Development and Application of Several New Technologies in Safety Locking Device of the Substation Screen Cabinet

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Abstract: Anti-misoperation locking device is a locking device for control operation circuit and primary equipment. At present, three faults of relay protection often occur in the secondary cabinet of substation. There will be a lot of safety threats if the secondary cabinet is lack of locking device. Therefore, in this study effective improvement strategies will be put forward in the aspect of technology and further analyze the technology of the secondary cabinet safety measures locking device and then replace the traditional setting mode of the secondary safety measures so that to technically prevent the violation of regulations in secondary maintenance and effectively prevent the occurrence of three fault events of relay protection. This technology can be applied to the secondary work site of power industry which is significant to ensure the safe operation of power grid. This study illustrates the application effect of the technology of the safety measures locking device for secondary panel cabinet in substation with specific cases which could provide help for the the relevant staff.

1. Introduction
For the substation, the secondary screen cabinet is an important equipment which includes communication device, measurement and control device, connecting piece, terminal block, precision instrument, etc. However, these devices are easily affected by external forces and once the equipment broke down, it will affect the safe operation of the primary equipment in the substation. Therefore, in the process of the secondary equipment maintenance of the substation, the staff should strictly standardize relevant processes, isolate the maintenance equipment from the operation equipment, and dispose according to the requirements of substation security measures. With the higher requirements of safety production, the requirements of the safety measures of the secondary equipment in substation became more and more complex. At present, in the layout of safety measures for the secondary equipment, besides hanging signs outside the working cabinet, the connection piece, terminal block or power air switch of maintenance device should be isolated from other operation devices in the case of there are multiple protection devices in the same secondary protection panel cabinet and only one device needs to be maintained and other devices are required to operate normally. This link is also a relatively difficult problem for current substation staff to operate and maintain. The current method is to use ordinary warning tape with insulating tape which however is inefficient and unable to ensure the safe and stable operation of the substation. In order to reduce the deployment workload of secondary equipment safety measures for the staff and effectively improve the isolation of maintaining and operating equipment in the protective bottle. In this research, the safety locking device for the secondary screen cabinet of the substation is proposed, and its technical principle is explained in detail.
2. Problem statement
In the process of the secondary equipment maintenance of the substation, to prevent the misoperation or accidental touch of the secondary screen cabinet or secondary equipment, relevant signs can be placed in front of the task panel or red cloth curtain can be suspended in the adjacent operation secondary cabinet. But these methods are easy to cause the following problems: Firstly, the red cloth curtain is not fixed and easily to fall off at the maintenance site which will easily lead to the confusion on site and cannot play its due value. What is more, it may lead the working staff to access to the improper bay by mistake which will be disadvantageous to the safety of life and the stability of the operation. Secondly, the red cloth curtain can only play a certain warning effect which lacks of effective locking function. Most of the secondary equipment panels and cabinets in the substation are not equipped with locks, only simple plug-in type anti opening devices are available, and some of them are equipped with simple lock cabinets. By using simple tools may fail to prevent the false opening and misoperation of the equipment after opening the screen door. Thirdly, it is easy to be time-consuming and laborious during the deployment of security measures. If only a few secondary screen cabinets are used, the security measures are difficult to handle. Only hanging the red curtain cannot achieve a good warning effect. Fourth, covering the operation screen cabinet with the red curtain brings inconvenience to the staff in the later inspection of the secondary equipment of the substation. Fifth, combining above-mentioned questions: the complexity of the safety lock of the secondary screen cabinets and secondary equipment maintenance of the substation, lack of the locking technology which makes the safety lock easy to move and fall off. And then this study proposes that secondary panel cabinet can be locked by safety measures. This technology can effectively prevent the secondary equipment from being accidentally touched or moved in the substation. At the same time, it can further replace the red cloth curtain and play a good role as a sign. The warning effect ensures that the safety measures of the secondary equipment screen cabinet of the substation meet the standard requirements. In addition, in order to reduce the manpower and time spent in the process of the layout of the safety measures for secondary equipment and to reuse the tools of the safety measures, further to reduce the operating costs of the power company, to improve secondary equipment maintenance and to maintain safety, the safety measures of the secondary screen cabinet of the substation will be improved and optimized.

3. Development of the safety locking device on substation secondary cabinet
The device can realize the security function in a more effective way with a series of analysis: the relevant standards of substation standardized management of the power company, experience summary and analysis of on-site installation measures for secondary maintenance equipment in substations, current problems of secondary safety measures and the situation of secondary equipment maintenance site, measuring and analyzing the secondary screen cabinet and form the safety locking device by integrated the lock and the safety sign. Also, combined with the safety signs, the two parts can only be used in switch to avoid overlapping effects. After analyzing the materials, methods and blocking methods used in the secondary safety lock, we believe that the device can use the following methods to further realize the function of safety measures: First, signs with warning words can be used to replace the original secondary safety measures; second, the signboard of the locking device can be used to replace the simple lock on the secondary screen cabinet of the original substation; third, the placement method of the signboard is used to replace the original secondary safety measures. The design and structure of the locking device of the entire secondary screen cabinet is simple which has strong reliability and easily switch the status of signboards which are firmly installed and not easy to move and fall off. By comparing and optimizing the weight and cost of materials, light weight and strong chemical stable materials are confirmed to be used for the signboards. At the same time, the material has strong corrosion resistance, high strength, good insulation, good colorability and can be molded into different shapes so that it can have a good warning effect. With the analysis of the existing locks in the market and comparison in the aspect of costs, service life and aesthetics, the button lock can finally be determined. After analyzing the experiment about the lock-and-unlock times of the
button lock signboards, it turns out that no lockout failure happened after more than 5000 times tests. Compared with the installation methods of the safety locking device of the secondary screen cabinet of the substation, it is more appropriate to choose the special glue for car signboards to stick the base of the signboard. After measuring the size of the secondary screen cabinet of the substation, the size of the signboard will be confirmed according to the measurement results. Through the fusion design of locks and signboards, the installation requirements of secondary safety measures and locking requirements can be realized which can effectively avoid the problem of red cloth curtain falling off or signboard moving in the operation of power secondary equipment or maintenance of secondary equipment. The rationality of the layout of secondary safety measures will shorten the setting time of safety measures, improve staff efficiency, make it convenient to inspect the secondary equipment on the work site and prevent the staff from opening or accidentally moving the secondary operation equipment or operation screen cabinet.

