Research on Condition Analysis of Secondary Equipment Based on Electrical Automation Technology

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Abstract. In the process of continuous development of electrical automation technology, power companies implement state maintenance of relay protection equipment, and then avoid the drawbacks in traditional maintenance methods to achieve the purpose of extending the service life of relay protection equipment. For the relay protection device, after the unfolding state maintenance, the corresponding data can be collected in real time, and the device state quantities of various automatic monitoring and monitoring devices are recorded, thereby judging whether the device is in a healthy state, thereby changing the tradition. The blindness of regular maintenance, reducing the number of times of equipment failure-free power-off maintenance, greatly improving the availability of relay protection equipment. This paper analyses the role, purpose and condition monitoring content and method of relay protection status maintenance of secondary equipment in substation, and discusses the problems that should be paid attention to when implementing state maintenance.

1. Introduction
The power industry is an important industry for social production and life, and has made outstanding contributions to the development of China's economy. Electric energy has become an important supporting energy for today's social development. Secondary equipment is an important part of the power system and plays an important role in maintaining the safe and stable operation of the power system. This paper will analyze the related problems of secondary equipment in power system, analyze the key technologies of secondary equipment state maintenance, etc. Based on computer technology and automation technology, the current level of social production is continuously improved, which has continuously affected more industry fields and achieved remarkable results. Applying automation technology to the state maintenance of electrical secondary equipment not only improves the efficiency of maintenance work, but also ensures the reliability of the final inspection results, and provides an important guarantee for the stable operation of the power system. It is an important direction for the current state of equipment maintenance research. Have a certain understanding and understanding of secondary equipment in the power system [1].

2. The concept of state maintenance
State maintenance is a result of the company's detection of the state of electrical equipment, mainly from the aspects of safety, environment, efficiency and other aspects of testing, analysis, and finally diagnosed.
Scientific and reasonable arrangements and planning are required for the maintenance time of the equipment and the maintenance methods for each project [2]. The inspection of the state of equipment and facilities; the diagnosis of equipment and facilities; and the decision-making of the maintenance of equipment and facilities. Safety refers to the harm that secondary equipment may cause to people. The environment refers to whether the equipment is damaged by the environment and whether it meets the requirements of sustainable development advocated now. Benefits are the direct or indirect economic benefits of the company when it uses secondary equipment [3].

2.1. The necessity of state maintenance of electrical secondary equipment
The electrical secondary equipment mainly includes automatic device and fault recording, relay protection device and local monitoring, remote control device, etc. It is necessary to ensure that all parts maintain the optimal operating state before the reliability of the power supply of the power grid can be realized. The state maintenance of the electrical secondary equipment needs to be based on computer technology and microcomputer protection technology. Based on the self-checking function of the microcomputer system, the abnormality of the protection device is detected at the first time, and then the device will immediately send an alarm to the management personnel. Information, reminding them to take timely measures to deal with [4]. If the device does not send any alarm signal during the running process, it can prove that the device is in a normal state and there is no hidden danger. The memory applied to the electrical secondary equipment protection device has relatively low anti-interference ability and is prone to aging under long-term operation. If any part is abnormal, it will affect the actual operating state of the protection device. In order to reduce the occurrence of problems such as disoperation and refusal of the protection device, it must be discovered and processed the first time after an abnormality occurs in the device [5].

For electrical secondary equipment, in the substation operating environment, the electromagnetic pollution is very serious, coupled with a large number of microelectronic components and high integrated circuits present in the protection device, the electromagnetic interference will have a significant impact on the protection device. As far as the past practical experience is concerned, under the electromagnetic wave interference, the sampling signal of the secondary device will have a distortion problem, and in some cases, it will directly refuse to move, or cause damage of the component, and cannot maintain the normal operating state. Therefore, it is necessary to pay more attention to the state maintenance of electrical secondary equipment, monitor and repair its operating status based on microcomputer protection, and strive to find and deal with the existing problems in the first time [6].

