Summarize on Application of Arc Protection Device in Substation

Benren Pan*, Yan Zhang*, Xiaozhi Gui†, Yong Wan‡ and Guannan Wang§
Electric Power Research Institute of Jiangxi Province, Jiangxi Nanchang, China

*Corresponding author e-mail: pbr168@163.com, †54597666@qq.com, ‡Gxz61612@163.com, §184346640@qq.com, §dell_wgn2006@163.com

Abstract. Arc protection device plays an important role in ensuring the faults of switchgear in substation. This paper analyses the operation problems of switchgear in substation, analyses the characteristics and necessity of arc protection device, expounds the principle and system structure of arc protection, and puts forward the design method of arc protection, which can quickly remove the faults in the operation of substation, and ensures that guarantee the safe and stable operation of substation.

1. Introduction
Safety and stability of substations are the most important factors in the operation process. In recent years, in the construction of substations, due to the small area occupied by indoor switchgear, centralized operation, convenient operation and maintenance, a large number of low and medium voltage switchgear are installed in substations. With the increase of switchgear number and operation life, more and more serious burning accidents of switchgear are caused because of the failure can not be quickly removed. The improper handling of substation accidents will directly affect the safety and stability of substation operation, and lead to the expansion of power grid accidents, which will not only bring serious economic losses, but also may cause casualties.

In the process of substation design, in order to ensure the safe operation of transformers, buses and switchgear, protective devices are configured according to relevant specifications. However, at present, the buses of 35kV and below in China are not equipped with special fast busbar protection, but with the backup overcurrent protection of the upper transformer to remove busbar short circuit fault, which leads to the prolongation of fault removal time and enlarges the damage degree of equipment.

2. Problems and Requirements of Low Voltage Switchgear Equipment

2.1. Problems in the Operation of Switchgear Equipment
Bus bar protection will be installed in the design process of buses of 110 kV and above substations. Bus bar protection with voltage level of 35 kV and below is usually not equipped with special fast busbar protection, but relies on the backup overcurrent protection of the upper transformer to remove busbar short circuit fault, which leads to the prolongation of fault removal time and enlarges the damage degree of equipment.
In the process of using equipment, busbar operation is frequent. The aging of insulation and mechanical wear of equipment are inevitable phenomena. The change of operating conditions and human operation errors will lead to the increase of busbar failure rate, and there are potential safety hazards to the operation of substations.

2.2. Requirements for Safe Operation of Switchgear

(1) Arc tolerance time in switchgear. According to IEC298 standard, the arc endurance time of the switch cabinet is 100 ms. The current sale of the switch cabinet is designed according to the requirements of the standard. The arc burning time of the switch cabinet can be endured in the use process is 100 ms. Because arc light fault usually occurs before the action of the circuit breaker, the short circuit arc is always in the burning state. The sum of the protection action time and the opening time of the circuit breaker is the duration of arc burning. Therefore, from the point of view of switchgear protection, the protection action should respond quickly within 100 ms to remove the arc short circuit fault, so as to prevent further expansion of the fault and cause greater harm.

(2) Arc fault protection of switchgear. In addition to strengthening the structure of switchgear, special fast protection for busbar configuration should be provided to remove faults within the arc-tolerant time of switchgear, radically limit the faulty arc, and eliminate the damage to switchgear and personnel safety.

3. Arc bus protection
Arc protection is a fast and reliable bus protection system. According to the principle of double criteria of arc detection and over-current, it can quickly respond to the faults occurring in substations. It is applicable to all kinds of operation modes and provides a solution for bus protection of medium and low voltage in substations. Arc light protection system mainly includes the following aspects:

3.1. Main Unit
The main unit is the main part of the arc protection system. It mainly detects the short circuit current and the action information from the arc light sensor, and processes and judges the collected fault information, so as to send out the fault processing signal and remove the fault. When arc light and overcurrent are detected at the same time, the arc light protection system will issue corresponding switch-off instructions. If the incoming circuit breaker does not act in time to remove the fault, the system will start the circuit breaker failure protection logic and issue trip instructions to trip the upper circuit breaker for fault removal. In addition, the main unit of the arc protection system will determine the position of the arc fault point and send out the temperature alarm information according to the action information of the arc sensor transmitted by the auxiliary unit.

3.2. Auxiliary Unit
The auxiliary units of arc protection system are usually installed in switchgear. Each auxiliary unit can be connected with 10 arc sensors, 1 temperature sensor and 1 portable arc sensor. When an arc fault occurs in the system, the auxiliary unit can collect the action information transmitted from the arc sensor and transmit it to the main unit, which then analyses and responds to the fault. In the main unit, the address numbers of auxiliary unit and arc sensor can be displayed, which is helpful for timely troubleshooting.

