Discussion on Remote Centralized Control and Operation and Maintenance Assistant Decision Model of Hydropower Station Based on Real-Time Data

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Abstract: With the rapid development of China's social economy, computer monitoring technology and network communication technology can bring earth-shaking changes to the development of all walks of life. With the development of computer monitoring and remote communication technology, remote centralized control of river basin cascade hydropower stations plays an important role in optimizing production, improving management level and comprehensive benefits. Based on real-time data, through the establishment of a centralized control center for hydropower stations, the dam safety automatic monitoring system and the water regulation automatic system can be integrated together to give full play to the social and economic benefits of the project. It has laid a solid foundation for the research and implementation of remote centralized control mode and operation and maintenance assistant decision-making for the construction of multi-basin cascade hydropower stations in China.

1. Introduction

The remote centralized control of hydropower station refers to the switching operation of unit starting and stopping and adjusting equal working conditions. The active power, reactive power, neutral point grounding switch of main transformer, AGC and AVC switching-off adjustment and monitoring of some important quantities are monitored remotely by the centralized control center set up at the headquarters of regional companies [1]. In order to ensure the optimal operation of small hydropower units, reach or exceed the expected technical and economic indicators, improve the overall efficiency, strengthen the use of new technologies and equipment, optimize the operation and management mode, and make hydropower stations develop towards an operation and management mode integrating knowledge, intelligence and technology, it is particularly important and urgent. With the continuous development of network communication technology, automation technology and remote sensing and telemetry technology, the foundation has been laid for the remote centralized control operation of river basin hydropower stations [2].

This paper proposes to study a set of auxiliary decision-making system for hydropower station operation and maintenance based on real-time data. The system collects, stores and processes data from sensors, and provides a standard data interface for the new access system to realize data interconnection. The research on the auxiliary decision system for hydropower station operation and maintenance based on real-time data provides a unified platform for power plants to collect, store and analyze data, and improves the level of effective extraction and analysis of monitoring data by the general plant. It provides effective decision-making basis for managers, thus assisting managers to make decisions on production plan, operation management, accident treatment and daily maintenance of hydropower stations quickly and effectively.

2. Necessity of Implementing Remote Centralized Control Operation Management Mode for Hydropower Stations

2.1 Enhance the Market Competitiveness of Hydropower Station Enterprises

According to the technical requirements of power grid dispatching center for power station

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control measurement and monitoring information collection, it is necessary to directly collect power station data on site. Remote control of hydropower station equipment, optimization of output efficiency and reduction of staff to increase efficiency can effectively improve the economic benefits of the power station [3]. In order to effectively utilize hydropower resources, improve the automation level of electric power production, reduce the operating cost of electric power production, strive to improve the economic benefits, social benefits and comprehensive competitive strength of enterprises, and better integrate human resources. Centralized and unified control and monitoring shall be implemented for basin power stations to complete basic functions such as start-up and shutdown, load adjustment and operation monitoring, and daily coordination and contact with power grid dispatching agencies shall be well done [4]. Change to the mode of operation and maintenance personnel working together to realize the integration of operation and maintenance. Only a small number of equipment patrol and maintenance personnel are left on site for each shift or on a regular basis. Reduce the on-site staffing of the power station, reduce the labor intensity of the personnel, efficiently utilize the limited human resources, reduce the production, operation and maintenance costs, and save the management costs.

2.2 The Operation Efficiency of the Power Station is Improved

According to the requirements of environmental and water conservancy departments on the supervision of the ecological environment, it is increasingly necessary to use the remote monitoring system and dispatching system of hydropower stations. The main reason is that although most hydropower stations have realized centralized control operation mode in terms of equipment control, the management mode and operation mechanism matching the technical standards of this mode have not yet been formed. According to the analysis results, the maintenance time can be reasonably arranged to ensure the reliability and stability of the equipment. Ensure safe, reliable and economical operation of power plant equipment, achieve controllable control, eliminate monitoring dead zone, and ensure timely response and effective treatment of abnormal situations. The “remote centralized control and few person maintenance” of hydropower station is a form of “unattended” on site, which is a concrete manifestation of the combination of unattended and the actual situation of hydropower station under the jurisdiction of hydropower station [5]. According to the principles of energy conservation and economy, priority should be given to the scheduling of renewable power generation resources, and with the goal of energy conservation and environmental protection, the scheduling mode of evenly distributing power generation capacity should be changed to the sequencing of power generation units. Focus on monitoring the water regime of the river basin, and timely send relevant monitoring data to the power grid dispatching center, providing important reference for the power grid dispatching center to optimize the power generation plan.

