Development of Charged Insulating Clothing Detection Device

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Keywords: Human Body Model, Iron Electrode, Insulating Megger, Live Working, Insulating Clothing

Abstract. In order to improve the reliability of power supply, power grid companies carry out the project of 10kV power distribution of live working actively, which gradually realizes the overhaul of distribution power without outage. The workers doing the operation to stop outage need to wear charged insulating clothing, which will be inevitably squeezed, rubbed, scratched and other damages from hard objects after being used. This paper introduces the detection methods of charged insulating clothing, namely to adopt the testing fork that is connected with the insulating megger dedicatedly, which move from up to down, left to right on the insulating clothing. When the insulating megger points to zero, it means that the insulation is damaged. Due to the testing method detects the mistake slowly, and the accuracy is poor, we develop “the human body model detection device”. It mainly focuses on the device that is composed of high voltage unit, model hangers, conductive material, iron electrode and detector, and it elaborates the effectiveness of the device in the actual work at the same time.

Introduction

In order to improve the reliability of power supply, the power supply enterprises increase the work's strength of 10kV power distribution of live working in recent years, try hard to expand the project of 10kV power distribution of live working, expand the areas of operation, increase the maximum times of live working on the basis of ensuring safety, which gradually realizes the overhaul of distribution power without outage. The current domestic each net, provincial companies belong to the power supply enterprises, the main mode of operation they use on 10kV distribution of live working is insulating gloves(insulating protective method), and insulating clothing is the important personal protective equipment to this method, whose quality is directly related to the safety of the workers.

Due to the limitation of the manufacturing level of domestic insulating materials, most of the insulating suits are imported from abroad, and the introduction time of the product is not long, so for insulating clothing, domestic has not a unified and general preventive test standards now. This makes the periodic preventive test of insulating clothing cannot be orderly done, which bring the safety hidden trouble to live working personnel. Since there is no testing standard for insulating clothing, its quality cannot be effectively judged after purchase and use, some insulating suits cannot be used correctly, which make the phenomenon that qualified insulating clothing is abandoned or unqualified insulating clothing is continued to be used.

Purpose of the Charged Insulating Clothing Test

Due to the using time of insulating clothing for 10kV power distribution live working is not long in the domestic, the preventive testing study of insulating clothing has not been seen in domestic publicly report now. It's understood that some domestic departments are doing the research, and there are some differences between the research methods and ways. Although some foreign companies have the test standards for insulating clothing, that has a great significance for us, there

are differences for test formed etc, which can't completely suitable for us.

Inside and outside surface of the insulating clothing should be in good condition, no deep scratches and wear, the thickness of it should be uniform and no obvious holes in it. Because it may be squeezed, rubbed, scratched by the hard objects when the insulating clothing is used, this may cause serious damage to insulation, which undermine its uniformity, damage the defects of the smooth surface contour, such as holes, cracks, local uplift, mixed conducting foreign body, incision, creasing, gap, bump tattooed, casting marks and so on.

Current Test Methods

Live working workers need have the test detection for insulating clothing before operation, so as to ensure that the insulating clothing conforms to the requirements of the procedures and the safety of workers. The recent detection methods of insulating clothing is to adopt the testing fork that is connected with the insulating megger dedicatedly, which move from up to down, left to right on the insulating clothing. When the insulating megger points to zero, it means that the insulation is damaged. The testing method detects the mistake slowly, and the accuracy is poor. It can only be detected when the insulating clothing's insulation reduces or penetrability defects exist, and one point damage of the insulating clothing cannot be detected. Therefore, the testing methods and means can't accurately detect the real defect of the insulating clothing. Detection methods are shown in figure 1 below.

Fig.1 The diagram of insulating megger detects insulating clothing

Designing Scheme of Developing “the Human Body Model Detection Device”

According to the requirement of DL/T 976-2005《The preventive test procedures of live working, device and equipment》to 10kV power distribution of live working, we develop the detection device for live working insulating clothing. The detection device of live working insulating clothing is composed of high voltage unit, model hangers, conductive material, iron electrode and detector. The conductive material with better electrical conductivity is used to close to the model hangers, and the high-voltage output terminal of high voltage unit is connected to the conductive materials, which make the model hangers with conductive materials become the adjustable positive electrode for voltage. Connecting insulated handle with iron electrode so as to make it become the cathode of the test. The insulating clothing is put on the model hanger, and then increases the voltage to the specified voltage, the iron electrode is moved from up to down, left to right on the insulating clothing, which can complete the detection test of insulating clothing. When there is a defect on the insulating clothing, the detector will make the sound and light alarm, that means leakage current. When the leakage current is too large, the device will protect itself automatically.