3.3. Arc Sensor
Arc sensor is the main component for fault induction. It is installed in the compartments of switchgear. Arc sensor is the light induction component. If there is an arc fault, the intensity of light increases greatly. The sensor detects the intensity of light, converts the light signal into current signal, and transmits it to the auxiliary unit.
3.4. Current Unit

The current unit mainly detects the current variables in the system, and can send them to the main control unit to analyze and process these data, and then use the processing results as the basis for judging the current situation of the system.

3.5. Arc protection system

The system uses arc detection and overcurrent detection to realize double detection and judgment of the whole substation operation equipment. If both arc and current increment signals are detected, indicating that the equipment and system have malfunction, it needs to start the relay quickly and issue the trip instruction. When only one of the signals is detected in the system, only an alarm message is needed. No. 3. Notify technicians that the system is out of order. The equipment and system equipped with arc light protection device have circuit breaker failure protection function, that is, when the incoming circuit breaker refuses to operate, it will send out the signal of over-step tripping, so as to cut off the upper short-circuit signal and ensure the stability of the system.

4. Application of arc protection in Substation

Taking a substation as an example, the application of arc protection in substation is analyzed and discussed. ZK1200-KARC arc protection system has been installed and applied in a substation. The system has been running steadily and reliably for several years, and has played an important role in bus protection. The wiring mode of this project is two power supply lines, single bus section, a total of 14 switch cabinets and two bus bridges. Arc protection configuration mainly includes a ZK1200-KARC main control unit, 16 optical probes and 300 meters optical fiber. The main control unit is installed on the panel of the 10kV feeder cabinet, and the light probe is installed in the 14 cabinet and two bus slots. When installing the project, arc equipment is installed on the substation in the process of operation, so in order to ensure that the installation and commissioning work can be completed, it is necessary to prepare in advance. The steps of installation are as follows:

1. According to the actual situation of installing arc system in substation, the designer of arc system equipment manufacturer designs the electrical installation drawings, and provides the drawings to the relevant technical personnel of substation for examination, and improves them according to the actual situation of substation until the drawings meet the requirements.

2. To prepare the auxiliary materials and accessories needed for installation, the substation should open the device and the pressing board installation hole in advance according to the drawings provided by the designer, so as to prepare for installation.

3. When the substation decides the blackout time, it should notify the manufacturer in advance, and the manufacturer arranges the technicians to go to the site to cooperate with the installation. When the substation blackouts, comprehensive factors must be taken into account to determine the specific time.

4. The main control device needs to be installed the day before the blackout. After the blackout, substation technicians should arrange common technicians of arc equipment, open the cabinet door of switch cabinet, and close the cabinet door in time after the completion of installation.

5. The CT lines between the input lines, buses and the control units of the power supply can be laid by substations. The jump switches at the exit of arc protection should also be laid by substations.

6. The specific installation and commissioning process should be completed by the technical personnel of the manufacturer.

7. After the commissioning of all the devices is completed, the technical personnel of the manufacturer shall train the technical personnel of the substation. After the training, the whole project will be completed after the acceptance of the test.

In this project, the arc light protection system should aim at the actual situation of the actual system. In technology, the arc light protection device should be able to provide "fault alarm signal" and "fault action signal" to the computer monitoring system, which is helpful for the computer monitoring
system to discover the faults and problems in the operation of substation equipment in time, improve the efficiency of solution and reduce the power supply. The impact of transmission. At the same time, the export trip relay of arc light protection should meet the requirements of starting power not less than 5W, operating voltage between 55% and 70%, and operating time not less than 10ms. When installing arc protection system, certain technical specifications should be followed:

1. Installation of metal armoured fixed high voltage switchgear. When installing switch cabinet, it is necessary to install the switch cabinet in the middle part of the cabinet according to the principle of protecting bus compartment and bus side isolator gate chamber. It can not only ensure enough insulation distance, but also have enough angle to detect whether the arc in the cabinet meets the requirements. For the switch cabinet of 35kV in this project, an arc sensor should be installed in bus compartment and bus side isolation knife gate chamber respectively. If it is 10kV, if bus and bus side isolation knife gate are in one room at the same time, only one arc sensor should be installed. If bus and bus side isolation knife gate are not in the same room, the arc sensor should be installed separately.

2. Installation of metal armoured closed switchgear cabinet. When installing switch cabinet, it can only be installed in bus compartment. Installation in the middle of the upper side can not only ensure enough insulation distance, but also ensure timely detection of arc in the cabinet.

3. In order to avoid the non-selective tripping of arc light protection, the secondary circuit should be simplified further. The 35kV and 10kV buses in substations should be operated in series.

4. The new substation should install the corresponding arc light protection device before it is put into operation. The operation substation can install the arc light protection device according to the overhaul of switch cabinet.

5. Conclusion
In summary, arc protection has the advantages of simple principle, fast and reliable operation, and its operation time is 5-7 ms, which can quickly realize the response and treatment of faults in substation switchgear. With the development and development of domestic and foreign enterprises, arc protection devices will be more and more widely used, which can effectively avoid the harm of arc accidents, reduce equipment losses and casualties, and greatly improve the safety and reliability of substation operation.

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