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Practical verification and accident prevention measures for line protection measurement and control device

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Abstract: This paper introduces the importance of line protection measurement and control device, the maintenance content and principle of relay protection device calibration. Combined with the practical experience and theoretical knowledge of field cases, a series of measures are taken to eliminate and reduce the incorrect actions of relay protection, so as to ensure the safe and stable operation of the system.

1. Introduction

Electric power has brought great power and benefits to the development of human economy and society. Modern production and life depend on electric power. Once a large-scale power system breaks down and causes a large-scale power outage, the consequences are disastrous. Therefore, around the theme of ensuring the stable operation of power system, scholars are constantly updating and iterating various technical means and management measures. Among them, the power system relay protection device is the most basic, important and effective technical means to ensure the safety of power equipment and the stability of power system.

In order to ensure the correct operation of the relay protection device and prevent the occurrence of power grid accidents caused by misoperation of the relay protection device, such as misoperation and refusal of operation, for the task of verification and maintenance of the relay protection device, in addition to issuing and implementing relevant guidelines for anti accident measures, the design, installation, commissioning and operation and maintenance of the equipment in the early stage are also very important[1]. Only each link is quite complete, To ensure that the relay protection device can operate correctly and meet the characteristics of reliability, selectivity, quick action and sensitivity.

2. Working principle of protective elements of line protection measurement and control device

Taking line protection as an example, this paper expounds the operation logic and standard flow of some common line protection measurement and control devices in practice verification.

2.1 Total starting element of the device

The main body of the starting element is realized by the over-current relay that reflects the power

frequency variation between phases. At the same time, the over-current relay that reflects the full current and the negative sequence over-current relay complement each other; The low cycle starting element can be switched on or off through the control word. The starting element that reflects the power frequency variation adopts a floating threshold. The unbalanced output of the variation during normal operation and system oscillation automatically forms an adaptive threshold. The floating threshold is always slightly higher than the unbalanced output. During normal operation, the device has high sensitivity because the unbalanced component is very small.

1) Current variation start

When the change of phase to phase current is greater than the starting setting value, the element acts and widens for 7 seconds to open the positive power supply of the outlet relay.

2) Start of negative sequence over-current element

When the negative sequence current is greater than the starting setting value, after a delay of 40ms, the negative sequence starting element acts and widens for 7 seconds to open the positive power supply of the outlet relay.

3) Over-current element start

When the phase current is greater than the over-current setting value of Section IV, after a delay of 40ms, the over-current starting element acts and widens for 7 seconds to open the positive power supply of the outlet relay.

4) Low cycle element start

When the low cycle protection is put into operation, the system frequency is lower than the setting value, and there is no low voltage lockout and slip lockout, the low cycle starting element acts and widens for 7 seconds to open the positive power supply of the outlet relay.

5) Re-closing start

When the re-closing conditions are met, it will be widened for 10 minutes. Within this time, if there is re-closing action, the positive power supply of the outlet relay will be opened 500ms.

2.2 High frequency pilot protection

1) Pilot protection relay

The distance relay set according to the out of range will constitute the direction comparison element, which is composed of low-voltage distance relay, phase to phase distance relay, and the reverse direction distance relay. The relay is only put into operation when the control word "on the weak power side" is set to "1". It is composed of three phase to phase distance relays. On the weak current side, when the distance component does not act, if the reverse distance relay acts, it is judged as the reverse direction fault. If the reverse distance relay does not act and any phase voltage is less than 30V, it is judged as the positive direction fault.

2) Latching pilot protection logic

Generally, it is combined with the special transceiver to form the locking longitudinal protection. The position stop signal, other protection action stop signal, channel switching logic, etc. are all realized by the protection device. These signals should be connected to the protection device without being connected to the transceiver, that is, the sending or stopping signal is only controlled by the protection sending contact point, the sending contact action is the sending signal, and the non action is the stopping signal.

