

The Analysis and Discussion in the Effective Application of the Dispatcher Training Based on Case Teaching Method with the Cause from the Action of the Gap Protection of Main Transformer

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Abstract: The combination of theory and practice is a difficult problem on dispatcher training. Through a typical example of case, this paper provides an effective case teaching method for dispatcher training, and combines the theoretical discussion of the rule of experience with cases and achieves vividness. It helps students to understand and catch the key points of the theory, and improve their practical skills.

1. Introduction

During the dispatcher teaching process of State Grid Corporation, the practical skills is one of the most important parts. However, the improvement of practical skills is based on the understanding of theoretical knowledge, how to combine the theory and practice is a difficult problem on dispatcher training. Through a typical example of case, this paper makes a deep mining and analysis of the key points of dispatcher training, correlates these points closely, puts them into application, and improves the training effect.

2. Case Introduction

2.1. Operation Mode of QingYuan Substation before Accident

No.1 & No.2 transformers of QingYuan Substation are operating in parallel. For No.1 transformer, its 110kV and 220kV neutral points are both direct grounding, and zero sequence protection is operating. For No.2 transformer, its 110kV and 220kV neutral points are both ungrounding and its gap protection is operating.

2.2. Formatting author names Accident Phenomenon

According to Figure 1 & 2, the key alarm information of QingYuan Substation is as follows.

The protection of No.1156 circuit breaker on QingYun2 Line 1 acts, but the circuit breaker does not open.

The protection of 110kV bus connection circuit breaker in QingYuan Substation acts, the circuit breaker opens correctly, and its 110kV Bus Line 2 loses voltage.



The protection of all the three sides of the No.2 transformer acts, and the circuit breakers all open correctly.

The 10kV automatic connection device of QingYuan Substation acts correctly, and there is no load loss.

