A Way of Centralized Monitoring Center of HVDC Transmission System

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Keywords: HVDC, Control System, Centralized Control.

Abstract. In this paper, a method about design and implementation of centralized control in HVDC(high voltage direct current) is proposed. Using the method, the centralized control center can be completed in a relatively short period of time. And the equipments in each stations can be monitored and controlled very effectively var the computers in the centralized control center. In this way, we can save more human and material resources of the convert station, and improve the efficiency of the monitoring and controlling. The method conforms to the strategic thought of "Three Intensifications Five Systems" of National Grid. ( intensive management in human, financial and material resources, and systemic management in planning, construction, operation, maintenance and production).

Introduction

According to the strategic objective of building a strong smart grid and the and carrying out the work deployment, combining with the law of development of trans-regional DC transmission project, this article introduces the research and construction of centralized control pilot of HVDC Transmission zone. On the basis of converter station’s "integrating operation and inspection, flat organization and responsibility matrix", around the State Grid's “Big operation and mass production” system, we will further promote the "regional centralized control", and gradually realize the converter station’s management mode of "centralized monitoring, fewer people on duty", internal potential and process reengineering. We will improve the production efficiency of operation and management of DC transmission to lay the foundation for the intensive management of human, property, and material resources, and achieve innovation in production and management.

The following is corresponding discussion on this centralized control center of DC transmission system

The Necessity of the Construction of the Centralized Control Center

The necessity of the construction of the centralized control center is shown in the chapter below. The construction of the centralized control center is in line with the requirements of the development of power grid.

The construction of a unified strong smart grid put forward new challenges for converter station operation and management. State Grid determines the strategic objective of building a unified strong smart grid. Unified strong smart grid is that State Grid takes unified planning, unified standard and unified construction as principle and takes the UHA power grid as the backbone network to coordinate development of all levels of power grid, with information technology, automation, interactive features. Trans-regional HVDC transmission project is an important part of the national grid, occupies a pivotal position in the national grid. The centralized control of converter station is one of the important contents of promoting State Grid’s building a unified strong smart grid. The construction of a unified strong smart grid puts forward new requirements on converter station’s production and management. The centralized control of converter station is an effective way for the construction of a unified strong smart grid, is an important means of innovating converter station’ operation and management. It is of great significance for the implementation of smart grid development strategy.
The implementation of intensive management of human, property, and material resources put forward new demands on converter station’s production and management. Comprehensively strengthening intensive management of human, property, and material resources is a major achievement of State Grid’s implementing scientific outlook on development, is also an important measure to further change the mode of development of the company. Compared with AC transmission, DC technology has meticulous professional division of labor and complex technology. According to the traditional management mode of the station, it is need to equip with professional and complete operation and maintenance personnel, with the development of interconnected power network and the operation and maintenance of equipment, operation and maintenance costs will bring substantial growth. Under the requirements of State Grid’s implementing intensive management of human, property, and material resources, The centralized control of converter station is the implementation of the policy.

Centralized monitoring and control is the development trend of power grid’s operation and management. At present, as the scale of national grid construction and operation continues to expand, at the same time as the level of the power grid equipment and the reliability of automation equipment has increased dramatically, the domestic substation’s operation and management gradually turn to the mode of “centralized monitoring, fewer people on duty”. There is mature experience on centralized monitoring. The corresponding centralized monitoring standards of production and management has been set up. At present, the developed countries in Europe and America basically adopt operation and management mode of centralized monitoring and control, integrating operation and inspection, which greatly improves the production efficiency of power grid’s operation and management. So the centralized monitoring has become the development trend of power grid's operation and management. Combined with the law of development of trans-regional DC transmission project, vigorously promoting the centralized control of converter station zone is an inevitable choice of conforming to the development trend of power grid.

The construction of centralized control center is the internal demand of the development of DC power transmission industry

Overview of the Construction Scheme of DC Centralized Monitoring Center

![Figure 1. DS3100 multi-terminal HMI software structure.](image)

This realization of mode move the workstation of converter station to the centralized monitoring center, as shown in Figure 1, under this kind of mode, the station LAN network of converter station expands to DC centralized monitoring center. When the central monitoring center is configured with the necessary operator workstations that access station LAN, these workstations can complete the same monitoring function of workstations of converter station just like the local workstations of converter station. The advantage of the scheme is not necessary to increases tele control communication equipment for each station’s monitoring system, only need to increase photoelectric conversion device between the station LAN network and fiber channel; after configuration changes in converter station, centralized monitoring center does not need to modify.

The disadvantage is each converter station has a corresponding workstation in the centralized
monitoring center, when there are more sites, it is not convenient to manage and use; workstations are independent of each other, and it’s unable to get the data of multiple converter stations to analysis and use in a unified way.

Concrete Realization Way

Structure Design and Configuration of Monitoring System

For each converter station, DC centralized control center is independently equipped with a set of operational personnel monitoring system to monitor and control each station.

Take a converter station as an example, communication network and single station diagram are shown in Figure 3-1 DC control center monitoring system. In the center of gridlines, except for PCM and optical monitoring system, it’s overall configuration diagram of monitoring center’s monitoring system.

In the last chapter, we know about the communication software and the communication Protocol. The following is shown the hardware of the VSC-MTDC System. We take the four terminal flexible HVDC system as an example to illustrate VSC-MTDC System.
Each monitoring system adopts double LAN structure, and interconnect with corresponding converter station LAN through optical fiber. LAN using 100Mbit / s dual Ethernet network structure, operator workstation, maintain workstation, report workstation and other converter station workstations use the same card binding technology (Teaming) to access network.

Each monitoring system is mainly composed of the operation workstation, maintenance workstation, report workstation and other converter station workstations. Operator workstation monitor their converter station operating conditions, display event alarms, and send control commands. It has the same functions as converter station workstations.

