Research and Development Scheme of Zero Line Live Fault Device for Low Voltage Overhead Line

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Abstract. In order to reduce the frequency of zero line live faults on overhead lines in low-voltage stations and shorten the time for maintenance and repair when zero line live faults occur, the existing zero line live fault repair methods are summarized, and the Preventive measures, and proposed a fast fixed-point device research scheme for the live line zero line live fault of low-voltage overhead lines. The simulation criterion of live line live fault of the zero line is studied with the help of simulation software such as ATP-EMTP. Live fault type identification model to improve the accuracy of fault type diagnosis. It is expected that the location of the zero line live fault can be located in a shorter time. This solution will greatly reduce the manpower and material input during the live line maintenance work. Maintenance time has engineering transformation value.

1. Introduction
Low-voltage station lines are limited by factors such as low voltage levels, strong user dispersal, and low utilization rates of smart devices. As a result, the maintenance efficiency is low when the line fails, and the number of live-line faults on the low-voltage stations increases year by year, posing a serious threat[1]. In order to improve the residents' production and life, the traditional zero line fault search mainly includes: segmented search and elimination, phase-breaking power outage and other methods. Not only is it labor-intensive and inefficient, frequent power outages also lead to various types of complaints and severely affect grid companies Image, so how to timely find and quickly locate the live line zero-line faults of overhead lines in low-voltage stations, and improve the operation and management of overhead lines has been a difficult problem in line maintenance for many years[2]. With the country ‘s increasing requirements for power supply reliability, especially intelligent The demand for power grid construction urgently needs to solve this problem[3]. This article is aimed at the problem of live line faults on the low line in low-voltage stations. Based on the previous research[4], this paper proposes a research scheme for fast fixed-point devices for live line faults of zero lines in low-voltage stations. It provides a useful reference for solving this problem.
2. Introduction to low-voltage stations
For the low-voltage station area power supply system, the circuit diagram during normal operation is shown in Figure 1. It is a three-phase four-wire TT wiring method. During the operation of this system, the zero line is only grounded near the transformer side, and the rest The wire is no longer grounded repeatedly. This TT power supply system is mainly suitable for low-voltage power distribution networks with scattered users and overhead lines. Therefore, the most widely used wiring method in the wiring of low-voltage stations is the TT wiring form.

3. Causes of zero line fault
In a TT-type power supply system, when the system is operating normally, no current flows or only a weak current passes through the zero line, but when certain faults occur, it may cause the zero line to be charged, including the following common ones. Several reasons.

3.1. Zero line disconnection
Figure 2 (a) is a schematic diagram of the zero line disconnection. Because the height of the overhead line in the low-voltage station area is lower than that of the high-voltage transmission line, and the environment is complex, it is easily affected by some outsiders. The force majeure interference caused the neutral wire disconnection accident, and the phase line current flowed from the user's electrical appliance to the neutral wire, which caused the neutral wire to be charged, and the user could no longer use electricity normally.

Figure 1. Schematic diagram of TT wiring mode in low voltage station area

Figure 2. Several common causes of zero line live fault
3.2. Transformer grounding resistance is too large or the ground lead is broken
Because the grounding body design and construction are not strictly operated in accordance with the grounding resistance assessment index, the grounding resistance value is much larger than the standard. Corrosion occurs, leading to thinning or breaking of the lead wire of the grounding body, which is equivalent to increasing the level of grounding resistance. As shown in Figure 2 (b), the zero line is opened, which causes the zero line voltage to increase and become charged.

3.3. Phase line ground fault
As shown in Figure 2 (c), when the phase A of the line has a ground fault, the fault current will flow into the grounding body and cause the zero line to be charged.

3.4. Three-phase current imbalance
There are many reasons for three-phase current imbalance. The three-phase current output by the power supply itself is unbalanced. During the voltage level conversion of the transformer in the low-voltage station area, the switch fails to open at the same time or has poor contact or three-phase load. Unbalance can cause the three-phase current to be unbalanced, so that the current flows through the zero line.

4. Traditional maintenance methods for live line faults
When a live line fault occurs, the cause and location of the fault must be found in the shortest time. The traditional method for locating a live line fault is described below.

4.1. Segment detection
The essence of the shared detection method is to measure the magnitude of the zero line current to locate the location of the fault. Therefore, it can also be called the current detection method. The specific implementation steps are as follows: The line is divided into several segments, the zero line of each segment is screened, the electrified area is selected by ammeter measurement, and then the screen is further sieved. This method takes a long time and sometimes requires frequent opening and closing of the switch, efficiency It is low, but it can accurately find the area where the zero line is charged (disconnected).

![Diagram](image_url)

Figure 3. The process of judging and finding the cause of zero line live fault
4.2. Phase-separation detection
The three-phase line is checked for power failures in sequence, and the voltage between the power failure phase and the zero line is measured with an AC voltmeter. If the voltage between one phase and the zero line is 0, the fault occurs in that phase. This method is used for the live line to be caused by a phase-to-ground short-circuit fault, and can only locate the fault to a certain phase. To determine the specific fault point, further maintenance is required.