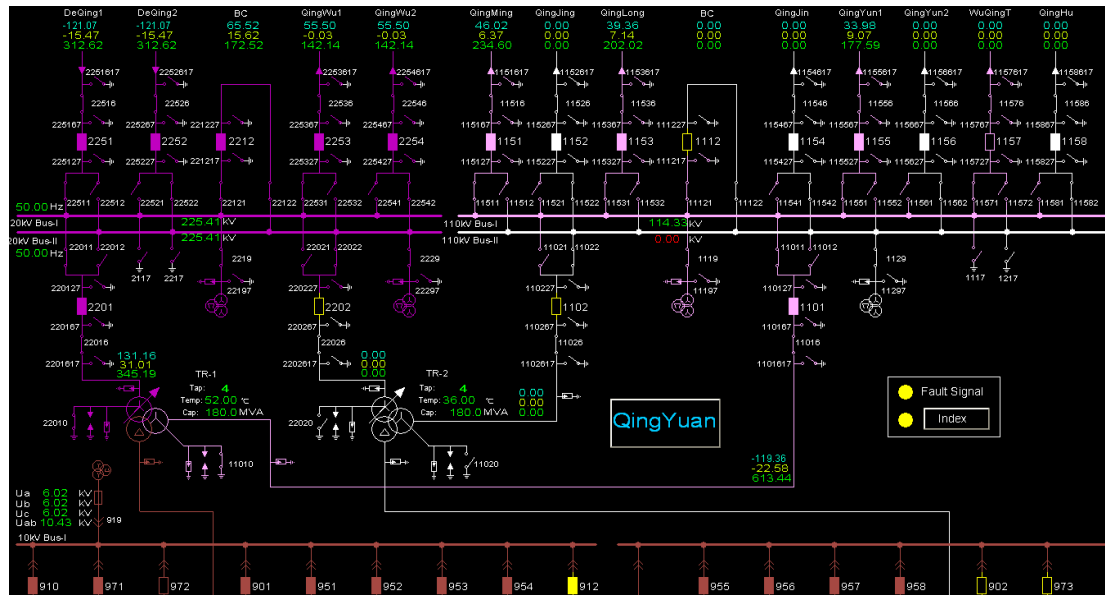


Figure 1.Operation Mode of QingYuan Substation after Accident

All Messages				
Index	Time	Factory station	Device	State
Confirm	2017-12-08 15:36:42:380	JinSha	10kV_C-2_Protection Undervoltage Protection_Action	Action
Confirm	2017-12-08 15:36:42:380	JingGang	10kV_C-4_Protection Undervoltage Protection_Action	Action
Confirm	2017-12-08 15:36:42:380	QingYuan	10kV_C-3_Protection Undervoltage Protection_Action	Action
Confirm	2017-12-08 15:36:41:864	QingYuan	TR-2_M-side Back-Up Protection_2_Outlet	Revert
Confirm	2017-12-08 15:36:41:864	QingYuan	TR-2_M-side Back-Up Protection_1_Outlet	Revert
Confirm	2017-12-08 15:36:41:814	QingYuan	10kV-side of TR-2_902_Handcart Breaker Bay Fault Signal s	Action
Confirm	2017-12-08 15:36:41:814	QingYuan	110kV-side of TR-2_1102_Circuit Breaker Bay Fault Signal s	Action
Confirm	2017-12-08 15:36:41:814	QingYuan	220kV-side of TR-2_2202_Circuit Breaker Bay Fault Signal s	Action
Confirm	2017-12-08 15:36:41:804	QingYuan	TR-2_M-side Back-Up Protection_1_Outlet	Action
Confirm	2017-12-08 15:36:41:804	QingYuan	TR-2_M-side Back-Up Protection_2_Outlet	Action
Confirm	2017-12-08 15:36:41:324	QingYuan	110kV QingYun2_Protection Exit	Revert
Confirm	2017-12-08 15:36:41:324	QingYuan	TR-1_M-side Back-Up Protection_1_Outlet	Revert
Confirm	2017-12-08 15:36:41:324	QingYuan	TR-1_M-side Back-Up Protection_2_Outlet	Revert
Confirm	2017-12-08 15:36:41:290	QingYuan	110kV_BC_1112_Circuit Breaker Bay Fault Signal s	Action
Confirm	2017-12-08 15:36:41:280	QingYuan	TR-1_M-side Back-Up Protection_2_Outlet	Action
Confirm	2017-12-08 15:36:41:280	QingYuan	TR-1_M-side Back-Up Protection_1_Outlet	Action
Confirm	2017-12-08 15:36:40:580	QingYuan	110kV QingYun2_Protection Exit	Action
Confirm	2017-12-08 15:36:40:300	QingYuan	Fault Signal	Action
Confirm	2017-12-08 15:36:40:295	QingYuan	110kV QingYun2_1156_Circuit Breaker Bay Fault Signal s	Action
Confirm	2017-12-08 15:36:40:285	QingYuan	110kV QingYun2_Protection Exit	Action

Figure 2.Alarm Information after Accident

All Messages				
Index	Time	Factory station	Device	State
Confirm	2017-12-08 15:36:47:130	YunFeng	10kV_BS_912_Circuit Breaker	Close
Confirm	2017-12-08 15:36:47:030	YunFeng	10kV-side of TR-2_902_Handcart Breaker	Open
Confirm	2017-12-08 15:36:46:100	JingGang	110kV_BS_1112_Circuit Breaker	Close
Confirm	2017-12-08 15:36:46:100	HuQiu	110kV_BS_1112_Circuit Breaker	Close
Confirm	2017-12-08 15:36:46:000	JingGang	110kV QingJing_1152_Circuit Breaker	Open
Confirm	2017-12-08 15:36:46:000	HuQiu	110kV QingHu_1151_Circuit Breaker	Open
Confirm	2017-12-08 15:36:45:070	QingYuan	10kV_BS_912_Circuit Breaker	Close
Confirm	2017-12-08 15:36:45:070	JinSha	110kV_BS_1112_Circuit Breaker	Close
Confirm	2017-12-08 15:36:44:970	JinSha	110kV QingJin_1151_Circuit Breaker	Open
Confirm	2017-12-08 15:36:42:910	YunFeng	10kV_C-4_974_Handcart Breaker	Open
Confirm	2017-12-08 15:36:42:400	HuQiu	10kV_C-2_972_Handcart Breaker	Open
Confirm	2017-12-08 15:36:42:400	JinSha	10kV_C-2_972_Handcart Breaker	Open
Confirm	2017-12-08 15:36:42:400	QingYuan	10kV_C-3_973_Handcart Breaker	Open
Confirm	2017-12-08 15:36:42:400	JingGang	10kV_C-4_974_Handcart Breaker	Open
Confirm	2017-12-08 15:36:41:824	QingYuan	220kV-side of TR-2_2202_Circuit Breaker ABC Phase	Open
Confirm	2017-12-08 15:36:41:824	QingYuan	110kV-side of TR-2_1102_Circuit Breaker	Open
Confirm	2017-12-08 15:36:41:824	QingYuan	10kV-side of TR-2_902_Handcart Breaker	Open
Confirm	2017-12-08 15:36:41:300	QingYuan	110kV BC_1112_Circuit Breaker	Open

Figure 3.Circuit Breaker State Information after Accident

2.3. Analysis of the Cause of the Accident

According to the operation mode before accident, for No.1 transformer, its 110kV and 220kV neutral points are both grounding with gap protection operating. For No.2 transformer, its 110kV and 220kV neutral points are both direct grounding. If one of the circuit breakers on 110kV line, connected with Bus 1, rejects act, while accident happens, the alarm information is as shown in Figure 2 & 3.

