Improvement Strategy to Improve Relay Protection Reliability in Smart Substation

Xuanyi Li*, Tiecheng Li, Junqiang Li, Huifeng Li, Cuiyan Huang

Electric Power Research Institute, Hebei Electric Power Company, State Grid
vivian.wang@cas-harbour.org

Abstract. Due to the continuous development of science and technology in China, technological innovations have started in various fields. In the background of this era, power companies have begun to build smart grids. As a key link in the construction of power grids, substations will inevitably follow the trend of smart development and become the focus of current power companies. However, relay protection determines whether smart substations can achieve efficient operation. This article analyzes the main points of smart substation relay protection, and draw the improvement strategy of smart substations on relay protection, which includes the protection of the transformer, voltage limit delay, and line protection, thus promoting a healthy development of smart grids in China.

1. Introduction
The smart substation refers to a Power facility using smart devices with emerging environmental protection properties to automatically collect, monitor and control the information of the power grid operating lines, so that the power grid system can successfully realize intelligent regulation. Relay protection has an important impact on the smooth operation of smart substations, therefore, to ensure the smooth operation of substations, the reliability of relay protection need to be improved first. This paper discussed about several key points of the smart substation in relay protection worthy to consider and tries to give some advice about how to improve the reliability of relay protection.

2. The main points about relay protection for smart substation

2.1. Reliability of Relay Protection
Reliability of relay protection needs to be discussed mainly in two aspects. On the one hand, protective measures should be taken in time when a failure occurs in the protection zone of the smart substation. On the other hand, misjudgment of the failure during normal operation should be avoided when the power system is operated normally [3]. The digitization of the entire power system based on automated electronic information technology is the core of the smart substation. Given that, many electronic devices must to be used properly in the protection section. However, there are many factors that affect the stability of electronic devices, such as the battery compatibility of the device and the frequency of device using, which may endanger the reliability of the relay protection. Therefore, ensuring the high stability of optical cables and reducing the frequency of interference from electronic devices are very necessary for the intelligent substation to achieve relay protection. Based on this, advanced technology should be used to implement self-testing on the relay protection system in smart substations, and respond to system error warnings in a timely manner. Figure 1 shows a Power grid fault diagnosis model.
In addition, a system model should be built to quantitatively analyze the reliability of relay protection [5].

2.2. Real-time performance
Real-time performance is an important requirement in the power system for the relay protection of smart substations. However, in the digital sampling process, the digital transformer will produce time errors under the influence of certain factors, resulting in severe data loss during the transmission process. The important factor that causes the time error of the digital transformer is the forwarding of the switch and the queuing of the combiner. Based on the above reasons, the plan implemented by the personnel operating the power system during the sampling process should be scientific and feasible, and estimate the possibility of error in advance, and then implement the sampling. In order to minimize the influence of errors and delays on the sampling results, in the actual operation process, the sampling results should also be combined with the calculation results, so that the real-time performance of relay protection can be fully improved.

2.3. Synchronization
The use of transformer equipment in traditional substations does not need the function of time synchronization. Therefore, the traditional power system lacks the protection of synchronization. However, for smart substations, the information collection relies on digital methods, therefore, the power distribution protection is required to be synchronized. There are two ways to achieve reliability and synchronization in relay protection in smart substations: Firstly, the synchronization detection device and the differential protection device should be used for the line protection. Since the two collect the signal amplitude and phase of different substations, and both the line data on the local side and that on the opposite side are collected, hence it is important to make sure that the entire power protection being synchronized and operated correctly; Secondly, the power system should implement over-current and over-voltage protection, for they are very easy to be achieved only by manually input the correct amplitude into the relay protection system, and there is no requirement for synchronization during that process.

3. Analysis on effective strategies for smart substations to improve the reliability of relay protection

3.1. Strengthen the protection of the transformer
When the voltage flows through the distribution lines in the power system, its quota is limited. Whether the voltage is higher or lower than the limit, it will have an adverse effect on the power distribution effect [1]. The most important voltage regulation device for the power system is the transformer, which
is also an important device in distribution protection. Therefore, when a voltage transformer device is used in the relay protection system of an intelligent substation, the transformer can be configured in a distributed manner to make the good use of the differential function in relay protection. Moreover, backup protection can be realized by the centralized configuration for the transformer devices in the smart substation, so that the reliability of the smart substation regarding relay protection is able to be improved.

3.2. Voltage limit delay
Smart substations in daily operation are easily affected by many external factors, such as current, voltage, etc., and any abnormal state of which may cause external disconnection and cause overload current problem. Compared with the normal current, Although there is no obvious difference between the normal current with the overload one, if the smart substation happens to have an external fault, then the possibility of tripping is very high, which seriously threats the relay protection of the smart substation in terms of reliability [7]. For this reason, if the voltage limit delay is adopted in the voltage system circuit of the smart substation, the amount of current passing through each circuit can be accurately measured. As long as the overload current problem occurs, the system can immediately issue an alarm notification. All relevant branch system will activate protection commands in real time, thereby significantly improving the reliability of relay protection.

3.3. Line protection
In the power system, the protection of the line is extremely important. It can not only effectively control and protect the interval units in the voltage at all levels in the system, but also has multiple functions such as control, measurement, communication monitoring and protection for the power system. Implementing the line configuration work in the relay protection can ensure the safe and stable operation of the power system and greatly improve the reliability of the relay protection. Therefore, the staff should make standard operation to protect the line. As shown in Figure 1, through the vertical differential linkage method, most of the line protection devices can be well protected in the power system. There are two main ways for line protection, backup line protection and centralized line protection. Under the combination of the two, once the line protection configuration has problems, they can be dealt with in time, which strengthens the reliability of the power system.

3.4. Technology to strengthen the line protection mechanism
Currently, the main method adopted for relay protection in smart substations is to reinforce the dual configuration. For the backup protection, the centralized configuration is used to realize the regulation of the backup facilities and avoid switch failures. At the same time, it realizes the line protection of the opposite bus in the adjacent interval and the entire system, so as to use the current information fed back by the backup equipment to judge the operation of the entire power grid, and to preprocess the problem to prevent the accident. In addition, a reasonable strategy should be developed to solve the problem of
line tripping [6]. Therefore, under the current protection mechanism, we should strive to find more complete and reasonable technologies to realize technical adjustments to smart substations. At the same time, according to the overall operation of the power grid, the situation of substation system need to be analyzed scientifically and effectively [2] and ensure the operation plan scientific and rational to further advance the reliability level of relay protection in smart substations.

4. Conclusion:
The main points about relay protection for smart substation includes reliability of relay protection, real-time performance, and synchronization. The reliability of relay protection is related to the overall stability of smart substations and power systems. Therefore, power companies should focus on the specific protection needs of smart substations, continuously strengthen transformer protection, voltage limit delay, and the line protection mechanisms to effectively improve the reliability of relay protection, and promote smart substations and power systems achieve sustainable, stable and healthy development.

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