Analysis of the Failure of Backup Automatic Switch in Substation

Yongbo Yang, Hao Zhong, Hezhe Wang, Xiaodong Gu, Kai Wang, Yaguang Zhang, Xiaobing Wang and Xiaofei Huang

State Grid Henan Electric Power Company Zhengzhou Electric Power Supply Company Zhengzhou Henan, China

Keywords: Backup automatic switch; Action logic; Substation

Abstract. Backup automatic switch is widely used in low-voltage power supply network, which is a kind of economic and effective technical measures to provide uninterrupted power supply to the consumer. The use of Backup automatic switch in the power grid is a powerful technical means to ensure the safe, stable and reliable operation of power network. But by needs of power grid operation constraints, backup automatic switch in the grid application will often encounter some problems, such as coordination with automatic re-closing, charge and discharge of backup automatic switch and other issues. These problems affect the backup automatic switch to play a positive role. An 110kV transformer substation backup automatic switch action failure reasons are analyzed and discussed in this paper. The logic of action analysis, it proposed three kinds of projects with different principle, to provide a basis for the preparation of similar situations in the power grid.

Introduction

Grid with 110KV and below is mainly radial grid. To ensure reliable operation of the power grid, to make the grid with uninterruptible power supply in the N-1 failure case, power grid connection generally use a master a backup dual-supply wiring form. Using backup automatic switch device, when the mains fails, backup automatic switch thereby immediately restore power to the user, which is a guarantee of economical and effective technical measures reliable power supply. But bound by the requirements of the power grid, the special nature of the operation mode, the practical application of backup automatic switch unit in the grid will often encounter some special problems. Typical 110kV devices considering issues were analyzed and discussed, and proposed solutions.

Event Process

Operation Mode. A 220kV substation with dual-bus wiring, that 110kV system in parallel operation with 3CB in working position, supplies an 110kV substation by 1CB and 2CB. The 110kV substation within bridge connection, Line 1 with 110kV bus I, bridge breaker 6CB in operation, and 5CB stand by.

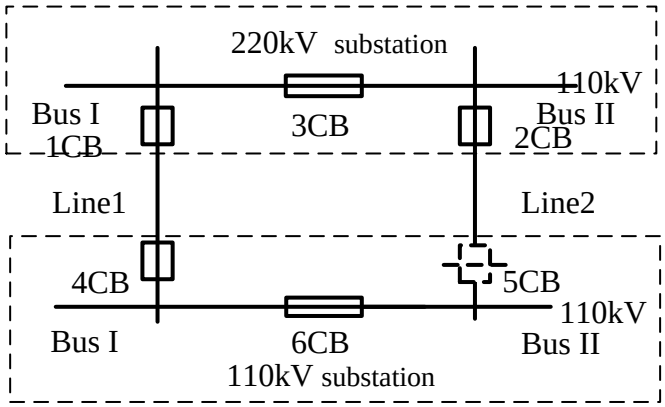

Figure 1. A system diagram of a substation

Related the protection equipment configuration as follow.

Two lines are in 220kV substation configuration of distance protection, zero sequence protection and re-closing device. Distance protection II action time is 0.6s, re-closing device not running. 110kV side of the terminal, a comprehensive consideration, not installed line protection device.

110kV substation is equipped with backup automatic switch, as Nari technology production of the model ISA-358 backup automatic switch device.

The Event Log. In the 110kV substation Line 1 Phase B permanent ground fault occurs, and line distance protection II act and after export. After 0.6s, jump 1CB and remove the line fault, while re-closing device not use. As the system designed, the 110kV substation should be prepared from the cast operation, entered the jump line 1 switch 4CB, confirmed after the jump delay in closing the hot spare breaker 5CB. So that the line 2 load with 110kV bus I, ensuring the normal operation of the substation. However, the backup automatic switch operation failure, caused loss of pressure by the entire station. Therefore, it is necessary to analyze the reasons for the failure action of backup automatic switch in the substation.

Event Analysis

Logic Analysis. Backup automatic switch device is a programmable controller, by setting different to adapt to different auto-restart way. The methods are the mother or the bridge auto-restart, line auto-restart, transformer auto-restart and special case auto-restart, such as small power supply auto-restart, or with balanced load. The substation uses for line auto switch.

To adapt to different running modes by setting different operation conditions in backup automatic switch device. Working conditions contain of start-up conditions, blocking conditions, charge and discharge conditions. Traditional were cast from the device using the charging and discharging of the capacitor to achieve some functions, type microcomputer device although have used logic judgment to realize, but in order to facilitate understanding, still defined using charging and discharging[1].

