

# GIS Electrical Circuit Resistance Instrum in Transformer Substation Maintenance Test Site

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## Abstract

Every year, the power grid accident caused by GIS fault has caused serious losses to the national economy. The full circuit resistance test of GIS equipment under power outage can timely and effectively find the defects such as loose node, poor contact or joint surface oxidation caused by long-term non-operation of the bus and each branch.

## Keywords

GIS; Circuit Resistance; Transformer Substation.

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## 1. Introduction

GIS (gas insulated substation) is composed of circuit breaker, disconnecter, grounding switch, transformer, lightning arrester, bus, connector and outgoing terminal. All these equipment or components are enclosed in metal grounded shell, which is filled with SF<sub>6</sub> gas.

Since the 1960s, it has been widely used all over the world. The maintenance interval of its main components is no less than 20 years. It has the characteristics of small installation volume, good safety performance, high reliability and long maintenance cycle.



Figure 1. GIS internal defects

## 2. Judgment Basis

“Regulations of condition-based maintenance & test for electric equipment of State Grid Corporation of China” defines the resistance test of GIS equipment's main circuit as diagnostic test, not routine test. It is specified that the resistance of the main circuit shall not exceed the manufacturer's specified value (note value).

“General management regulations on substation detection of State Grid Corporation of China (Volume 36 detailed rules for main circuit resistance measurement)” stipulates that for GIS, if there is incoming and outgoing line bushing, the incoming and outgoing line bushing can be used to inject measurement current for measurement; If the conductive rod of GIS grounding switch is insulated from the outer shell and led to the outside of the metal shell before grounding, the movable grounding strip can be opened during measurement, and the conductive rods of two groups of grounding switches on the circuit can be closed to the measurement circuit for measurement; If the conductive rod of the grounding switch is not insulated from the shell, first measure the parallel resistance  $R_0$  between the conductor and the shell and the DC resistance  $R_1$  of the shell, and then convert the loop resistance  $R$  according to the formula:

$$R = R_0 R_1 / (R_1 - R_0). \tag{1}$$

### 3. Test Method

By conducting the full circuit resistance test of GIS equipment and analyzing and comparing the test data, we can eliminate the potential hidden dangers of the equipment in time, check whether the internal contact surfaces are in good contact, and ensure the safe and stable operation of GIS equipment.

State Grid Handan power supply company, in combination with its own reality, stipulates that the measured value is not allowed to exceed 1.2 times of the measured value during the handover test. In the previous maintenance and test work, major problems such as defects of 110kV No. 2 bus of 220kV LZ Transformer Substation and poor contact of grounding knife switch of 110kV WXZ Transformer Substation have been found successively.

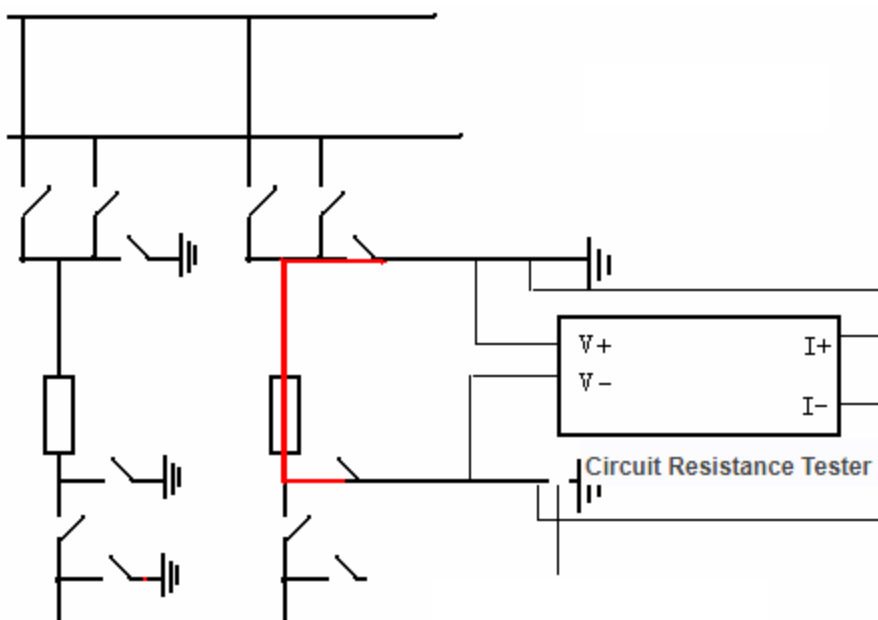
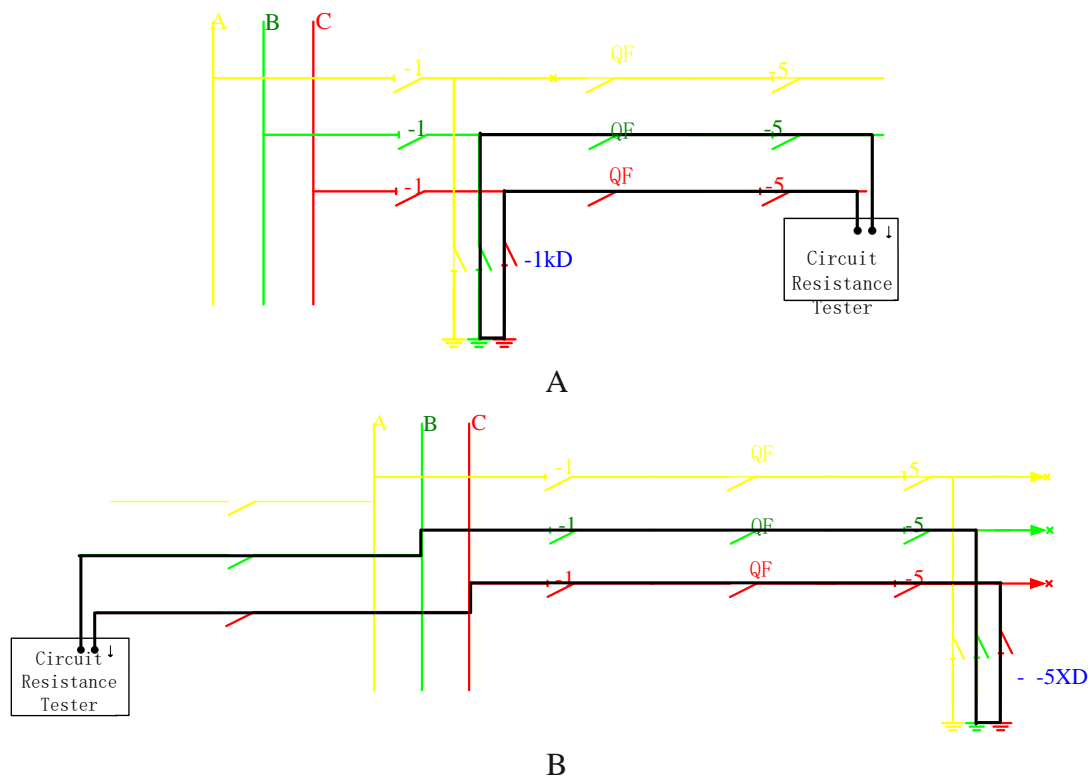


