Study on the application of the integrated protection and control device for 220kV intelligent substation

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Abstract. Power system is a complex and huge network composed by power generation, transmission, substation and distribution, of which substation is an important part. In this aspect, the intelligent degree of substation is especially important. The 220kV substation of high intelligent degree is built in Hejia, and in order to popularize the application of the integrated protection and control technology of this substation, keep safe and stable operation of the intelligent substation after its operation, and carry out research of key technologies, the accessed dynamic model of the station scale is built and the dynamic model test of the substation is done.

Introduction

First, the simulation of the normal operation, each system abnormality and fault of the system of the station scale is carried out, and the performance indexes of substation are tested as a whole; secondly, the influence degree and scope of equipment abnormality and fault of the primary system and secondary system on substation function are obtained; then the device matching properties and the transient characteristics of various kinds of abnormality and fault are fully assessed; the operation, maintenance and inspection strategies of the secondary system of Hejia substation are formulated; the action reliability of integrated protection in the mode of network sampling and tripping is tested.

It is to ensure the safe and reliable operation of intelligent substation, save the construction time of intelligent substation engineering, lay the foundation for the technical supervision, fault analysis and other technical services of the intelligent substation, verify the reliability of the integrated protection in the mode of network sampling and tripping and provide technical reserve for the application of integrated protection and control of 500kV substation.

Design features

(1) integrated power: the "centralized + scattered" mode is used and the screen is placed in the interchanging field, which largely reduces the quantity of cables into the machine room.

(2) equipment room: the environment construction: according to the standard of the computer room, "the confined space + air conditioner + new fan " guarantees the requirement of temperature, humidity and dust prevention of the secondary equipment to the environment.

(3) integrated wiring: the mode of "wiring above" bridge is adopted, which effectively avoids cable and optical cable frogging.

(4) optimized cabinet: the professional boundaries of equipment group cabinet are broke through and the standards of the secondary equipment cabinet and intelligent control cabinet are uniformed.

In order to promote the application of the integrated protection and control technology of 220kV intelligent substation in Chaoyang Hejia and ensure the safe and stable operation of transformer substation after its operation, the study of key technologies is carried out. The dynamic model of the station-scale access is built and the dynamic model test of the substation is carried out.

Technological innovation

The project mainly studies the three-in-one network technology, the integrated protection and control server, the two-in-one physical integration of merging unit and intelligent terminal, photoelectric transformer, wireless communication application and other technologies, where equipment group cabinet is innovated, secondary equipment room is constructed, realizing functional integration, highly equipment integration, resources optimization, and information sharing.

The main advantages of intelligent substation:

(1) the original cable has been changed into fiber now, making design, installation, and debugging simplified.

(2) analog input and output circuits are replaced by the communication network, making the hardware system of the equipment simplified.

(3) the information model is unified, which avoids the protocol transformation, and realizes fully information sharing.

(4) it is applied in the condition control and station protection control, enhancing the observability and controllability.

Main innovation points:

(1) it is the first time which achieves integrated protection and control program in the intelligent substation, which reduces the number of protective devices and screen cabinets, and realizes the overall savings of 76.7%

(2) the seamless interchanging technology of the IEC61588 double master clock and the interchanger boundary clock can be realized in first time, making accuracy and reliability of the time synchronization system improved.

(3) the combination unit and the side protection synchronization technology can be realized in the first time, so that the problem of the synchronization of the line differential protection relying on the merging unit is resolved.

(4) the circumscribed optical current transformer is applied in engineering for the first time, so that there is no need of blackout during maintenance and replacement.

(5) the protection adopts the allocation and maintenance program of a single network with both sets and the terminal uses handheld smart software package for deployment, which improves the operation reliability and maintenance convenience of integrated protection.

(6) A process network layer is composed by GOOSE, synchronization information of IEEE 1588 and sampling value of IEC61850-9-2, where technology makes breakthrough, the total information of the station is shared, the network sampling and tripping is protected, and the quantity of interchangers and fiber interfaces are effectively reduced.

(7) the design of integrating the merging unit and the intelligent terminal is used in the process layer, so that the reliability of the device is improved and the number of the interchanger interfaces is reduced.

(8) an overall station control system is based on wireless communication, realizing "no cable installation".

Application of new technology and new equipment

Secondary system structure

The automation system of the total station is in the structure of "three layers and two networks", where the process layer network achieves high reliability of the "three-in-one network", and the protection achieves the network sampling and tripping.

