Measurement and Analysis of abnormal noise of 10kV switch Cabinet

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Abstract. When the load current flows through the main row of the switch cabinet, the induction current is generated on both sides of the cabinet, and the electric power of the interaction between the bus and the panel appears. Because of the thin switch cabinet panel and double-layer plate structure, when the load current is large, the double-layer panel vibrates violently and collides with each other under the action of electric power, and then resulting in abnormal noise. It may lead to hidden danger of equipment safety for long time. In this paper, acoustic imaging technology is used to accurately locate the sound source, and then the vibration acceleration amplitude is measured by the vibration sensors. Based on its spectrum characteristics analyse result, the causes of abnormal noise are discussed and solutions are put forward.

1. Noise source location test by acoustic imaging technology

At first, we use the acoustic imaging system to position the sound source of the switch cabinet, and the results of the positioning and testing of the noise source on the left and right side of the switch cabinet are shown in Figure 1.

![Detection results of noise source location in switching cabinets](attachment:image_1)

Obvious vibration abnormal area exists on the right side of the switch cabinet, and the area of the abnormal area is large, and the area is in line with the position of the through-screen sleeve; the left side of the switch cabinet also has certain abnormal vibration, but the area of the abnormal area is relatively weak, and the area of the abnormal area is small. In combination with the on-site operation,
the left and right side panels of the switch cabinet are of double-layer structure, the right-side feeder cabinet of the switch cabinet is in the running state, and the load current is larger than that of the feeder cabinet on the left side of the When the load current flows through the inner bus bar of the switch cabinet, induced current is generated on the panel on both sides of the cabinet body, and the electric power of the interaction between the bus bar and the panel is generated. As the metal thickness of the panel of the switch cabinet is thin and the double-layer plate is a double-layer plate, when the load current is large, the double-layer panel vibrates and collides with each other under the action of the electric power, so that the abnormal noise is generated.

2. Switch cabinet vibration test

2.1. Measuring point arrangement

According to the test results of the noise source positioning device, the vibration test is carried out at the large position of the sound source. The layout of vibration measuring points of switching cabinet and related bridges is shown in figures 2 and 3. Five vibration measuring points are arranged on the left and right sides of the switch cabinet, and one vibration measuring point is arranged on the front of the switch cabinet. The PT cabinet connected to the right side of the switch cabinet and the front of the feeder cabinet have one vibration measuring point respectively.

![Diagram of surface vibration point arrangement of switching cabinet.](image1)

![The frequency characteristic curve under different boundary conditions.](image2)
2.2. Vibration test results of each measuring point of switch and feeder cabinet

In order to quantitatively analyze the vibration intensity, the vibration acceleration of each side of switching cabinet and its surrounding feeder cabinet is measured. The linear amplitude of vibration accelerometer weight at each measuring point is shown in Table 1. It can be seen that the vibration amplitude of the front, left and right sides of the switching cabinet is obviously higher than that of the feeder cabinet. The maximum vibration amplitude appears on the right side of the switching cabinet, and the maximum value is 10.67 m/s². With the increase of distance, the surface vibration of PT cabinet and feeder cabinet connected to the right side of switching cabinet decreases gradually, and the minimum vibration value is only 0.14 m/s².

| Measuring point | Linear amplitude of vibration accelerometer (m/s²) |
|-----------------|-----------------------------------------------|
| 1               | 4.45                                          |
| 2               | 3.12                                          |
| 3               | 10.24                                         |
| 4               | 10.67                                         |
| 5               | 9.74                                          |
| 6               | 8.76                                          |
| 7               | 7.62                                          |
| 8               | 8.16                                          |
| 9               | 8.17                                          |
| 10              | 7.56                                          |
| 11              | 7.86                                          |
| 12              | 6.16                                          |
| 13              | 3.11                                          |
| 14              | 0.90                                          |
| 15              | 0.30                                          |
| 16              | 0.14                                          |