Figure 2. CIRCUIT resistance test diagram of GIS single-phase mode

During the handover test between the equipment manufacturer and on-site installation, the conventional test methods of A phase to A phase, B phase to B phase and C phase to C phase shall be adopted. The routine test and diagnostic test after the substation is put into operation, affected by

the equipment site and system operation mode, the method shown in the figure is often adopted on site, which is different from the equipment manufacturer and on-site handover test.

The work of frequent disassembly and assembly and repeated disassembly of grounding connecting piece is avoided.



**Figure 3.** CIRCUIT resistance test diagram of GIS non-single-phase mode

Take the measurement of RBC as an example for explanation, Fig 3A shows the circuit resistance test method in case of single outgoing line interval maintenance power failure. During measurement, ABC three-phase forms the test circuit from the outgoing line side through the common ground knife – 1KD. Fig 3B: when the main transformer, corresponding bus and its outgoing line are powered off, the circuit resistance test method is ABC three-phase common ground knife - 5XD. During measurement, the test circuit is formed from the main incoming side through the outgoing line interval - 5XD.

For GIS equipment, the main circuit resistance shall not exceed the manufacturer's specified value. The manufacturer requires the allowable deviation between phases  $\leq 20\%$ . No more than 1.2 times of the measured value during the handover test.

#### 4. Other precautions

(1) The output current of the loop resistance tester shall meet the requirements. According to the requirements of the regulations, the DC voltage drop method shall be adopted, and the test current shall not be less than 100 A, so as to ensure the test accuracy and reduce the error.

(2) The measurement wiring is correct. The loop resistance value of GIS equipment is small, and the measurement error directly affects the overall test results and has a great impact on Fault Analysis and judgment. Therefore, to ensure correct wiring, the current line is required to be on the outside and the voltage line is inside, and the voltage lead and current lead shall be in good contact. If necessary, the contact surface shall be polished with fine sandpaper to remove the oxide layer or paint on the surface.

- (3) Before measuring, the circuit breaker and disconnecting switch should be divided and closed several times, so that the contact can contact well, so as to ensure the accuracy of the measurement result.
- (4).Please review and familiarize the operator in advance.
- (5).The protection personnel shall review and determine whether it affects the action of transformer differential protection

**Table 1.** Possible main abnormal phenomena and Countermeasures in GIS internal defect test

No	countermeasures
1	Use a special test line to check whether the connection of the test line is good
2	The connection between the test line and the GIS circuit to be tested shall be firm and reliable
3	The voltage test clip is inside the current test clip
4	Use sandpaper to polish and clean the contact surface between the test clamp and the outlet sleeve, grounding connector, etc
5	Operate the circuit breaker, disconnecter and grounding switch of the circuit to be tested in GIS for several times to eliminate the influence of contact resistance
6	Select appropriate current gear for measurement, and the actual output current shall not be less than 100A
7	Select another instrument for comparative test

## Acknowledgments

Natural Science Foundation.

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