Design of "One-key" security measures system for smart substation

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Abstract. With the continuous advancement of technology and the ever-increasing demand for information digitization in power systems, smart substations have become the most mainstream substations currently used in China. The secondary circuit and pressure plate of the intelligent substation are virtual forms constructed by internal software. There is no obvious electrical disconnection point, so there is a big difference in operation and maintenance and repair methods from conventional substations. Combined with the requirements of the intelligent station maintenance business, this paper proposes to deploy a "one-click" security system in the station control layer monitoring system of the intelligent substation. This system is only used as an additional module and does not depend on the software and hardware structure of the station control layer. It is of great significance to effectively improve the efficiency of intelligent secondary equipment operation inspection and better guarantee the safe and stable operation of the power grid.

1. Introduction

Intelligent substation is the product of modern technology, which can effectively improve the level of network and informatization of the power system. In this era, China strive to develop smart grids, smart substations have become the most mainstream substations currently used in this country. Its safety and stability have an important impact on the operation of the entire power system [1-4]. In the conventional substation, the security measures of the secondary circuit follow the principle of "obvious electrical break point". The secondary circuit and the pressing plate of the substation are physical objects, which can form obvious physical break point. When the maintenance personnel work, they can ensure that the exit of the equipment will not be touched by mistake by detecting the obvious electrical power failure [5-7]. However, compared with traditional substations, smart substations have many differences. Intelligent substations use fibre-optical as a medium to transmit data, and the interconnections between the devices become fibre-optical communication links, and the corresponding secondary circuits and pressure plates become "virtual circuits" and "soft pressure plates" built inside the program. In the eyes of operation and maintenance personnel, a visualized substation changes from "real" to "virtual", resulting in a large difference between the operation and maintenance methods of intelligent stations and conventional stations [8-10].
In this paper, in combination with the maintenance business requirements of smart substations and relevant measures for security measures, proposed to deploy a set of independent "One-key" security measures application modules on the host of the integrated monitoring system to realize automatic generation of security measures orders and preview of security measures orders at the whole station, "One-key" security control execution and verification, security measures recovery and other functions. This application module does not depend on the original software and hardware structure, and is very convenient for both new stations and stock stations. The security measures proposed in this paper can effectively improve the efficiency of the secondary equipment maintenance in smart substations and are of great significance for ensuring the safe and stable operation of the power grid.

2. "One-key" security measures architecture

The so-called "one-click" security measures system is a technology that helps the maintenance personnel of smart substations to quickly complete maintenance operations. Operation and maintenance personnel only need to select the maintenance target, and then the software program automatically generates maintenance security measures orders. This system greatly improves Overhaul efficiency of smart substations. The one-button security system is deployed in the station control layer monitoring system as a new module of the original monitoring system. The system architecture diagram is shown in the following Figure 1:

![Figure 1. "One-key" security measures system structure diagram.](image)

2.1. System software structure

The system functions are implemented by adding independent software modules to the original monitoring system of the intelligent substation. It does not depend on the software and hardware structure of the station control layer. It is convenient to deploy the system whether it is a new station or a stock station. The system uses C++ and QT programming, and object-oriented design.

2.2. System communication plan

The "One-key" security measures function module is deployed in the station control layer monitoring system. It collects the platen status of each secondary circuit in the protection device through the existing
61850 protocol and mms protocol of the monitoring system, including the status of the protection function and the status of the outlet plate, GOOSE send / receive platen status, SV send / receive platen status, interval receiving soft platen status, isolation knife gate forcibly enabling soft platen status. The status of the overhauled hard platen and outlet hard platen of the intelligent terminal and the merging unit can be connected to the one-button safety measure module through measurement and control or the configuration of the acquisition unit. For the remote operation of the soft platen, the mms remote control service is used, without any additional communication equipment and services.

3. Field application examples
The method proposed by this research institute has completed the preliminary software and hardware development work, completed the automatic generation function of "One-key" security measures orders, and has been run and tested at the test station of Hebei Provincial Electric Power Company of China. Figure 2 shows the global interface of the system.

Figure 2. Interface of the "One-key" security measures system.

Figure 3. Security measures order generation interface.
When performing maintenance operations, operation and maintenance personnel can select the corresponding maintenance target from the equipment list of the "One-key" security measures system. After the maintenance target is selected, the system automatically generates security measures order based on the selected maintenance target and the current operating status of the system. Take 220kV line as an example, the generation of security measures orders is shown in Figure 3.

![Figure 4. Security measures sequence control preview (1).](image)

![Figure 5. Security measures sequence control preview (2).](image)
After the security measures order is generated, the maintenance personnel only need to click the "Confirm" button after determining the security measures step, and the one-click security measures system performs sequence control operations based on the generated security measures order, and determines the execution result of each step.

Figures 4-5 shows the implementation results of the "One-key" security measures system proposed in this paper. In Figure 4, the generated security measures are listed on the right, in order; the current maintenance equipment, operating equipment, and operating conditions are listed on the left; when the security measures are performed in sequence, the corresponding pressure plate on the left will use lights to indicate exit or investment Intuitively reflect the results of security measures implementation.

4. Conclusions
This paper combines the maintenance work requirements, and deploys a set of independent application modules on the host of the integrated monitoring system to achieve automatic station-wide security measures orders generation, security measures orders preview, one-click sequential execution and verification, and security measures functions are very important. Promoting the construction of a complete and intelligent "One-key" security measures system is of great significance for effectively improving the efficiency of the secondary equipment operation inspection of smart substations and better guaranteeing the safe and stable operation of the power grid. At present, the actual operation results show that this system solves the problem of writing traditional maintenance tickets difficulty, lack of flexibility, and low efficiency. It can play a role and be used in intelligent substations, with certain reference value and promotion value. This system will be put into use in various substations in Hebei Province.

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