The start-up condition can be defined as the monitoring of the equipment to be prepared to monitor the loss of power of the equipment. Blocking conditions include protection device of prepared from the cast a locking instruction which is used to avoid by self-cast of action secondary to the point of failure, expanding the scope of the accident, causing greater harm; under special working conditions, to avoid preparation auto cast device malfunction, such as manual block preparation auto cast device; manual tripping close-down; voltage transformer disconnection locking and so on [2].

The charging condition is set to prevent the device from repeating the action. The following conditions are fulfilled, first the charging condition is satisfied, second the locking condition is not satisfied, third the start condition is not all satisfied, finally the time is 15 seconds [3,4].

After the charging is completed, the discharge condition of the device is designed to ensure that the equipment does not act by mistake. When the discharge condition is satisfied, or the condition of the need to be locked for the automatic feeding, the device discharge is not satisfied with the action condition. Table 1 shows charging conditions and discharge conditions for the preparation of the self-feeding device.

Table 1 backup automatic switch working condition table

charging conditions		discharge conditions	
1	backup automatic switch working	1	backup automatic switch exit
2	Line2 with pressure	2	The standby power supply cannot meet the pressure more than 0.2S
3	circuit breaker working	3	Manual operation
4	Standby circuit breaker jump	4	Standby circuit breaker working
5	Non-blocking signal	5	working circuit breaker jump
6	No discharge condition	6	back-up breaker
		7	Other blocking signal

When the operation condition of the equipment is satisfied, the device charged to complete, and no locking condition received, the automatic switching device sends out the action exit command after the device is adjusted in advance. The action logic diagram of the automatic switching is shown in Fig. 2.

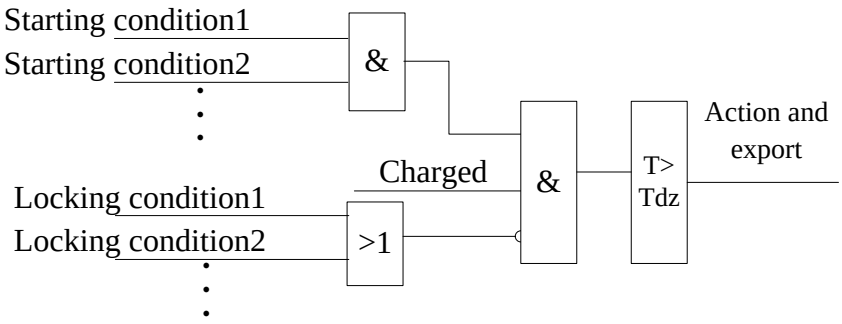

Figure 2. Action logic diagram of backup automatic switch

Line auto-restart action logic of backup automatic switch is that bus I without pressure, the power bus line 1 of bus I no flow, and to meet the line 2 with pressure, then by time delay tripping 4CB, with confirmation of 4CB jumped and delay, close 5CB. Thus, bus I power up again.

Pressure, No Pressure and No Flow Condition. The input AC signal of the substation backup automatic switch equipment is the two bus line voltage Uab, Ubc , B phase voltage UL1, UL2 of two lines, line B phase current IL1, IL2 of two lines. Bus with pressure is that since two voltage of the bus line voltage Ubc, Uab, at least one is greater than the bus bar pressure voltage setting value. The bus has a fixed value according to the set value, usually 70V. Bus with no pressure is that two line voltages Uab, Ubc are less than the bus setting value. As the same, the value of the no pressure setting is based on the fixed value, usually 30V. The phase current of the feed line is less than the current value of the feed line. The fixed value should be less than the minimum load current, in order to prevent the automatic error action when the operation of the power supply voltage transformer three-phase break. The inlet line voltage UL is greater than the feed line has a pressure value, the value of the wire into the set according to the set value, while this program 40.4V.

Incorrect Action Analysis. Checking the 110kV substation backup automatic switch equipment by the staff of relaying squad, the transmission scheme is correct, and the device is reliable action. There is no fault in the equipment itself.

Retrieval the wave records in the fault recorder of substation of power side, records analysis showed that at the time that the line 1 grounding, power transient side B phase voltage drop to 28kv, voltage transformer secondary output UB 31v, UAB 61.8V and UBC for 61.5V. Not considering the case of pressure drop, using the principle of equal potential, the 110kV system of the power side substation and line 2 voltages are the same with line 1, which is that Ub 31V. Obviously at this point, the B phase voltage of the line 2 is less than the line voltage, as the backup automatic switch system detected.