2.2. The significance of electrical secondary state maintenance under automation technology
Automation technology has now been widely and reliably applied in many fields and has achieved good results. Facing the rapid development of electronic technology and computer technology, it is applied to the electrical secondary state maintenance. Compared with the traditional manual statistical method, it can directly control the equipment through the computer, and then complete the collection of equipment operation status information. The software performs statistics and analysis to determine whether the device is abnormal or not, as the basis for the next phase of management work. The application of automation technology is of great significance to promote the sustainable development of the electrical industry. It can realize the maintenance of equipment under working conditions, monitor its operation dynamically, and use equipment health diagnosis and automation technology to obtain more reliable maintenance results in less time. Improve the scientific management of equipment management and extend the service life of equipment.

2.3. Maintenance background of electrical secondary equipment
In the process of power system operation, various state abnormalities occur, which makes the whole system unable to perform normal operation. Therefore, the overhaul of its state has become a hot research topic. China's economic development has driven the continuous advancement of the power industry, and its demand has gradually increased. Therefore, the competitiveness among power
companies is gradually expanding, so the technology of state maintenance of electrical equipment will become a powerful competitive weapon; the development of various advanced technologies, such as computer technology, microelectronics technology, and communication technology, has made the development of electrical equipment status an implementable direction. The overhaul of primary and secondary equipment will not be independent and has many links. Under normal circumstances, if you want to carry out maintenance work on the secondary equipment, you should operate it in the state of power failure maintenance of the primary equipment. When repairing the problems encountered in the overhaul of secondary equipment, it should also fully consider the situation faced by the equipment once, and make a comprehensive analysis and correct decision. In the process of secondary equipment maintenance, it is necessary to strictly control the time of maintenance, reduce unnecessary waste and loss, reduce maintenance costs, etc., and ensure that the equipment can operate normally after maintenance.

3. Characteristics of secondary equipment status maintenance

Maintenance of power system equipment is a key link to ensure the safe and stable operation of the system. Overhaul can be carried out for specific fault problems, or it can be overhauled regularly to prevent overhauls. Later, there were two ways to overhaul the power system. One was to regularly check the equipment to ensure the stability of the equipment; the other was to overhaul the reliability of the equipment, that is, the state maintenance. The state maintenance of the secondary equipment is a scientific maintenance method, which can effectively repair the complex circuit system and improve the efficiency of use of the equipment and the stability of performance. The state maintenance is to analyze the test results based on the detected data, and then arrange the repair time and maintenance method reasonably. The secondary equipment status maintenance is to detect the use status of the secondary equipment, and judge according to the status to obtain the time and method of maintenance. A special inspection instrument is required for the conditional maintenance of the secondary equipment.
3.1. Electrical secondary equipment maintenance status maintenance

Electrical equipment is divided into primary equipment and secondary equipment according to functions. Secondary equipment mainly includes functions such as relay protection, fault recording, automatic device, local monitoring and remote control. The stable operation of the power grid can be guaranteed when the equipment is in normal operation. However, in the actual operation of the power system, the failure of the secondary equipment causes the entire system to be difficult to operate efficiently, and the cause is complicated. The microcomputer has been widely used in automatic devices and relay protection, and has improved the flexibility, accuracy and reliability of relay protection. This indicates that the electrical secondary equipment is inspected according to the traditional maintenance regulations, and it is difficult to meet the current power system. Operational requirements.

3.2. Electrical secondary equipment condition monitoring

The main content of electrical secondary equipment condition monitoring is the life of secondary equipment, equipment correctness and reliability. Condition monitoring is one of the basic tasks of secondary equipment status maintenance. In addition, the main object of secondary equipment status maintenance is the AC measurement system. During the maintenance process, the working characteristics of the AC measurement system and the component characteristics in the relevant lines need to be monitored. Unlike primary equipment, secondary equipment status monitoring is not a single component, but a unit or the entire system in the entire electrical system. Therefore, in the secondary equipment monitoring, each component in the working line needs to be monitored and judged. Whether its dynamic performance is normal and stable. If part of the components need to be monitored during component monitoring, offline monitoring can be used. Offline detection is the most commonly used method for equipment status maintenance, providing a basis for related work.