3) Permissive pilot protection logic

Generally, it forms permissive pilot protection in cooperation with carrier or optical fiber digital channel. Position signaling and other protection action signaling are realized by the protection device. These signals should be connected to the protection device instead of the transceiver.

2.3 Distance relay

The device is equipped with a three-stage inter-phase distance relay and a quadrilateral inter-phase distance relay as a remote backup. G-type protection is also equipped with two sections of grounding distance relay. The relay is polarized by positive sequence voltage, so it has great ability to measure fault transition resistance; When used in short lines, in order to improve and expand the ability of measuring transition resistance, the impedance characteristics of Sections I and II can also be shifted to the first quadrant. When the positive sequence polarization voltage is high, the distance relay polarized by the positive sequence voltage has good directivity; When the positive sequence voltage drops below 10%un,enter the three-phase low-voltage program and polarize by the positive sequence voltage memory.

2.4 Ground distance relay

The grounding protection relay is only used for G-type protection device. The G-type protection device is equipped with two sections of grounding distance relay as the protection for two-point grounding fault in neutral ungrounded system or small current grounding system. These two sections of directional impedance relay are polarized by positive sequence voltage, and its polarization voltage introduces phase shift angle as the phase to phase distance I and II sections. Its function is to shift the directional impedance characteristics to the first quadrant in the application of short lines, so as to expand the ability to allow fault transition resistance.

In case of two-point grounding fault of different lines, the user can select the 2/3 probability tripping mode (i.e. only reflect phase A and C fault tripping) through the control word "grounding distance two-phase tripping", and cut off a line with 2/3 probability. If one line is phase B grounded and the other line is phase a grounded, only the line with phase a grounded shall be cut off.

Sections I and II of the grounding distance are locked by zero sequence current to prevent misoperation of the grounding distance due to low grounding phase voltage after the system has a disturbance device and enters the fault measurement program. Through zero sequence current locking, when two-point grounding fault occurs in the cascade line, only the next line can be cut off to prevent expanding the scope of power failure.

If "grounding distance two-phase trip" is set to "0" on cascaded lines, only the latter line can be cut off in case of two-point grounding faults of different lines; If "grounding distance two-phase tripping" is set to "1",that is,2/3 probability tripping mode is adopted. The disadvantage is that if phase B grounding occurs in the latter line, the grounding distance cannot act, and only the phase to phase distance or over-current protection of the previous line can remove the fault. The 2/3 probability tripping mode is adopted on the radial line, which has the advantage that only one outgoing line can be cut off in case of two-point grounding fault; The disadvantage is that if phase B fault occurs at the line outlet and phase a or C fault occurs at the far end of the line, the tripping time will be delayed. Therefore, the above problems should be considered when setting the "grounding distance two-phase trip" control word. Different from the grounding distance, when two points are grounded, the fault currents sensed by two fault phases of overcurrent protection are the same, so the above problems need not be considered when setting the control word "two phase tripping of overcurrent section I and II".

2.5 Oscillation locking

The oscillation locking of the device is divided into three parts, and any action opens the protection.

1) Start open element

Instantaneous opening protection of starting element: if the positive sequence over-current element set to avoid the maximum load does not act or the action time is less than 10ms, open the oscillation locking for 160ms. This element will be opened immediately for 160ms in case of sudden failure during normal operation. When the system oscillates, the positive sequence over-current element will act. In case of subsequent failure, this element has been locked. In addition, it will also be locked in case of external failure or failure 160 ms after operation.

2) Asymmetric fault opening element

In case of asymmetric fault, the oscillation locking circuit can also be opened by symmetrical component elements.

3) Symmetrical fault open element

In case of three-phase fault after 160ms of startup element opening or during system oscillation, the above two opening measures can not open oscillation locking. A special oscillation discrimination element is set in the device, that is, to measure the oscillation center voltage.