Beside that, in order to make the secondary equipment protection screen safety measures implement easy to layout, easy to recycle and able to sealed and isolated protection devices in operation, we applied light weight and recyclable material, like Acrylic plate, then, those Acrylic plates were assembled into rectangular plastic frame as the main part of the safety device. Isolated plastic panels mounted on rails are fitted on one side of the plastic frame. Since the light weight of the material, we built supporting beam at four corners and long edge on the other side of the frame. In those beams, magnets were embedded to fix the frame on protection screen. The total height of beam and frame should be corresponding to the isolated power equipment in secondary protect screen. It is required that the height of the connector should be higher than that of the front panel of the vertical protection screen, yet, this height should be reasonable, it should not hinder the opening and closing of the front door. During the specific installation process, power air switch should be higher than the gap between air switch and base panel.

4. The analysis of secondary safety locking device
To some degree, the secondary safety locking device is a sign with lock. Those signs are made from ABS, and shaped in a single step, thus the dimensions were rather accurate. Those locks require keys to unlock. Front side of sign were marked red “running”, back side were marked green “work in progress here”. The running sign could be placed at the same height of front and back doors. According to regulation, during the running of the secondary equipment, the locking device should be locked and running sign should be placed at opening direction of the door, in the actual maintenance process, workers need to switch on the safety locking device of the secondary cabinet, and open the work task screen door and set the “work in progress here” sign board outward. Other panel cabinets are locked during this process. Locking devices of different sizes are applied on front door and back door of substation secondary cabinet. During staff inspecting equipment in running state or signal resetting, locking device can be unlocked with keys. After the inspection, doors should be locked timely. Relevant rules for substation secondary cabinet safety locking device should be made and Strict followed. Besides that, this safety device is light weight and can be recycled. Since this locking device was fixed on with magnet, it is easy to dismantle. This safety device can be made collapsible to isolate different sizes of protect device, terminal block, air switch etc. Improved secondary protection cabinet locking devices can be easily arranged with shorter time and high efficiency. Since the materials of secondary protection screen and protecting device are similar, therefore, it can be used in other substation secondary protection panel, to meet the substation secondary safety layout requirements.

5. The analysis of certain case
The comparison of before applied the locking device and after applied the locking device is shown in Fig 1
According to Fig1, application of secondary cabinet locking device and requirements of safety measures for on-site maintenance of substation secondary equipment can be met and the adjacent cabinet doors can be locked during the inspection procedure. This procedure is more standardized. Since workers cannot open doors of running cabinet, misoperations can be prevented and safety measures can be accomplished. What is more, it radically ends the misoperation, a violation of safety regulations on secondary equipment, during inspection which ensures safety of power grid. The application of secondary panel cabinet of substation safety locking device in certain power company is a combination of lock and secondary safety measures. This device not only has a good warning effect, but also has a locking function. It can effectively prevent the staff from misoperation activities in the secondary equipment inspection which is good for physical and mental health of staff and equipment safety. In addition, the application of secondary safety locking device can further improve warning effect of safety measures on site equipment maintenance. Good appearance of this device can make sure the safety rules and regulation of the standardized secondary equipment cabinet. The traditional red ribbons can easily confuse workers during inspection and the random movement of the warning sign may lead to electric shock or equipment failure caused by trespass of secondary stall. When the secondary safety locking device is adopted, the problem of incomplete safety locking in the past secondary equipment maintenance site can be fundamentally solved. The device can prevent doors from misopening and prevent the secondary equipment in the running state from misoperation thus ensure the safe operation of power equipment. In addition, the large dimension of red ribbon can cause visual problem in later power equipment inspection. From the point view of efficiency, the application of secondary panel cabinet of substation safety locking device in certain power company ensure integrity of secondary safety locking device. Preventing the staff from frequently restoring the secondary safety measures during the night duty can improve efficiency, avoid laying out, dismantle and storage of the red ribbon. Now, tedious operation of red ribbon is replaced by a simple flip of the state sign.

6. Conclusion
To sum up, the likelihood of traditional signs and warning signs falling off during operation is rather high. In addition, lacking of locking device in secondary cabinet could lead to power safety accidents.
Due to those facts, we start this research about safety locking technology of secondary cabinet in substation. In this research, we developed a safety locking device of secondary cabinet, which can be applied in substation secondary equipment protection. According to actual cases, this device is able to prevent the secondary equipment from by mistake touching or moving. It ends the safety accident of secondary equipment radically.

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