**Protection and Fault Recording Information System**

DC control center is equipped with a set of protection and fault information system, to receive and deal with the data that converter station protection and fault record management information system relay up, the system consists of a set of protection and fault recorder information workstation to achieve. In order to ensure the reliability and rapidity of monitoring data, protection and fault recorder information system directly communicate with the converter station information protection substation through the network of independent channels without front system. The communication mode is dedicated network.

The protection and fault recorder information system can check the protection device information of converter station, collect protection events of each device, the self inspection signals and related waveform, and record according to the importance of classification, and give the clear alarm. The protection and fault recorder information system must be able to set protection fixed value of protection device of converter station. To protect the device with software plate, it also should have the function of remote switching board.

Figure 3. Protection and fault recording information system access.
Video Surveillance System

Each station is equipped with network video monitoring system. DC control center is equipped with a set of video surveillance system, the system communicate with video monitoring systems of each converter station through dedicated network, so that the control center can monitor scene images of the main control room, valve hall, high voltage room, main transformer, circuit breaker, isolating switch, outdoor venues in each converter station. In order to ensure the reliability and rapidity of the monitoring data, the video surveillance system of the centralized control center directly communicates with the video surveillance system.

Transformation of the Original System in Converter Station

a) Monitoring system
In addition, the station LAN networks access to optical fiber channel, the other does not require any transformation.

b) Converter protection and fault recorder information sub station
In the original converter protection and fault recorder information substation, we only consider the communication with remote dispatching center. When the DC centralized control center is established, the converter protection and fault recorder information substation needs to upload the protection information and fault record information to the DC centralized control center. As long as the communication channel is available, the protection and fault recording information substation, the modification and the workload are not heavy, the converter protection and fault recorder information substation only needs to do some configuration. According to the calculation, between the protection and fault recorder information substation and the DC Central Control Center, it needs two 2M special network channel for communication. Its interface program as shown below:

![Diagram](image_url)

**Figure 5. Access scheme of image monitoring system.**

In addition, in order to achieve the image monitoring system that can be able to freely switch in the monitoring center, the image monitoring system needs to support the function of remote switching.

The communication between the central control center, converter station and scheduling

a) The structure of the communication system between the three communication system architecture requirements in DC central control center, the monitoring of the converter station and the scheduling center as show below:
The arrows in the figure indicate the existing communication channels, and the double-headed arrows indicate the communication channels that need to be added after the DC central control center is established. This is what we need to increase:

- the scheduling of dual-channel telephone between the DC centralized control center and the dispatch center.
- the data transmission channel between the DC centralized control center and the scheduling center is used to transmit the automatic power curve and so on.
- the dual-channel telephone between DC centralized control center and the converter station.
- the dual-channel data transmission between DC centralized control center and the various converter stations.

b) Specific requirements for communication system

The overall requirements of the communication system are as follows:

- the telecontrol data channel, the dispatching telephone channel and the configuration between the original converter and the dispatch center remain unchanged.
- DC centralized control center communication system should include two parts of the communication system which are the various converter stations and the scheduling center.
  - communication system between the DC centralized control center and the converter station
    - The remote data transmission system
    - The telephone communication system
  - communication system between the DC centralized control center and the scheduling center
    - The dispatching telephone system
    - The data transmission system

Among them, the data transmission system between the scheduling center is mainly used to transmit the automatic power curve issued by the dispatching center and so on.

The data transmission system with each converter station should meet the following requirements:

- Ensure that the DC central control center achieves consistent channel requirements with the converter station monitoring data transmission;
- Using the double independent channels of data network to realize the redundancy allocation of main and standby channels;
The bandwidth of the channel should meet the requirements of monitoring data and event information data transmission;

Conclusion

Station LAN network extension of centralized control mode is comprehensive in the monitoring of the information, monitoring function and other function is equivalent to the converter station operators; the monitoring center station communicates directly with each station protection system through the station LAN control station, the reliability is high. In addition to the communication channel link, its reliability is equivalent to the converter station operator's workstation. The speed of the monitoring is almost the same as that of the operator workstation of converter station; the expansion of the system hardware is relatively easy. The system scale expansion (access to other converter stations) can be easily accessed to other converter stations. Extended, Access to the converter station configuration of independent network equipment and operating personnel workstations; from the implementation of the difficulty, it is achieved easily, and its cost is low. The construction period depends mainly on the network channel construction. As long as the network channel constructs well, monitoring system can be achieved in a short period, and without large-scale testing and debugging, it can be used directly.

References

[1] Liu Yi, Huang Hao-ran, Li Long-wei, Rao Guo-hui, A Way of automatic power in UHVDC transmission system.

[2] Tu Ren-chuan, Research on Sequence Control in UHVDC Converter Station, Southern Power System Technology, Vol. 2 No. 4, 2008, (08).

[3] Liu Li fang, the communication system of HVDC transmission network. Telecommunications For Electric Power System, 2002, (12).

[4] Shi Yan, Han Wei, Zhang Min, Wang Qing A Preliminary Scheme for Control and Protection System of UHVDC Project. Power system Technology, 2007, 31(2).

[5] Wang Qing; Shi Yan; Tao Yu et al. Simulation Study on Control Strategy for Balanced Steady Operation and Block/Deblock of Dual 12-Pulse Converter Groups in ±800 kV DC Transmission Project[J]. Power System Technology, 2007, 31(17):1-6, 10.

[6] Liang Shaohua, Tian Jie, Cao Dongming, Dong Yunlong, Zhang Jianfeng: A Control and Protection Scheme for VSC-HVDC System, Automation of Electric Power Systems, 2013, Vol. 37 No. 15.