3.3. Electrical secondary equipment status monitoring method

Electrical primary equipment condition monitoring relies more on sensors, while electrical secondary equipment condition monitoring has less dependence on sensors. It can be seen from the actual work that the technology exhibited by the electronic secondary equipment switching monitor is more mature. In actual work, it is difficult to monitor the electrical secondary equipment in conventional protection, mainly because the monitoring technology application is difficult to match the actual electrical system operation. To optimize the state monitoring technology, we should first familiarize ourselves with the monitoring technology of electrical secondary equipment, and continuously innovate on the basis of existing technologies to introduce and develop new technologies. The development of electrical secondary equipment monitoring technology is inseparable from the microcomputer automatic device diagnostic technology and microcomputer protection technology. These two technologies continue to develop and promote the development of secondary equipment detection technology. In addition, the continuous development and improvement of the substation diagnostic system has also promoted the development of electrical secondary equipment monitoring technology. There are many different modules in the electrical secondary equipment protection device. The functions of different modules are different, and the roles in the system are also quite different. The module generally has a self-diagnosis function, so each module in the equipment protection device also has a corresponding diagnostic function, which can inspect each zero in the module and diagnose the abnormal situation, which plays an important role in the efficient development of the electrical secondary equipment maintenance work. Effect. In addition, after the diagnostic program is added, the devices and components of the system can be automatically detected.

4. The key link of the state maintenance of electrical secondary equipment

4.1. Collection of operational data of electrical secondary equipment

In the state maintenance of the secondary equipment of the power system, a large amount of relevant maintenance data needs to be collected. This involves the collection of status maintenance data. Due to
the limitation of technical level and the omission in the management of secondary equipment, the traditional operational data collection has some practical operational problems in the data collection of state maintenance, which cannot provide accurate data detection for maintenance and provide decision-making reference for equipment maintenance. Therefore, in the state maintenance of the secondary equipment, it is necessary to provide the effectiveness of data collection. At this stage, the main method is to improve the collection capability. Collecting data offline has accumulated rich experience in the long-term practice process, and it is a more accurate form of data collection at this stage. However, this method also needs to strengthen the management of primary equipment and secondary equipment, record and archive the problems that occur during the operation of different equipments, and provide literature and solutions for future state maintenance. At the same time, for the complex maintenance problems, professional maintenance personnel should be analyzed and experimented to find a solution.

4.2. Electrical secondary circuit monitoring
As the key part of substation electrical design, electrical main wiring determines the operation status of the whole substation, which has a direct impact on the selection of electrical equipment, the design of relay protection and control mode, and the configuration of power distribution equipment. It is necessary to pay more attention to it. The electrical secondary circuit is a collection of secondary equipment. All secondary equipments are connected according to certain rules. The electrical circuit that meets the specified technical requirements can be called an electrical secondary circuit, which can not only divide the electrical primary equipment from the function. And electrical secondary equipment, can also be divided into electrical secondary circuit devices and electrical secondary circuit protection devices according to structural differences. In terms of electrical circuit devices, including multiple relays, equipment, and cable components, there are many circuit branches, which determines the complexity of the entire system. The actual control is very difficult, and it is necessary to effectively judge whether the loop connection is abnormal, and whether the cable and device connections are standardized requires not only a lot of resources to support, but also more time. In contrast, the electrical secondary equipment protection device can achieve automation and micro-computerization effects, the control is less difficult, and the monitoring of the loop is easier to implement. To monitor the electrical secondary circuit, it is necessary to focus on equipment management analysis, analyze the accumulated experience of equipment acceptance management in the past, and strive to achieve online diagnosis of the secondary circuit through offline maintenance data management and online monitoring. Problem and take action

![Image](image-url)

**Figure 2.** Secondary state maintenance analysis
4.3. Solving the problem of electromagnetic interference
Secondary equipment in the power system is basically operated in electromagnetics. With the development of electronic integration technology, a large number of electromagnetic devices are used in power equipment. Therefore, in the state maintenance, it is easy to be disturbed by the surrounding electromagnetic and the monitoring signal is unstable, so that the monitoring data cannot provide information data for the diagnosis process. The reference does not provide an accurate signal for the development of the maintenance plan. These are difficult to carry out maintenance work, affecting the final power system work. To solve the electromagnetic interference problem. At this time, a compatible electromagnetic experiment can be taken to perform separate tests on some sensitive components in the secondary device. At the same time, it is necessary to conduct supervision and prevention from where electromagnetic interference is concentrated. In the power system, for the connection of different equipment, the channel for isolating electromagnetic communication should be used to maintain the power equipment. In the area of secondary power equipment, the restrictions on the use of electronic equipment should be strengthened. Electronic equipment has great electromagnetic interference in secondary equipment, so it is necessary to strengthen supervision. In addition, it is necessary to effectively supervise the working range of the secondary equipment. During the electromagnetic compatibility experiment, the relevant electronic equipment can not interfere with the signal, ensuring the authenticity of the information collection, and providing the secondary equipment status maintenance plan. Accurate creed.

