

A Study of a Variety of Multifunctional Direct-inserted Ground Rods

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Abstract: With the rapid development of social economy and the continuous improvement of science and technology, the demand for electric energy is increasing, and people are increasingly dependent on electric energy. The requirements for personal safety, equipment safety and power grid safety of power grid employees are getting higher and higher during their work, so it is necessary to eliminate obvious and potential potential safety hazards during the installation of equipment. In this paper, the problem that the installation of the grounding rod at the lower door of the switch cabinet is not secure and difficult to install is studied in depth, and a new type of multi-functional direct plug-in grounding rod is designed. This design effectively solves the problem that the installation of the ground wire is not secure and difficult to install, and ensures the safety of the staff, equipment and electric network.

1. Introduction

With the rapid development of economy and the continuous improvement of modernization level, the demand for electricity in society is growing and the dependence is becoming stronger and stronger [1-3]. At the same time, the State Grid Corporation of China also has higher requirements for the safety of electric personnel, power grid and equipment, so it is necessary to eliminate all unsafe hazards as far as possible. When the 35kV and 10kV lines in the high-voltage room of the substation are powered off, the space in the switch cabinet of the high-voltage room of the substation is narrow, and the distance between the phases in the rear lower cabinet door and the bus at the place where the ground wire is installed is not enough. When installing the ground wire, it is difficult and the risk factor is high. During installation, common grounding rods need to be suspended from the middle of two phases of the line to the rear of the line (row) [4]. A little carelessness will touch the live parts beside or above, posing a great threat to the personal safety of operators. At the same time, when the outdoor capacitor bank is powered off, it is very difficult to install grounding rods (wires) at the cable head side of the disconnecter and at the capacitor bank side. Because of the high height, there are often no suspended grounding rods (wires) on both sides. The use of ordinary concave grounding rods (wires) cannot be suspended vertically and reliably, resulting in cross and virtual connection [5]. At the same time, in case of virtual connection and

disconnection of the grounding rod (wire), the ordinary grounding rod cannot detect it. The operator can only judge whether the grounding is reliable by moving the grounding rod based on experience. However, this kind of problem is very serious. If the grounding rod (wire) cannot be determined to be reliably grounded, it will pose a great threat to the operators [6].

Therefore, a multifunctional direct plug-in grounding rod for substation is proposed to ensure the reliable grounding of the grounding rod (wire) and the personal safety of operators. It is of great practical significance on site to ensure the smooth implementation of various maintenance work in the substation and eliminate all potential safety hazards caused by grounding problems.

2. Importance of Grounding Wires and Rods

2.1. Importance of Grounding Wire

The ground wire is a wire directly connected to the ground, which can also be called a safe return line. When it is dangerous, it directly transfers the high voltage to the earth, which is regarded as a lifeline [7-8]. Due to poor insulation performance or humid use environment of household electrical equipment, its shell will have a certain amount of static electricity, and electric shock accidents may occur in serious cases. In order to avoid accidents, a wire can be connected to the metal shell of the electrical appliance, and the other end of the wire can be connected to the ground. In case of electric leakage, the ground wire will bring static electricity to the ground and release it. In addition, it is important for electrical maintenance personnel to use electric soldering iron to weld circuits, sometimes because the electric soldering iron is charged, the integrated circuit in the electrical appliance will be broken down and damaged. Friends who use computers sometimes ignore the grounding of the host shell [9]. In fact, grounding the host shell can prevent the occurrence of a crash to a certain extent.

In electrical engineering, the following points should be noted when using high-voltage grounding wires.

(1) When hanging the grounding wire: Connect the grounding clamp first, then connect the electric clamp; When removing the grounding wire, the grounding clamp must be removed first and then according to the procedure.

(2) Installation: Fix the double eye copper nose on the phase separation of the grounding soft copper wire on the corresponding position of the grounding clip (fixed and movable) on the grounding rod, and fix the single eye copper nose on the phase closing of the grounding wire on the grounding clip or grounding pin to form a complete set of grounding wires.

(3) Verify that the voltage level of the grounding rod is consistent with that of the operating equipment.