4.3. Voltage method detection
After the short-circuit phase line is determined, by measuring the voltage value between the zero line and the zero potential reference point, if the voltage measurement value at a certain place is the largest, the location can be located as the fault occurrence point. This method is an improved scheme based on the phase separation detection method, which can be used in combination with shared detection.

In addition, a set of flowcharts for determining the cause of the zero-line live fault are summarized in Reference 5, as shown in Figure 3 [5], but the implementation of this process still requires a lot of manpower and material resources to operate. It is also cumbersome and inconsistent with the current goals of smart grid construction.

5. Zero line live failure prevention measures
Regarding how to reduce the frequency of live line faults and maintain the safe and stable operation of power lines in low-voltage stations, it is mainly based on a summary of the causes of previous zero line faults. In the analysis of the causes and solutions of live line faults, Summarized some effective measures to prevent live line faults.

For the corrosion of the grounding body of the transformer and the zero line, or accidental breakage, and the grounding impedance is not up to standard, you need to use a professional grounding impedance tester regularly and measure the grounding resistance of the grounding body in accordance with the test procedures of the regulations to effectively avoid the cause. Zero line live fault caused by ground impedance exceeding standard.

Regarding the zero line live fault caused by three-phase current imbalance, attention should be paid from the beginning of power system planning and design, so that the load of the three-phase line is evenly distributed as far as possible, and it needs to be considered from the perspective of the three-phase power supply to ensure three-phase The balance of the power supply output current itself is also a critical step. In addition, it is necessary to ensure that the three-phase switches in the low-voltage station area are reliably contacted to avoid unbalanced three-phase currents caused by poor contact of one phase switch. Finally, it is necessary to pay attention to the quality and construction technology of the zero line to avoid accidents such as the zero line breaking due to the poor quality of the zero line.

6. Research and development of fast fixed-point device for live line fault
On the basis of digesting and absorbing the existing technology, this project conducts research on the detection of live line faults on zero lines of low-voltage overhead lines, and proposes a research and development plan for fast fixed-point devices for zero-line live faults of overhead lines on low-voltage areas. The rapid location of live line faults on the zero line improves the accuracy rate of live line faults on overhead lines. It is convenient for maintenance personnel to troubleshoot in a timely manner and increase the operational reliability of low-voltage stations. The research mainly includes the following key technical issues:

6.1. Simulation study of fast fixed-point device for live line zero line live fault in low-voltage stations
- Use finite element simulation analysis software to build a physical model of the overhead line zero line simulation, give the simulation process, and conduct a simulation analysis of the live line zero line fault.
- Research zero Criteria for live line faults, based on simulation analysis, feature extraction of live line faults on the zero line, to achieve rapid fault diagnosis.
• Research on fast fault location methods, based on ATP-EMTP software simulation to study fault amplitude criteria, to achieve rapid fault diagnosis.

6.2. Fast fixed-point hardware research on live line zero-line live faults in low-voltage stations:
• Study the design method of high-accuracy electronic zero-sequence current transformers, propose calculation formulas for the optimal turns of the secondary side and the minimum current of the primary side, and simulate the core The method of selecting the best working point.
• Study the hardware anti-interference technology, such as power supply anti-interference, circuit protection and circuit board shielding, to ensure the stable operation of the device; study the signal pre-processing circuit design method, data acquisition and processing method and wireless transmission method.
• Research software algorithms such as noise filtering and fast calculation of asymmetric current to improve the reliability and sensitivity of the device.
• Based on typical laboratory faults, establish a zero line live fault judgment model, design a zero line live fault type identification model, and improve the accuracy of fault type diagnosis.

7. Conclusion
Aiming at the problem of live line faults in low-voltage stations, on the basis of summarizing the existing causes and detection methods of live-line faults in low-voltage stations, an effective method for preventing live-line faults in zero-lines is given. Research plan of fast fixed-point device for live faults. The proposed research method of fast fixed-point device for live line zero faults on overhead lines in low-voltage stations can improve the technical level of live-line fault diagnosis for zero-line overhead lines in low-voltage stations. The rapid location of faults can improve the operational reliability of low-voltage stations, and can effectively improve the operation and maintenance management level of low-voltage stations. In the next research, engineering experiments will be carried out for the proposed device research and development scheme to further test the feasibility of the proposed scheme.

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References
[1] Ma Shisheng, Hui sanjun, Lang Yiwei. Troubleshooting of neutral line electrification caused by mixed lines in adjacent stations [J]. Rural electrician, 2017,25 (11): 34.
[2] Liu Huangbao. Cause analysis and fast search method of zero line live fault of low voltage TT system in rural power grid [J]. China strategic emerging industry, 2017 (32): 174-175.
[3] Wang Lixin. Cause analysis and troubleshooting of zero line electrification in overhead line power supply residential area [J]. Electromechanical information, 2017 (12): 17-18.
[4] Ma Zhiyong, Wang zhaoman. Diagnosis and treatment of zero line live fault in low voltage power grid [J]. Management and technology of small and medium enterprises (next ten issues), 2016 (12): 178-179.
[5] Wu Huanyu, Wu chengran, Chen Huahao. Study on live fault of neutral wire in TT system [J]. Rural electrician, 2019,27 (05): 34-35.