Line protection device of line 1, after a delay of 0.6s, protection and export, jump the line side switch 1CB. At this time, the time that backup automatic switch system cannot meet the line pressure is greater than 0.2s. So the backup automatic switch system discharging and backup automatic switch is not succeed to act and recharge the bus. In the event record of the protection device, the logic analysis is consistent with the logic analysis.

Improvement

In view of the problem of the failure action of the backup automatic switch equipment in the substation, the following suggestions are put forward.

Change the Structure of the Power Supply Network. Changing of the network structure, to make the 110kV power supply line in operation and standby line not from the same substation, will

not lead to line voltage drop, which causing backup automatic switch equipment discharge. Obviously, in this case, changes in the transmission line network architecture on the existing investment, engineering over a long period of time, the program should not be used.

Change the Relay Protection of Transmission Line. Using line protection without delay, such as optical fiber differential protection, can greatly reduce the action time of the protection, which makes the protection action time less than that of the equipment to determine the time of non-pressure discharge. Obviously, this kind of solutions should be technological overhaul that protection device to transform. Since the board quick line protection devices are expensive, investment decreases than scheme 3.1, but longer duration, the scheme should not be used either.

Change the Setting Time Value. When the backup automatic switch device considering the subject line has a discharge pressure limit is increased, thus extending the duration 110kV prepared from the cast opening hours, so that action before reliable protection device considering not erroneously discharged. Such programs is simple, but there is an alternate line detection discharge pressure limit value is too large, in the case of loss of pressure in the standby line, the monitoring mechanism is not timely, since the impact of equipment reliability.

Change the Logic of the Backup Automatic Switch. For the transformation, while the non-pressure condition of the equipment is changed to the three-phase voltage is less than the non-pressure value, the automatic switching device will discharge. The logic series of three phase non voltage is distinguished, which reduces the possibility of preparing self - throw false discharge due to the monitoring phase of the fault phase, which greatly increases the reliability of the system. The program needs to be prepared to extend the AC input module, in order to meet the three-phase voltage monitoring of the standby line, or to replace the corresponding principle of the equipment. However, taking into account existing systems line-side voltage transformer often only a phase, can not meet the demand. If need to transform the line side voltage transformer transformation, the invest in this program need becomes too large.

After comprehensive consideration and analysis, according to the manufacturers to provide technical information, the final solution is the 110kV by auto cast device fixed value setting requirements will change the line loss of pressure discharge time from the original 0.2s to 2s. In the extension or protection of the new station, the scheme four is adopted to improve the reliability of the equipment.

Conclusion

With the enlargement of power grid scale and the increasing complexity of power grid structure, the backup automatic switch equipment is widely used in 110 kV substations to ensure the safe and stable operation of the system and to improve the reliability of power supply. But due to the complexity of power system operation mode, different protection configuration, design scheme of the system is not the same, in this case, in all aspects of the design, construction, acceptance, the use of further comprehensive and refinement, combine with the actual operation of the power grid, according to the design scheme to ensure backup automatic switch device reliable action and the power grid safe and stable operation.

First, through the analysis of the action logic of the equipment, this paper finds out the reason of the failure of the operation of the substation equipment.

Second, the prepared self-switching device action failure is special fault phase and line protection action time and automatic switching device into the line of pressure less discharge time with caused. In view of this situation, the paper puts forward different improved schemes from four aspects, which are the initial structure planning and design, the line protection equipment coordination, the present preparation of the self - cast improvement, and the preparation of the self - casting device.

Third, the analysis and evaluation of the proposed scheme, the new substation should be the unified timing logical backup power automatic switching device; the transformation of the existing

device can be added to maintain tuning time, in order to realize the two auto cast device with delay timer.

In this paper, through in-depth analysis of the causes of the failure of the operation of the equipment, this paper provides a reference basis for the operation mode and the connection mode, and provides a guarantee for the reliable operation of the power grid.

References

[1] Zhang Bao-hui, Yin Xiang-gen.Power system protection [M]. China Electric Power Press, 2005.

[2] GB / T 584-2007, 3 ~ 110kV power grid protection devices running the tuning procedure [S].

[3] Shenzhen Nari Technology Co. Ltd.. ISA-358 standby power supply automatic switching device technology specification [EB / OL].

[4] Zheng Quzhi, Cheng Ying. BZT device design and application problems [J]. Power system protection and control, 2003, 31(8):18-21.