(4) The grounding flexible copper wire has split phase type and combined type, and the grounding rod has flat mouth type and double spring hook type clamp.

2.2. Importance of Grounding Rod

The grounding bar is an auxiliary device necessary for the installation and maintenance of equipment in the substation, and its role is mainly to discharge short circuit to ground [10]. When the equipment is grounded, first connect the connecting device and grounding clamp on the grounding wire, then connect the other part of the grounding wire with the multi-functional grounding rod (metal connection), and finally connect the metal part of the equipment through the metal head clamp of the grounding rod, so as to ensure the safety of the equipment in the process of maintenance and installation, and also ensure the life safety of the maintenance personnel in the process of equipment maintenance [11].

3. Analysis of Substation Grounding Rod

It can be seen from the existing grounding rods that most of them are composed of grounding rods, and the connection mode is that the grounding clamp is directly connected with the grounding rod. Therefore, when overhauling the electrical equipment of the high-voltage switchgear, it is necessary to check whether the grounding rod is closely connected with the metal of the equipment, and the corresponding grade of grounding rod must be equipped before the overhaul. Only in this way can the equipment overhaul requirements be met. Before equipment maintenance, each substation shall be equipped with 36 left and right grounding rods (12 groups) of corresponding voltage grade, so as to ensure personnel safety during maintenance.

In order to reduce the line tripping fault, the requirements for power grid grounding devices are becoming higher and higher. A good grounding system should have the following two main conditions:

(1) The grounding resistance shall be as low as possible. The lower the grounding resistance is, the more safely the lightning current, surge and fault current can dissipate to the ground.

(2) The grounding conductor shall have good anti-corrosion capacity and be able to repeatedly pass large fault current. The service life of the system shall not be less than that of the main ground equipment. Generally, the service life shall be at least 30 years. The long-term, reliable and stable grounding system is the fundamental guarantee for maintaining the stable operation of equipment and ensuring the safety of equipment and personnel. The key to the long-term safe and reliable operation of the grounding system is to correctly select appropriate grounding materials and reliable connections.

At present, the grounding rod is an integral rod, which is simple in structure and not a multi-functional grounding rod. When repairing equipment in the substation, grounding rods shall be installed on each side of the high-voltage switchgear, thus increasing the number of grounding rods with different voltage levels and increasing the cost. Generally, there are dozens of substations in a power supply bureau, and each substation needs about 36 grounding rods, and different levels of substations need different grounding rods. For example, a grounding rod as high as a person needs to have a 90 degree turning angle during installation; Some grounding points require workers to climb the equipment to repair and install the equipment, thus causing potential safety hazards. During the inspection of grounding rods, the number is large, and the inspection is time-consuming and laborious. Some parts are not easy to inspect, especially those with narrow space are inconvenient and easy to ignore during installation and inspection. As a result, resources are wasted and personal safety of equipment maintenance personnel is not guaranteed.

When the 35kV and 10kV lines in the high-voltage room of the substation are powered off, the space in the switch cabinet of the high-voltage room of the substation is narrow, and the distance between the phases in the rear lower cabinet door and the bus at the place where the ground wire is installed is not enough. When installing the ground wire, it is difficult and the risk factor is high. During installation, common grounding rods need to be suspended from the middle of two phases of the line to the rear of the line (row). A little carelessness will touch the live parts beside or above, posing a great threat to the personal safety of operators. At the same time, when the outdoor capacitor bank is powered off, it is very difficult to install grounding rods (wires) at the cable head side of the disconnecter and at the capacitor bank side. Because of the high height, there are often no suspended grounding rods (wires) on both sides. The use of ordinary concave grounding rods (wires) cannot be suspended vertically and reliably, resulting in cross and virtual connection. At the same time, in case of virtual connection and disconnection of the grounding rod (wire), the ordinary grounding rod cannot detect it. The operator can only judge whether the grounding is reliable by moving the grounding rod based on experience. However, this kind of problem is very serious. If

the grounding rod (wire) cannot be determined to be reliably grounded, it will pose a great threat to the operators.