2.3 Economic Dispatch of Hydropower Stations in the Basin

The focus of remote centralized control operation is to adjust the load and monitor the operation of the equipment. Handle abnormal situations such as daily monitoring and load adjustment during operation. On-line monitoring of deformation, displacement, seepage and stress of hydraulic structures in power stations [6]. The monitoring center shall be responsible for the safety monitoring, remote operation, basin water regime measurement and reporting of power station production equipment, etc. The monitoring center shall make suggestions on reservoir dispatching plan and power generation plan to the power grid dispatching organization. According to the data reported by each power station cluster control center, the power generation plan or load curve of each basin is issued, and instructions such as operation mode, maintenance plan, equipment operation and load adjustment are issued. A centralized control center for river basin power stations will be established to centralize the computer monitoring system for mechanical and electrical equipment, the automatic water regulation system and the automatic dam safety monitoring system. Specifically, it is to give full play to the organization function under the principle of strictly executing the dispatching instructions of power grid and anti-coincidence department, optimize the planning, command, control, coordination and supervision of electricity for the production process of the system, ensure the stable operation of equipment and provide sufficient power for users.

3. Remote Centralized Control of Hydropower Station Based on Real-Time Data

For the cascade hydropower stations in the river basin, when planning the power transmission scheme, full consideration should be given to connecting the power to the power grid system after the power is collected to realize the concentration of power transmission points. Based on the platform of big data architecture data collection platform, combined with the standardization of data coding, the data collection and sharing center is formed by integrating and unifying the data of existing multi-monitoring systems in the mode of data library [7]. The remote centralized control center can be implemented immediately, and emergency handling of accidents can be strengthened through the transfer of control authority. Therefore, the access of the remote centralized control center cannot change the power station computer monitoring system and dispatching automation system. Remote centralized control makes the production, operation and equipment maintenance of hydropower stations a whole and no longer separate from each other. Therefore, hydropower stations should be set up according to the integrated operation and maintenance mode. Ensure that when there is a fault, the equipment fault can be eliminated immediately. The duty room should also be equipped with corresponding guard personnel to ensure that the fault can be handled quickly. Basin hydropower stations should do a good job in centralized monitoring, control and adjustment of basin power stations, actively explore specialized management modes, and coordinate and communicate with provincial dispatching centers to reasonably dispatch economic operation of basin power stations so as to maximize the benefits of basin power stations.

Code management is the most basic application of the data collection platform platform. It is used to maintain the code data of each power plant and unify the code specification, so that the code management of the power plant is no longer chaotic. Through the standard code, the data generated by the power plant can be further mined and some professional analysis can be made [8]. The code uses a three-layer structure to describe the monitoring quantity, as shown in Figure 1.

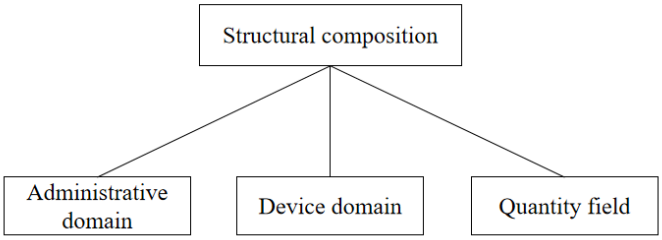

Fig.1 The Coded Three-Layer Structure

Among them, the management domain: defines the management information of monitoring quantity, such as the ownership of provinces and cities, the ownership of factories and stations, etc. Equipment domain: defines the source equipment information of monitoring quantity, which is consistent with the equipment code; Value field: defines the physical attributes of monitoring quantity, such as data source, physical category, algorithm category, etc.

The real-time data of the power station are further processed and mined by using big data algorithm tools, and the index data with various specific functions are finally obtained from the multifarious data through extraction, processing and calculation, so as to directly reflect the operation state, fault characteristics, health indexes, operation characteristics and the like of the equipment or system. The collection of structured, semi-structured and unstructured massive business data collected through various data collection channels such as sensors, intelligent equipment, video monitoring equipment, audio communication equipment and mobile interruption. The computer monitoring system equipment in the centralized control center shall have seamless access to most protection, PLC and instruments. During the operation process, the power plant load setting value with AGC function is dynamically issued by the power grid EMS system, and the rectification process is implemented by the automatic control device [9]. If the equipment is abnormal, an alarm can be issued immediately to improve the operation effect of the remote centralized control system of the basin hydropower station. Through automatic transformation, the

stability and reliability of the equipment are improved. After centralized control, the equipment can operate autonomously, and the accuracy and real-time performance of power generation capacity control are improved.

