the efficiency of fault maintenance of distribution network lines, and promote the development of distribution network lines toward high speed and modernization.

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