Clock synchronization system

The station clock is configured redundantly, and master clock and backup clock, by using multi-source selection strategy and dual source of CBD/GPS, are complementary through B code.

The synchronization strategy of the master clock, interchanger and merging unit is proposed and realized, so as to avoid any misoperation and failure in any abnormality and fault, which greatly

improves the robustness of synchronization system and greatly promotes the engineering application of the relay protection network.

Integrated protection and control server

Based on the concept of regional protection, the integrated protection and control server takes use of embedded hardware platform and VLD software platform, to achieve the integration of protection, control, measurement and other functions, and the relay protection adopts network sampling and tripping.

High integration - 4 devices are equipped on each network, which achieves the protection, measurement and control of the total station lines and elements; high reliability - the scheme of single network and dual sets is used, which solves the problem of wide influenced scale and long blackout time during breakdown or maintenance of the integrated protection, and any one of the device failure cannot reduce the reliability of the relay protection; flexible and changeable operation mode- the protection of single network and dual sets can run simultaneously, or a set is running and the other is maintained.

According to the voltage level, the interval layer is equipped with the integrated protection and control server, which completes such functions as protection, measurement and control, so the number of devices and screen cabinets drop sharply.

There are all together 12 servers and 3 group cabinets in the station, of which 8 servers and 2 groups cabinets are in 220kV system of dual network, while 4 servers and 1 group cabinet are used in 66kV system of dual network and single set.

Comprehensive intelligence unit

The process layer is equipped with the double intelligent unit by gaps, so that a CPU fulfills all the functions of the combined unit and the intelligent terminal, which reduces the number of the device, saves the installation space, and is easy to install and debug.

The device is equipped with one process layer optical fiber interface, with the common network transmission of SV/GOOSE/1588, so that there is a significant reduction in heat and it is running more stable; the number of interchanger interface is decreased and the network architecture is clear.

Application of electronic transformer

The circumscribed current transformer of magneto-optical glass is applied in engineering of 220kV system for the first time, and it works very well, so that there is no need of blackout during maintenance or replacement.

The 66kV system adopts the electronic current transformer with the Rogowski coil.

The whole station adopts electronic voltage transformer with capacitive voltage divider.

Operation and maintenance strategy

In view of the configuration scheme of the integrated protection and control server, the 220kV single network and double sets in particular, the A1/A2 dual sets of devices set up the operation mode of "operation / maintenance" respectively, and the fault of any device will not reduce the stability and reliability of the relay protection.

Operation and maintenance tools

The deployment of intelligent terminal --- one key backup and one key recovery are applied in the protected programs and the configured files, and the setting of one key and the contrast of differences are carried out online, so that the setting value is more efficient, fast, accurate.

Handheld simulator of instrument transformer – The digital value is added from the source through FT3, to complete the tests of the protection of the whole set.

Main content

The dynamic simulation test of the secondary system of 220kV intelligent substation in Chaoyang Hejia includes such equipment: 220kV line protection, 220 kV element protection, 66kV lines and 66kV element; the test model and the test system are established, the total scale of the dynamic simulation test platform is take as the basic platform for various experiments and tests, and the RTDS (real time digital simulation system) as the core of the system. The primary system model is built on RTDS, to simulate the operating characteristics of the primary system. The simulation

system can simulate the characteristics of the actual operation and small disturbance of power system, the transient characteristics of the fault state, and the characteristics of power system oscillation and the abnormal frequency. And then the fault test of the primary system and the abnormal test of the secondary system, the test of double outlet relay strategy of 220kV intelligent terminal, the test of background control remote operation, the test of synchronization mechanism and timekeeping accuracy of intelligent terminal are done. Besides, the background flow of the secondary network interchanger port is tested, to monitor the influence of the GOOSE flow to the action characteristics of secondary network and protection. And, the identification code strategy of longitudinal contact channel of intelligent terminal, the maintenance strategy of Hejia substation clock, the equipment synchronous precision and clock timing accuracy, the automatic transfer function of 66kV, the sampling value SV vibrating error in the mode of network sampling and tripping and special performance are tested.

Conclusions

Through all the above experiments and tests, here come the following test results: through the simulation of about three thousand kinds of faults of the primary and secondary systems, the correctness of the relay protection action and the consistency of the action are fully checked, and the consistence of the action, device report and the alarm of the control system are verified. A total of 86 general problems, including the configuration error, are detected, 6 of which are the major problems affecting the system security and stability operation, the settlement of these problems are brought forward, and the operation and maintenance strategies of integrated equipment are developed.

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