4.4. Electrical state maintenance relationship
Electrical primary equipment includes generators and transformers, contactors and knife switches, circuit breakers and automatic switches, transmission lines and power cables, busbars and disconnectors, etc., mainly responsible for production and transportation, grooming and distribution of electrical energy. The electrical secondary equipment can be regarded as a supplement to the primary equipment, and detects, adjusts and controls the operation state of the primary equipment to realize the protection of the low-voltage electrical equipment. At the same time, it can also provide direct production command signals to maintenance personnel, and the primary equipment and the secondary equipment are completely independent of maintenance. The relationship between the two determines that the secondary equipment can be inspected after the primary equipment stops working. The technical requirements for the conditional maintenance of electrical secondary equipment are higher. Through the application of automation technology, the maintenance can be completed in a shorter time, the time for maintenance and power failure is shortened, and the number of inspections is reduced, so that the entire inspection work is more efficient and economical.
In order to facilitate the state maintenance of the secondary system, we need to construct the judgment matrix to compare the importance between the indicators to determine the weight. It is worth noting that the construction of the judgment matrix is performed separately according to the indicator affiliation. For this paper, a judgment matrix needs to be constructed between the first-level indicators of each secondary equipment, and a judgment matrix needs to be constructed between the secondary indicators belonging to the same first-level indicators. The constructed judgment matrix needs to be scaled by importance, and then a series of algorithms are used to get the initial weight. The indicator scale is performed with numbers of different sizes. The larger the number span, the finer the score, and the more accurate the weight will be.

Therefore, the maintenance evaluation matrix is established. Taking the first-level index of the protection and control device as an example, the judgment matrix is constructed for the four indexes of time performance, communication performance, operating condition and hardware performance of the device, as shown in Table 1.

| Index | Time performance | Communication performance | Operating condition | Device hardware indicator performance |
|-------|------------------|--------------------------|--------------------|----------------------------------------|
| U1    | U2               | U3                       | U4                 |                                        |
| U1    | 1                | A21                      | A31                | A14                                    |
| U2    | A21              | 1                        | A23                | A24                                    |
| U3    | A31              | A32                      | 1                  | A34                                    |
| U4    | A41              | A42                      | A43                | 1                                      |

Figure 3. Substation secondary system automation state maintenance process
Generally, the judgment matrix has the following properties:

\[ A_0 = \frac{A_{i,j}}{\sum_{j=1}^{n} A_{i,j}}, \ (j=1, 2, \ldots, n) \]  

(1)

The scale method compares the indicators to each other. The communication performance of the protection and control device is compared with the other three indicators as an example. The average operating condition of the equipment is \( A_0 \).

\[ U_i = \sum_{j=1}^{n} A_{i,j}, \ (i = 1, 2, \ldots, n) \]  

(2)

We believe that the communication performance of the protection and control device is slightly more important than the time performance, the time interval \( W_i \) required for maintenance.

\[ S_{i,j} = \begin{cases} \frac{u_{\min} + A_i}{u_i} & \text{if } u_i > u_j \\ \frac{u_{\min} + A_j}{u_j} & \text{if } u_j > u_i \end{cases} \]  

(3)

The communication performance is as important as the operating conditions, so the communication performance is between the important and the slightly important compared to the hardware performance of the device. By analogy, the comparison judgment matrix can be obtained, and the comprehensive inspection interval is \( W_0 \).

\[ W_i^0 = \frac{W_i}{\sum_{j=1}^{n} W_j}, \ (i = 1, 2, \ldots, n) \]  

(4)

Calculate \( W_0 \) to get the best state maintenance cycle of the substation secondary system.