4. Structure Analysis of Multi-function Grounding Rod

The new grounding device is designed in reverse with the common grounding rod, with the opening forward and a hook device, which can improve this problem. Install a button below the grounding rod. During installation, press the button to open the first grounding head (chuck), align it with the equipment grounding wire (row) and directly insert the buckle, then release the button to close the first grounding head, lock the grounding rod, and ensure that the grounding rod is reliably suspended and will not fall off. The grounding rod is mainly composed of the following parts: grounding plate, guide sleeve, guide rod, tension plate, plywood, mounting plate, connecting plate and other structures. Its structure is shown in Figure 1:

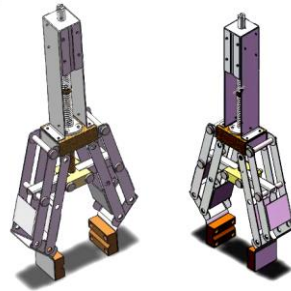


Figure 1: Structure of multi-functional direct plug-in grounding rod.

The direct plug-in grounding rod is also equipped with an alarm device, which can not be detected by the ordinary grounding rod in case of virtual connection or disconnection of the grounding rod (wire). Therefore, in order to ensure the reliable grounding of the grounding rod (wire), an alarm device is added at the end of the developed grounding device. The intelligent device is mainly composed of a single chip computer, a grounding data detection device, and a power drive module. When the intelligent device is started, the grounding detection module will detect whether the direct plug-in grounding rod is in good contact with the ground wire at any time, and input the detected data into the central processor of the single chip computer in real time. After being processed by the single chip computer, if the grounding rod is in poor contact with the ground wire, The alarm device connected to the microcontroller will send out alarm information (buzzer sounds and red alarm light flashes). In the warning light circuit, the multi-functional grounding bar adopts LED, which is essentially a light-emitting diode and belongs to a semiconductor element, and can convert electric energy into dazzling light. The semiconductor is composed of two parts. One end is a P-type semiconductor with many internal holes, and the other end is an N-type semiconductor with many internal electrons. When these two semiconductors are connected, they form a PN junction. When the forward voltage is applied to the PN junction, the electrons are pushed to the P region, so the electrons and holes combine to emit energy in the form of photons, which is the working principle of LED luminescence. The material of PN junction in LED can change the color of light emitted. Not only that, LED also has many advantages, such as high light energy conversion rate, strong durability, less radiation to human body, high recyclability, etc., which are widely used in various occasions. In the design of alarm system device for virtual connection of grounding rod and ground wire, it is certainly necessary for some alarm modules to send out alarm sounds under unsafe situations to remind people to take action quickly when virtual connection or poor contact just occurs, so as to ensure that the grounding wire of high-voltage switchgear equipment installation in the substation is in good contact and the personal safety of the installation personnel. The alarm modules in electronic technology products include voice alarm,

audible and visual alarm, prompt alarm, remote host computer alarm, etc. However, considering the need and practicality of this alarm device design, audible and visual alarm is adopted, and the alarm device uses an active buzzer. The active buzzer can convert the constant DC current into pulse signal. This is because there is an oscillating circuit in the internal structure of the active buzzer, which makes it have this conversion function. Only the DC current as a trigger signal can drive the active buzzer to work. Considering all aspects, the display device adopts the active buzzer with simple structure, convenient operation and stable input signal. This will inform the operators that the grounding device is not reliably grounded and needs to be reinstalled, so as to protect the operators' personal safety during maintenance.

5. Conclusions

In this paper, the existing grounding devices are deeply analyzed. Through the analysis of the structure, connection mode and working principle of the existing grounding rods, it is found that the existing grounding rods cannot meet the requirements of the rapid development of power. The installation of high-voltage switchgear in some substations requires the installation of grounding rods. Because some space positions are narrow and it is difficult to install them, and it is difficult to check whether their installation is correct after installation, this paper aims at this problem and designs a new type of multi-functional direct plug-in grounding rod. This grounding rod has an alarm and early warning function. When the connection of the grounding rod is virtual or broken, its alarm device will alarm immediately. Through the alarm, it can ensure that the grounding rod has a problem, that is, it can be located, and it can ensure that the electric power personnel can safely and smoothly complete the work when maintaining equipment.

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