By contrast of Figure 2 & 3, the protection of QingYun2 acts, but its circuit breaker does not open, which means the breaker rejects act. Next, the zero sequence protection 1 of No.1 transformer acts and the bus connected breaker opens. In addition, the gap protection of No.2 transformer acts and the circuit breakers of all the three sides open.

According to the analysis of alarm information, the series of the event is as follows. The No.1156 circuit breaker of 110kV QingYun2 rejects act, while permanent fault for single-phase happens on this transmission line. And the scopes of the event expanded, which reaches the setting value of the zero sequence protection of No.1 transformer. Next, the zero sequence protection acts and the 110kV bus connected breaker opens. the scope of the fault current is limited on the fault bus line 2. Because of the ungrounding neutral point of No.2 transformer, the gap protection acts and the circuit breakers of all the three sides of the transformer open. After all these series of operation, the fault current is eliminated and the safety of the power grid is kept.

3. Key Knowledge Point

3.1 Difference Between Zero Sequence Protection and Gap Protection

Both of the zero sequence protection and gap protection are the backup protection of transformer. As for a system with neutral point direct grounding, while there are zero sequence current on the primary side, there would be fault current induced on the secondary side. If both the peak value and duration of the fault current reach the setting value, the zero sequence protection would act. For gap protection, it acts while the discharging gap of neutral point is breakdown and there is fault current on the primary side of the current transformer on the gap.

The logic of the zero sequence protection is as follows. The bus connected breaker opens while the protection section 1 acts, the circuit breaker of this side of the transformer opens after a delay time while the protection section 2 acts, the circuit breakers of all the three sides open while the protection section 3 acts. For gap protection, the circuit breakers of all the three sides while it acts.

3.2 Whether the Zero Sequence Protection and Gap Protection Could Be Operating at the Same Time? What Is the Harm if Both of Them Use the Same Current Transformer?

Answer for Q1. These two protections could not be operating at the same time. Hence they could not use the same current transformer. If their current transformers are separated, they could be set independently, and there is no need of manual operation. While the neutral point is grounding, the zero sequence protection is operating and the gap protection is out of service, while the neutral point is ungrounding, on the opposite, the gap protection is operating and the zero sequence protection is out of service, automatically and safely.

Answer for Q2. There are some disadvantage if they use the same current transformer. While the neutral point is grounding, once the gap protection is not out of service, and unfortunately there is a grounding fault of system, the gap protection would misoperate and request the the current breakers of the transformer to open. Even through the setting value of the gap protection is quite small, the overcurrent of grounding fault is always too big to damage the devices.

3.3 The Instruction of the Protection of Transformer

Through the instruction of protection of transformer, students could have a better understanding of the case. The setting values of the protection is as shown in Fig.4.

