Development of Intelligent Operation Platform for GIS Combiner Installation

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Abstract: In order to improve the installation efficiency of GIS combined electrical apparatus and reduce the installation cost, the intelligent operation platform for GIS installation is developed in this paper. The platform adopts the concept of functional modular design, can replace the modular manipulator according to the different types of installation, and is easy to disassemble and assemble. The application of accurate installation and one-time positioning platform can effectively reduce the dependence on large lifting equipment such as cranes and scrapers, avoid the occurrence of bumps and damage to insulation during installation, and improve the installation quality of equipment. Effectively prevent equipment from the defects caused by engineering construction, and ensure power grid operation safety.

1 Introduction
Substation GIS combination electrical appliances refer to gas insulated metal enclosed switch gear(GIS Insulated witch gear), refer to as GIS. It is a high-voltage power distribution device composed of circuit breakers, isolating switches, bus bars, voltage transformers, current transformers, lightning arresters, bushing grounding cutters and other components. Bus bar installation is a key step in the installation process of GIS equipment. The quality of bus bars installation affects the safe operation of the overall equipment, and the bus bar installation time also directly affects the equipment installation period. At present, the installation of GIS bus bars with voltage levels of 110kV and above is mostly carried out by cranes (See Figure 1), its installation is time-consuming, laborious, and costly.

According to statistics, the average installation time for each bus bar of the 12 engineering GIS is 4.2 hours. Because the crane will shake during the bus bar hoisting process, it is difficult to accurately adjust the bus bar position, causing the bus bar flange bolts to be unable to align and penetrate quickly, which causes the bus bar installation to take a long time. In order to improve the efficiency of GIS bus installation and reduce installation costs, there is an urgent need to improve the construction equipment and tools for bus installation.
2 Development of intelligent operation platform for GIS combined electrical bus bar installation

2.1 Scheme design
According to the needs of actual work, the performance of the developed product was analyzed, and the following two overall schemes were proposed: a suspended GIS bus installation intelligent operation platform and a supporting GIS bus bars installation intelligent operation platform. Both solutions are required to achieve horizontal movement, control vertical lifting, and load 300kg; the intelligent auxiliary platform is simple to operate and convenient to move.

The suspended GIS bus installation operation platform realizes horizontal movement through the horizontal part, and the lifting part realizes vertical lifting. The belt suspends the bus bar under the lifting part to realize lifting. The supporting GIS bus installation and operation platform is realized by the horizontal part moving horizontally, the lifting part realizes vertical lifting, and the bus bar is placed above the lifting part to realize lifting.

Fig. 1. Installation of GIS combined electrical appliances by crane on site

Fig. 2. Suspended GIS bus installation operation platform & supporting GIS bus installation operation platform
3. Results of the program comparison

Choose a section of the 220kV GIS bus bar installation process in the supervised substation, with a weight of 200kg, use two devices for installation test, repeat 10 times, and record.

The suspended GIS bus is equipped with an intelligent operating platform, which can be moved, 10 times are successful, but the lifting situation is only successful 6 times, and the stability during the lifting process is poor. The experimental results show that the suspended GIS bus installation intelligent operating platform can provide sufficient lifting force, freely lifting, stable and controllable lifting speed, high safety, and heavy load, which can easily meet the 200kg load requirement. However, the disadvantage is that the busbar is fixed with a sling, which has poor stability.

The supporting GIS bus is installed with an intelligent operating platform, which can realize the movement, 10 times are successful, and the lifting situation is also successful 10 times. The horizontal movement and the lifting process are very successful. The experimental results show that: the operation is simple, the movement is convenient, it can provide enough lifting force, and the lifting is free; the lifting speed is stable and controllable, the safety is high, and the load is heavy, which can easily meet the 200kg load requirement.

3. Research and development of supporting GIS bus installation intelligent auxiliary platform

The design of supporting GIS bus bar installation intelligent auxiliary platform is broken down according to functions, and it is broken down into five main parts: supporting structure, lifting transmission mode, horizontal movement mode, supporting module, and power module, as shown in the following figure3.