5. Content monitoring of electrical secondary equipment

The condition monitoring of the equipment is a basis for the state maintenance. Then, the monitoring content is mainly the monitoring of the correctness and reliability of the secondary equipment work, and the life expectancy of the secondary equipment. The main object of the state monitoring of electrical secondary equipment is AC measurement system, DC operation and signal system, communication system and shield grounding system, etc., and the electrical primary equipment is not the same as the status monitoring of the secondary equipment. The original, but an entire unit or an entire system, monitors the dynamic performance of each component. For the monitoring of the performance of some
components, offline monitoring is still required. Therefore, the offline detection data of electrical secondary equipment is also an important basis for condition monitoring and diagnosis.

Figure 4. Distributed intelligence driven by new sensors and intelligent switch

5.1. Method for condition monitoring of electrical secondary equipment
Compared with the electrical primary equipment, the state monitoring of the secondary equipment does not rely excessively on the sensor. Therefore, the state monitoring of the electrical secondary equipment is technically and economically superior to the primary equipment. It's easier to do. For the conventional protection status monitoring, it is relatively difficult to achieve. If the new input is not increased, the existing measurement methods should be fully utilized. Microcomputer protection and the continuous development of self-diagnosis technology of microcomputer automatic devices, the continuous improvement of substation fault diagnosis system has laid the technical foundation for the state monitoring of electrical secondary equipment. Each module of the protection device has a self-diagnostic function for performing inspections and diagnostics on the device's power supply, CPU, input and output interfaces, A/D conversion, and memory. Therefore, the methods of state monitoring of electrical secondary equipment mainly include: comparison method, coding method, calibration method, watchdog timer method, feature word method and the like. For the protection device, each device and component can be automatically tested by loading a diagnostic program.

5.2. Analysis of the maintenance method of secondary equipment relay protection status
The maintenance status of the relay protection status of the secondary equipment is as follows: including condition monitoring, equipment diagnosis, and maintenance technology. For condition monitoring, because it belongs to the main work content of state maintenance, it is also the key to launching diagnosis and decision-making. Therefore, strengthening state monitoring is an indispensable part, and it will make the maintenance work in the future more convenient and provide corresponding the theoretical basis.

The basic content of the so-called state maintenance is: monitoring of the state of the equipment to further monitor the correctness and reliability of the work of the secondary equipment, and to evaluate and analyze the health status of the equipment. In the substation, the status monitoring objects of the secondary equipment are as follows: DC operation, signal system; logic judgment system and AC measurement system. In order to improve the efficiency of secondary equipment maintenance, the
operator needs to clarify the difference between the overhaul and the second overhaul; that is, for the maintenance of the secondary equipment, the object of the overhaul will no longer be a single original equipment, but The maintenance is carried out from the entire system to further monitor the dynamic performance of components in the system, and some component performance needs to be detected offline. Simply put: monitoring offline detection data of electrical secondary equipment is one of the essential contents in the second overhaul. It can not only reflect the current equipment usage, but also provide data for future maintenance work. Based on this, the maintenance work will be better carried out to continuously improve the quality and effect of the overall maintenance.

6. Conclusion
The implementation of state overhaul of electrical secondary equipment is the need of power system development. With the continuous development of integrated automation system, the microcomputer protection technology is relatively mature, and the digitalization and intelligence of substation become its main development direction. Based on this protection device, each device and component can be automatically monitored by means of a loading diagnostic program. However, in the conventional maintenance process, the above requirements cannot be achieved. The reason is that during the process of secondary maintenance, because the composition of the secondary circuit is complicated, and there are more scattered points, the online monitoring relay touches. The way the point feedback is not good and does not meet the economic requirements. In the process of equipment maintenance, on the one hand, it should start from the equipment management link, combine online monitoring to diagnose its status, and start maintenance work in the shortest time. On the other hand, in the context of the new investment does not increase, the existing measurement methods need to be fully utilized to complete the maintenance work. For the purpose of maintenance of the protection equipment, in order to effectively improve the work efficiency, the maintenance operation personnel can be appropriately reduced in the actual maintenance process, and the labor maintenance intensity can be reduced while reducing the maintenance workload of the equipment. Improve labor productivity.

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