Fig.2 The principle diagram of charged insulating clothing detection device

- Ps: 1. The conventional voltage regulator: The range is 0-250V, the capacity is 3kVA.
 2. The step-up transformer: 50000/200, the capacity is 3kVA.
 3. The effective insulation of lower part of hangers is 100kV.
 4. Because the “hangers” are the high voltage part, the highest voltage should be 30kV when the insulating clothing is tested.
 5. “Electric funnel” goes through the ammeter grounding of the instrument.
 6. The displayer is composed of ammeter, over current protection, indicator light and grounding.
 7. The current limiting resistor of “electric funnel” is 100Ω.

Instructions

- 1) The insulating clothing is put on the model hanger, which can be seen as the insulating test.
- 2) The high voltage unit outputs the high voltage value it need, which is put on the model hanger with conductive material directly, at this time the whole model hanger will become an equipotential high voltage electrode.
- 3) The iron electrode with insulated handle is moved from up to down, left to right on the insulating clothing. The iron electrode is a conductive material, through wires connects with the detector, which can be seen as the grounding electrode.
- 4) When there are some defects on the insulating clothing, the high voltage loop will have larger leakage current necessarily. The leakage current goes through the defects of insulating clothing to iron electrode, then through the iron electrode's connecting line input to the detector.
- 5) The detector can indicate the leakage current value through the panel of microampere mete directly. When there is a defect on the insulating clothing, the detector will make the sound and light alarm, that means leakage current. When the leakage current is too large, the device will trip to protect itself automatically.

Testing Standard and Cycle

Insulating clothing is the safety protective equipment when the live working workers contact with the charged object directly, which has the function of protecting the wearers from electric shock that directly relates to the personal safety of life. Insulating clothing should be done the power frequency withstand voltage test, and insulating withstand voltage test is to determine the reliability of the electrical insulation. It's the test that experimental article trying to taste much higher test voltage than the working voltage that according to the testing voltage standard, which is the most rigorous test. As the instrument that relating to the safety of users' safety, the protective appliance usually adopts the power frequency withstand voltage test as a testing project. Based on<The preventive test procedures of electric power safety instruments (trial implementation)>that is issued and implemented by the state power company on November 7, 2002, it demanded to do the power frequency withstand voltage test for insulating clothing.

Based on the industry standard DL/T854—2004 that was issued in 2004, it announced the provisions of preventive testing project for insulating clothing. The testing standards and cycles are as follows: testing voltage 20kV, application time 1 minute; testing cycle 6 months. The insulating clothing is tested as qualified with no flashover, no breakdown and no obvious fever.

On-site Application

Gebu main 59 rod of Shuncheng District in Fushun replaced the insulator with charge on October 25, 2016. At 14 o'clock of that afternoon, the insulator of Gebu main 59 rod took off, to ensure 9.18' commemorative activity to go on smoothly, they exchanged the insulator with live working. After decorating safety measures, they tested the live working insulating clothing. First, the insulating clothing was put on the model, then connected with electricity, and pressurized at last. When the grounding "iron" was used to detect the insulation, the model discharged with the grounding "iron", the power switch protected itself at the same time. To examine the insulating clothing after blackout we found that there was a discharged point under the joint between axillaries sleeves and rib from the insulating clothing. The damaged reason of insulating clothing was that axillaries often worn, the joint between sleeves and rib was not close. By using this device, the potential safety hazard was avoided effectively, and the personal injury was also avoided. The on-site test is shown in figure 3.

Fig.3 On-site application

Conclusion

The advantages of "the human body model detection device" are: 100% detects the insulation declining and transfixion damage of insulating clothing with high accuracy; whether the armpit or the neck, sleeve detection will finish at one time with no dead by humanized models designing; save operation time with high detection speed. Based on a period of time of theoretical research and test, we basically solve the key technical problems in the test. We can test the insulating clothing accurately, to ensure the safety of insulating clothing when it's used, the main frame of the test standards is formed, which can be put into trial use in local pilot. The device is simple and reliable, the test method is reasonable, that are suitable for promotion in the city-level electric power bureau.

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