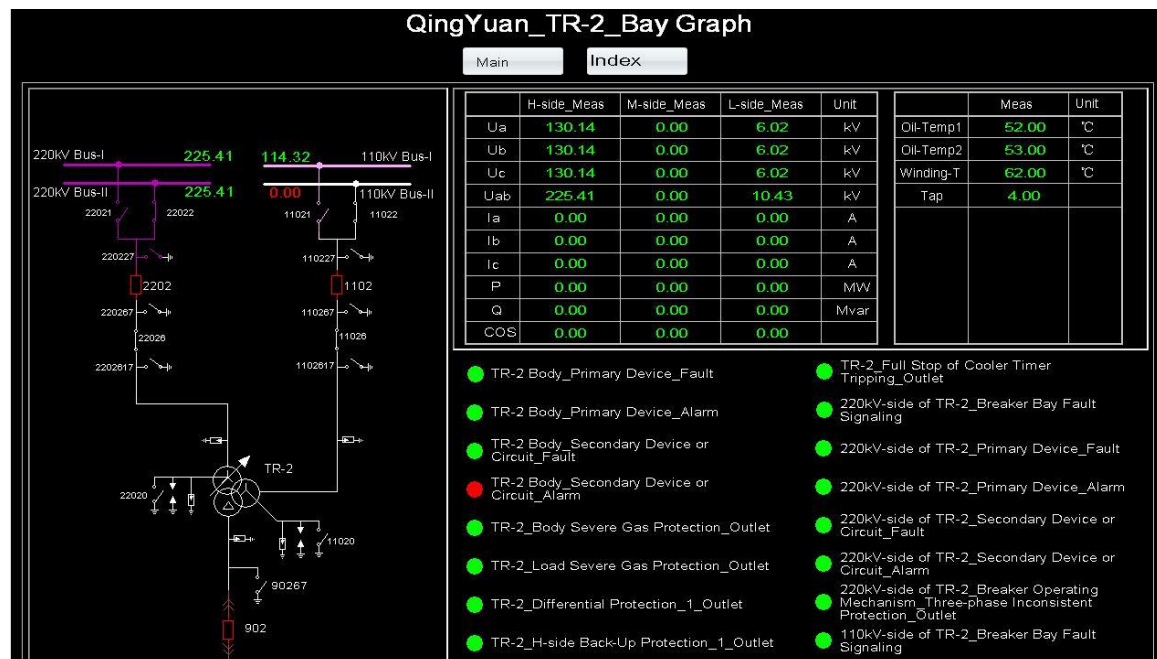


Figure 4. Setting Value of the Protection of Transformer

The direction from HV-side backup protection to the transformer is the positive direction, the direction from MV-side and LV-side backup protection to the bus line is the positive direction.

3.4 Why the Hybrid Voltage & Current Blocking Protection Does not Act?

Consider the direction of impedance of the MV-side current transformer. If the direction to 110kV is positive, and if the backup protection of MV-side of the transformer is voltage blocking, and the setting value is appropriated, the hybrid voltage & current blocking protection would act. In another word, the action condition of the protection is positive direction, setting value of current, and operating time. Similarly, the tripping operation matrix could be set. According to the analysis of the setting value of protection, the operating time of the hybrid voltage current blocking protection is 2.2 seconds, and the setting value of zero sequence protection is 1 second. Hence this protection does not act, and the zero sequence protection acts.

3.5 The consideration of factors of grounding natural point of transformer

Ensure the sensibility and selectivity of zero sequence protection is enough. And ensure the stability of grounding current.

In order to prevent the overvoltage to damage the devices, make sure while splitting the system, which is caused by operation or tripping, the neutral point of the system keeps grounding.

The insulation ability and instruction of the transformer determine the operating mode of the neutral point. For example, the neutral point of the self-coupling transformer.

4. The Application of the Key Knowledge Point

In this case, the No.1 and No.2 transformers are operating in parallel. Hence while the protection is setting, the problems like breaker rejection should be considered. This problem would cause the 110kV overcurrent of both the No.1 and No.2 transformers, and make the position of fault to be indistinguishable. In order to keep one of the bus line out of the fault, the tripping matrix of the protection device RCS978 is set to distinguish the faulted bus line by setting the 220kV zero sequence protection of No.1 transformer. After the bus connected breaker opens, the voltage of the 110kV bus line 1 is back to normal. After the bus connected breaker opens because of the 110kV zero sequence protection of No.1 transformer, because of the uninsulated fault, the system of No.1 transformer is still

a grounding system, but the system of No.2 transformer turns to a ungrounding system. There is overvoltage on the 110kV discharging gap of No.2 transformer, which would make the gap to be breakdown, and the gap overcurrent protection would act, the current breakers of all the three sides of the No.2 transformer would open. Both the zero sequence protection and gap protection are sectorial and time limited, hence the faulted current would not return to the neutral point of No.1 transformer, through the discharging gap of No.2 transformer, before the bus connected breaker open. The faulted current would just return to the neutral point of No.1 transformer, because its neutral point is direct grounding with small resistance, after the section 1 of the zero sequence protection starts, the gap protection would be delayed. In actual operation, if they do not use the same current transformer, the arrester may be breakdown before the discharging gap, and the system turns to a grounding one, and the 110kV zero sequence protection operates, and the current breakers of all the three sides of No.2 transformer open after the secondary time limit.

5. Conclusion

Most of the students feel confused about the case of the gap protection of main transformer, and may even feel difficult to analyze the action logic and steps. The reason of this is as follows.

1. The abstract theories are too difficult to understand, and students feel unclear about the setting values of the protection, the difference between the protections, the preference of the protections.
2. The knowledges are difficult to be connected efficiently. In the process of the analysis of the case, it is difficult to combine the theories and the phenomenon together and make any analysis.

The case teaching method is a great method to integrate the theories with practice. In the process of dispatcher training, teachers should make full use of the typical cases and combine the key theoretical knowledge and practice. it would improve the ability of analyzing and solving problem of the students.

In addition, if teachers could make the knowledge visualized by preparing some demonstration, it would help students to learn better and enhance the teaching effects.

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