3. Operation condition and abnormal treatment of line protection and measurement and control device

3.1 Ways to reflect operating conditions during maintenance

- The switching on and off of the protection outlet can be realized by tripping and closing the outlet pressing plate;
- The protection function can be switched on or off separately through the on-screen pressing plate or internal soft pressing plate and control word;
- The device always performs self inspection on the hardware circuit and operation status. See the printing and display information below for the self inspection error information. In case of serious fault, the device will lock all protection functions and turn off the operation light. Otherwise, only part of the protection functions will be exited and an alarm signal will be sent[2].

3.2 Embodiment of device locking and alarm

The hardware circuit and software working conditions of the protection device are always under the monitoring of the system. Once any abnormal condition occurs, the corresponding alarm information will be displayed. Some abnormal alarms may block some protection functions, and some serious hardware faults and abnormal alarms may block the protection device. The running light will go out. At the same time, the locking connection point of the device that sends out the signal will be closed, and the protection device must be out of operation, which needs maintenance to eliminate the fault[3].

4. Maintenance, calibration and practical operation of line protection measurement and control device

4.1 Precautions for maintenance and test

- In the process of maintenance and test, try not to plug and unplug device modules, do not touch module circuits, and do not plug and unplug modules with power.
- The electric soldering iron and oscilloscope used must be reliably grounded with the screen cabinet.
- Before the test, check whether the panel, cabinet and device have obvious damage or loose screws during transportation. Especially the screws and connecting pieces of CT circuit. No

looseness is allowed.

4.2 Zero drift, sampling value and switching value inspection

1) Zero drift check

Short circuit the voltage circuit and disconnect the current circuit on the terminal strip, enter the "device status" → "analog status" → "protection measurement" and "start measurement" menus, and check the zero drift value of voltage and current[4].

2) Sampling accuracy test

Add rated AC voltage and current to the device terminal block, enter the "device status" → "analog status" → "protection measurement", "start measurement" and "phase angle measurement" menus, and check the sampling value displayed by the device. The error between the displayed value and the measured value shall not be greater than 5%.

3) Input quantity inspection

Enter the "device status" → "switching value status" menu to view the status of each input value, enable and disable each functional pressing plate and input value, and the device can correctly display the current status.

4.3 Whole group test

Before the test, set the internal pressing plate control word "locking and reclosing pressing plate" soft pressing plate in the setting value of the pressing plate to 0. In case of reverse direction fault, ensure that the applied fault current I <u / zzd1, u is the rated voltage, and zzd1 is the fixed value of impedance section I. To ensure the effectiveness of fault phase selection and distance measurement, please ensure that the tester cuts off the fault current 20ms after receiving the protection tripping command during the test.

5. Main types of accidents of protection, measurement and control device

As the first line of defense to ensure the safe and stable operation of the power grid, relay protection bears the important responsibility of protecting the power grid and the safe operation of equipment. With the continuous development of the power grid, large capacity units, ultra-high voltage equipment and ultra-high voltage equipment are continuously put into operation, and the supporting relay protection principles are becoming more and more complex. The dual and multiple protection configurations with various types and principles make the secondary circuit wiring complex and diverse. Although the protection management is becoming more standardized, the protection configuration is more perfect, and the protection action is more correct and reliable, the protection accidents still occur from time to time. The causes of relay protection accidents are various[5]. The main causes of relay protection accidents are protection setting, device power supply, secondary circuit, anti-interference, maintenance and commissioning, device principle, design principle, protection channel, protection software version, etc. in order to improve the ability of on-site relay protection personnel to analyze and deal with accidents, technical means are used in combination with the actual situation on site, Relay protection accidents are mainly divided into the following five categories.