![Fig. 3. Supporting GIS busbar installation and operation platform functional modules](image)

The entire GIS combined electrical bus is installed with the support structure of the intelligent auxiliary platform and the lifting transmission device. Move the device horizontally. The supporting module, power module and other functional modules have been separately manufactured, and the parts are assembled and connected in place as required. Completed all the assembly work of the intelligent auxiliary platform, as shown in Figure 4 below.
Auxiliary device developed for the installation of electrical equipment such as GIS bus bars and transformers. The platform is easy to move and can be firmly fixed in the equipment installation area. The platform uses a battery as a power source. The remote control can be used to control the manipulator up and down, left and right, forward and backward, and rotate. The core component is a precise transmission system driven by a DC stepper motor. The platform adopts a functional modular design concept, and the modular manipulator can be replaced according to the different types of equipment installed. The manipulator and the platform body are reliably connected with inner hexagon bolts, which is convenient for dis-assembly and assembly. A laser positioner can be installed on the manipulator to assist the installer in accurately judging the relative distance between the installed component and the intended position, so as to achieve precise installation and one-time placement. The application of the platform can effectively reduce the dependence on large-scale hoisting equipment such as cranes and poles, and can avoid knocking and damaging the ring insulating components during the installation process, and improve the quality of equipment installation. Effectively prevent equipment defects and grid operation safety incidents caused by engineering construction.

During the installation of the GIS busbars of the 10 substation projects under construction, the successfully developed supporting GIS busbar installation intelligent auxiliary platform was put into the project construction to verify its use effect, and the installation time of the GIS busbars of each project during each use. The record was carried out and the results were as follows: The supporting GIS bus installation auxiliary platform was used for equipment installation, which shortened the average time for GIS bus installation to 2.8 hours, which greatly improved the equipment installation efficiency.
4. Conclusions

By installing an intelligent auxiliary platform instead of crane hoisting, the bus bar can be installed without deviation, which improves the installation quality, reduces the bumping problem caused during the installation process, and reduces the workload of repairing. The supported GIS bus bar installation intelligent operation platform is developed, and the GIS bus bar is installed evenly. Time-consuming was shortened from 4.2 hours to 3 hours. The auxiliary vehicle collision damages the insulating components, further improves the quality of GIS equipment installation, effectively prevents equipment defects and power grid operation safety incidents caused by engineering construction, and provides a strong guarantee for the reliability and stability of GIS equipment operation, which greatly reduces Equipment safety accident risk.

The total cost of the intelligent auxiliary platform for the development of GIS busbar installation is 38,000 yuan. Its application fully promotes the mechanized construction requirements advocated by the State Grid Corporation of China, realizes the error-free installation of the bus, greatly improves the efficiency of equipment installation, and saves the construction period (each project saves 2 days: 1.4 hours × 12 intervals = 16.8 hours), Saving construction costs about 32,000 yuan (2 days × 0.35 million yuan / day × 10 projects-3.80,000 yuan = 32,000 yuan), and achieved good economic benefits.

References

[1] Cao Kai, Yu Chunhui. Application of GIS Dust-free Construction in Electrical Installation of Substation[J]. Northeast Electric Power Technology.2(42), 36–38 (2021).
[2] Zhong Yu, Chen Yu etc. Analysis of Management and Control of Keypoints of GIS Equipment Installation and Test in Substation[J]. Electric engineering. (17) 103–105,108 (2020).
[3] Zhang Peng. Analysis on installation and debugging Technology of Substation GIS equipment in Power system[J]. Electronic Test. (2):100–101,35 (2020).
[4] Liang Yong-shun. Installation Control Points and Handover Test of 1100 kV GIS[J]. Electric Power System. 12-14,1(2021).
[5] He Zong-bao, Hu Chun. Analysis of Dustproof Measures During Installation of GIS Equipment[J]. Electric Power System Equipment. 34-35,8(2020).
[6] LIU JiananTIAN WenminZHANG Guoqiang etc. Manufacture and Application of the Fully-Enclosed Self-Assembly Building for UHV GIS Installation[J]. Electric Power. 108-112, 50(6), (2017).