2.3. Vibration measuring point spectrum test

The vibration spectrum distribution of each measuring point is shown in figure 4. It can be seen that the vibration of each measuring point (1~12) on the switching cabinet has similar spectral characteristics: the amplitude of fundamental frequency 100 Hz is generally larger, the high frequency component is more in the range of 600 Hz to 20 kHz, and the amplitude is higher, and the amplitude of frequency vibration of 600 Hz to 4 kHz, 10 kHz and above is generally higher. The surface vibration of PT cabinet and feeder cabinet connected to switching cabinet is relatively weak, and the spectrum distribution characteristics are slightly different. The amplitude of vibration is larger in the frequency range from 300Hz to 2 kHz, and the corresponding frequency of the maximum amplitude is 600Hz.

(a) Spectral map of No. 1 measuring point
(b) Spectral map of No. 2 measuring point
(c) Spectral map of No. 3 measuring point

(d) Spectral map of No. 4 measuring point

(e) Spectral map of No. 5 measuring point

(f) Spectral map of No. 6 measuring point

(g) Spectral map of No. 7 measuring point

(h) Spectral map of No. 8 measuring point

(i) Spectral map of No. 9 measuring point

(j) Spectral map of No. 10 measuring point
3. Conclusion and suggestions

3.1. Conclusion
(a) The results of noise source location and detection show that the abnormal noise of switch cabinet comes from the left side of the switch cabinet, the right side passes through the panel where the casing is located, and both sides of the panel have obvious noise anomaly area, and the area of the right noise anomaly area is large and the amplitude is higher.

(b) The vibration acceleration amplitude detection results show that the abnormal vibration position of the switch cabinet is located on the left and right sides of the switch cabinet, and the maximum vibration amplitude is located on the right panel of the switch cabinet, which can reach 10.67 m/s². With the increase of the distance from the switch cabinet, the surface vibration of the PT cabinet and the feeder cabinet connected to the right side decreases gradually, and the lowest value is 0.14 m/s².

(c) The results of vibration acceleration spectrum analysis show that the amplitude of vibration fundamental frequency of each measuring point of switch gear is generally large, there are general
medium and high frequency harmonic components, and the amplitude of frequency vibration of 600 Hz to 4 kHz, 10 kHz and above is generally high. In the connected PT cabinet, the surface vibration of the feeder cabinet is weak, and the vibration amplitude is larger in the frequency range of 300 Hz to 2 kHz, and the corresponding frequency of the maximum amplitude is 600 Hz.

(d) The main causes of abnormal noise in switch gear include loosening of components, insufficient mechanical strength, mechanical resonance, partial discharge and so on. Generally speaking, the area of noise source caused by partial discharge is small and the intensity is weak, which is not enough to cause the large vibration of the whole panel of switch gear, and the spectrum distribution is wide and the amplitude is relatively uniform. According to the results of acoustic imaging and acceleration spectrum detection, the cause of partial discharge is excluded. Mechanical strength is insufficient, mechanical resonance is often related to structural design. In general, the vibration caused by electromotive force is mainly 100 Hz. Considering the non-uniform distribution characteristics of the vibration spectrum of the switch cabinet and the double-layer panel structure, it is preliminarily judged that the abnormal noise of the switch cabinet lies in the thin metal panel, the insufficient strength and the unreasonable structural design of the switch cabinet.

3.2. Suggestions

(a) The switch cabinet can be kept low load operation until the cause of the problem is found and solved.

(b) Strengthen the structural strength of the panel on both sides of the cabinet to suppress abnormal vibration.

(c) It is normal of the abnormal noise and vibration problem for switch gear. It is suggested that special technical key problems should be carried out, the structural parameters of equipment should be obtained from equipment manufacturers, the numerical simulation analysis of electromagnetic structure should be carried out, the force and vibration mechanism of switch gear should be studied, and the improvement measures or technical specifications for the formation of related equipment into the network should be put forward to eliminate hidden dangers from the source.

References

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