- Incorrect protection action caused by relay protection setting problem.
- Accidents directly caused by damage of protective device components and accidents caused by damage of secondary circuit insulation.
- Accidents caused by artificial wrong wiring or touching the protection device or secondary circuit in operation. Problems of current transformer TA, voltage transformer TV and their

secondary circuits

- Protection device performance and protection software version

The correct action rate of relay protection is not only affected by the working principle and process quality of the device itself, but also depends on the technical level and professional quality of the design, installation, commissioning and operation and maintenance personnel. At present, there are about less than 2% incorrect relay protection actions in China every year, which has become a hidden danger threatening the safe and stable operation of the power grid. Some anti accident measures of relay protection have been issued and implemented for more than ten years, but the accidents still occur repeatedly. For example, relay protection accidents caused by multi-point grounding of current and voltage circuits have been prohibited repeatedly. In addition, accidents such as device process quality, secondary circuit design and relay protection "three errors" also occur frequently. Eliminating and reducing incorrect actions of relay protection is a long-term and arduous task, which also requires the unremitting efforts of personnel at all levels engaged in relay protection.

6. Basic ideas and principles for dealing with relay protection accidents

6.1 Correctly use accident information of secondary system equipment

Attention shall be paid to the operation and maintenance of various secondary information auxiliary equipment to ensure the normal operation of these equipment under working conditions. The fault information of the protection device cannot replace the information of the special fault recorder. It is required that the relay protection personnel shall be able to correctly and skillfully use the relevant detection equipment, record and back up the secondary system accident information, and file it orderly.

6.2 Correct use of primary equipment information

The secondary equipment information indication is used to judge whether the primary equipment fails. When it is impossible to distinguish whether the primary equipment is really faulty or the secondary equipment malfunctions, the best way is to carry out accident investigation at the same time in the primary and secondary aspects. The necessary inspection and detection of primary equipment can quickly draw a conclusion.

6.3 Select the sequential inspection method or the reverse inspection method according to the actual situation

The sequence inspection method is relatively the most comprehensive inspection method, including external inspection, insulation inspection, inverter power supply inspection, input quantity inspection, output quantity inspection, fixed value inspection, protection function inspection, protection characteristic inspection, etc. It is generally carried out when the reverse order inspection method fails. The reverse sequence inspection method mainly refers to that the application requires the staff to have a high degree of proficiency in the protection action principle and secondary circuit wiring, and have experience in handling similar accidents, and often check the fault at a faster speed.

6.4 Improve the level of fault handling and necessary theoretical knowledge

Understanding the basic types of relay protection faults and mastering the basic ideas of relay

protection accident handling are important conditions for improving the level of relay protection accident handling. At the same time, it is also necessary to master the necessary theoretical knowledge and use the correct working methods. The handling of relay protection accidents requires the staff to be clear and thoughtful.

6.5 Strengthen the whole process management and reduce relay protection accidents

The realization shall be strictly controlled from the design aspect. The quality of relay protection and secondary circuit completion acceptance shall be closely watched. In the later operation and maintenance process, the protection equipment and protection elements shall be reasonably and orderly inspected regularly according to the correct operation process, and the relevant problems shall be summarized and archived in time to ensure that the problems can be found and rectified in time. Only from the details can we reduce the occurrence of relay protection accidents and provide reliable guarantee for the stability of power system.

7. Conclusion

The accident handling of relay protection not only involves the principle and components of relay protection, but also the experience of dealing with relay protection accidents on site shows that the occurrence and handling process of most relay protection accidents are closely related to the capital construction, installation and commissioning process. It is the primary condition for analyzing and handling accidents to master the necessary basic principles of microcomputer relay protection and relay protection theory. However, sufficient and rich field experience often plays a key role in accurately analyzing and determining the nature of accidents. In dealing with relay protection accidents, we must find out the causes and try to find out the root causes of the problems, and then formulate targeted preventive measures to avoid the recurrence of similar accidents. This will inevitably involve the person responsible for the accident, and may even be severely punished. Therefore, the combination of theory and practice is the most basic principle for dealing with relay protection accidents.

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