Analysis of Relay Protection in Power System Based on High Voltage

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Abstract. In recent years, China's economic development level has continuously improved, great achievements have been made in the construction of electric power, the size of the power grid has also been continuously expanded, and higher requirements have been placed on the safety and stability of power systems. Power system protection occupies an important position. The essential. In the context of today's high-voltage direct current transmission, line construction has gradually increased, and with it came defects in relay protection technology, which have seriously affected the further development of the power system. This article will specifically analyze the strengthening of relay protection technology in HVDC transmission lines, and improve the power system safety level by improving the performance of relay protection devices.

Key words: Relay protection; Power system; High voltage.

1. Relay Protection
In the event of a power system failure, maintaining the normal operation of the entire power system is of great significance for protecting people's lives. The relay protection will ensure that the relevant faulty equipment switch is cut off within a minimum range, and other power systems can still work normally. Relay protection can also deal with related faults in time when an accident occurs to avoid affecting the normal use of regional power. It has the fastest operating speed to solve relay protection problems, and ensures continuous power supply. When the power system fails for the first time, the relay protection device can sense and take appropriate measures to deal with it. Handling faults in the shortest time can ensure the normal and stable operation of the power system, and all faults must be eliminated.

2. Existing Problems in Relay Protection of HVDC Transmission Lines
According to the protection principle of HVDC transmission, the current HVDC protection schemes are not reliable, the protection methods are not strong, the sensitivity is not high, and the failure processing time is not long. In the later protection, the main protection speed is a little slow. According to the standards of protection configuration, HVDC transmission protection is not rich in various types, the reliability is not strong, and the rapid processing method after a fault is slow. It is necessary to focus on the frequency band of energy concentration for HVDC and AC power transmission. In the process of AC power transmission, due to long-term transmission operation experience, the reliability is high, and the technical theory is relatively complete. [1]
3. Reliability Analysis Relay Protection System based on Fault Tree Method
The fault tree analysis method was developed in 1962 by Bell Telephone's telephone laboratory. One of the main analytical methods of this subject is the study of the systematic, accurate, and computational aspects of safety systems engineering.

The devices constituting the relay protection hardware system mainly include a power transformer, a relay protection device, and a power communication device. Because there are many devices and systems, the fault tree method can be adopted to analyze layer by layer, so that the faults in the relay protection system can be better discovered. As shown in Figure 1, the system hardware system is divided into two parts: the relay protection aging and the blocker failure. A indicates that the guarantee is accurate, and B indicates that the interrupter is accurate. The hardware failure of the relay protection system is $AB + AB = AB + B$ pointed out. Through accurate measurement, the probability and importance of the hardware components of the relay protection system are clearly understood. [2]

![Figure 1. Failure tree of relay protection system hardware failure](image)

4. Relay Protection Technology Commonly Used in HVDC Transmission Lines

4.1. Differential Undervoltage Protection Technology
Differential undervoltage protection technology has a wide application range and strong applicability. The main protection system and backup protection system of HVDC transmission lines can use this technology. The differential undervoltage protection technology can protect the line based on the voltage amplitude level and the voltage differential value.

In the application of current relay protection technology solutions, SIEMENS and ABB solutions are more common. At the same time, the two schemes have certain similarities in principle. Both can be used in voltage amplitude and voltage differential measurement. Taking the ABB solution as an example, the application of differential undervoltage protection technology can make full use of the solution. Compared with other subsequent products, when the 20ms rise delay is reached and reaches a certain standard, the backup protection system of the solution is fully used. The application of differential undervoltage protection technology can effectively improve the sensitivity, stability and safety of the system.
Differential undervoltage protection technology is widely used and has strong applicability. Differential undervoltage protection for transmission lines is based on the voltage amplitude and voltage difference technology. It can be used for the main protection system and backup protection system of high-voltage DC transmission lines. [4]

4.2. Low Voltage Protection Technology

Low-voltage protection technology in high-voltage DC transmission lines, low-voltage protection technology is a relatively common relay protection technology, which can perform fault diagnosis and relay protection based on the detected voltage amplitude. In the application of low-voltage protection technology, the protection function of computer-controlled low-voltage and low-voltage interconnection lines should be brought into full play. The shortcomings of low voltage protection technology is that it is not effective to determine the cause and location of the fault. Therefore, in the application of low voltage protection technology, the situation of the line should be considered dialectically, and the function of the modified technology should be dialectically considered.

In high-voltage DC transmission lines, traveling wave protection technology is the main protection technology. Once a high-voltage line fails, the retrograde wave propagating from the fault point to both ends of the line can be used to accurately locate the fault location. When the ABB scheme is used, the main role of the ground mode and polar waves is to perform faults on the types and levels of faults. In the SIEMENS scheme, the voltage is differentiated into a tool for judging the failure of the circuit system. The integration of SIEMENS scheme and traveling wave protection system enables the system to determine the fault type based on the reverse microwave component within 10ms. Compared with the two schemes, under the influence of differential link, the detection speed of ABB scheme is better than SIEMENS scheme, but the anti-interference performance of ABB scheme is relatively worse than SIEMENS scheme. The problems of high sampling requirements, inaccurate theory, and limited resistance to excessive resistance are the common problems between the two.

4.3. Traveling Wave Protection Technology

In high-voltage DC transmission lines, traveling wave protection technology is the main protection technology. Once a high-voltage line fails, the retrograde wave propagating from the fault point to both ends of the line can be used to accurately locate the fault location. When the ABB scheme is used, the main role of the ground mode and polar waves is to perform faults on the types and levels of faults. In the SIEMENS scheme, the voltage is differentiated into a tool for judging the failure of the circuit system. The integration of SIEMENS scheme and traveling wave protection system enables the system to determine the fault type based on the reverse microwave component within 10ms. Compared with the two schemes, under the influence of differential link, the detection speed of ABB scheme is better than SIEMENS scheme, but the anti-interference performance of ABB scheme is relatively worse than SIEMENS scheme. The problems of high sampling requirements, inaccurate theory, and limited resistance to excessive resistance are the common problems between the two.

5. Conclusion

The relay protection of the high-voltage substation system plays an important role in ensuring the safe and stable operation of the power system and provides an important guarantee for the development of relay protection technology, thereby protecting the high-voltage substation system to the information society. At present, high-voltage DC transmission lines still have problems such as low sensitivity during the relay protection process, which affects the stability of the power system. Therefore, in order to meet the needs of relay protection, during the operation and maintenance of power systems, relevant technical personnel should pay attention to the application of modern relay protection technologies, such as traveling wave transient quantity protection technology, differential undervoltage protection technology, etc. Find out and solve the problems in relay protection, improve the reliability of protection, and make the DC system more stable.
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