At present, the mainstream technology for real-time analysis of big data is basically event-driven streaming processing, in which data are analyzed and calculated in the process of flow under event-driving. Batch analysis is used for statistics and analysis of historical data, and it further digs data information in depth based on the results of real-time analysis. Batch analysis is based on Apache Spark computing engine. Figure 2 shows the Apache Spark-based computing engine.

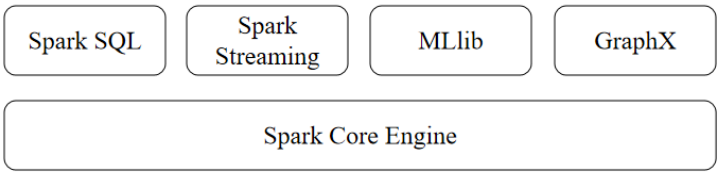

Fig.2 Apache Spark-Based Computing Engine

Spark is a big data processing framework built around speed, ease of use and complex analysis. The control link is mainly responsible for data link maintenance, such as data link opening, closing, alarm and other information transmission. The application of computer comprehensive processing and analysis technology can ensure the optimal dispatching and scientific and reasonable optimal load distribution between cascade power stations and reservoirs. According to the hydrological information and considering various factors, the paper puts forward suggestions on optimizing the power generation plan to the power grid dispatching center. Through professional management methods such as process standardization, organization system optimization, operation and maintenance institutionalization, informatization and team building, the highest comprehensive efficiency of equipment is achieved. Taking equipment asset management as the core and foundation, and taking the execution of power generation production, operation, overhaul and maintenance, production technology, material support and other key businesses as the main line, the data collection of power station core equipment is simultaneously integrated. When the amount of information is relatively large, optimization and processing can be carried out on the power station side first. The temperature of the generator stator coil can be uploaded by using the three points with high ranking, so as to catch the focus of information and filter out unimportant information. Through reasonable monitoring, operation and analysis of each equipment, the safe, stable, economical and reasonable operation of the equipment is ensured, and the emergency treatment is timely and reliable after the fault occurs, so that the whole power station can continuously operate in a safe and economical state.

4. Assistant Decision-Making Model for Centralized Control and Specialized Operation and Maintenance of Hydropower Stations

4.1 Process Standardization of Centralized Control for Hydropower Stations

Process standardization is an extension of process sorting and optimization design under centralized control mode, and is the standardization and standardization of redesigned processes in practice. Equipment is the cornerstone of the stable operation of the system. It is necessary to give full play to its functions and reasonably manage the equipment. The main tasks of equipment management include the daily maintenance and repair of equipment, the detection and analysis of equipment operation, and the renewal and transformation of equipment. According to the power generation plan and the real-time water level, the system calculates the current number of starting units, and adjusts the load of the unit by adjusting the opening of the guide vane, finally achieving the purpose of economic optimization operation. In the process of operation, man-machine interface can help managers to realize remote monitoring. Therefore, it is required that the monitoring images should be complete and clear-cut, and the connections between the images should be smooth. It is the key to implement remote centralized control of river basin cascade and maintain the reliability

of equipment. The system of post responsibility for equipment management should be established, the division of management responsibilities should be implemented, and post benchmarking should be conducted to achieve closed-loop management. We should also promote the network security protection function of the computer monitoring system, ensure the overall quality of the entire security protection system, and promote the related functions of the computer monitoring system to be safer and more reliable.

4.2 Organization System for Centralized Control of Hydropower Stations

To strengthen the daily maintenance management from two aspects of equipment and personnel, one is to use the monitoring system to establish the maintenance cycle to carry out maintenance on time, the other is to improve the professional level of maintenance personnel and strengthen the control and supervision of maintenance work. In the process of computer graphic plane operation, it is inevitable that the wrong images will be adjusted and the wrong objects will be selected, especially when multi-plant centralized control management is carried out, the wrong power plant selection will also be encountered. Through the integration of equipment operation and maintenance of various technical ledgers, standardize the basic work of technical management and take effective technical management measures. In addition to these basic requirements, it is also necessary to ensure that the remote centralized control operation control terminal of the hydropower station can realize manual adjustment operation, which can ensure the overall management of the remote centralized control operation control terminal of the hydropower station. Its purpose is to enable maintenance personnel to maintain the secondary equipment of the intelligent substation through the network, such as from regular maintenance to state maintenance, from on-site operation and maintenance to remote diagnosis, from empirical management to data analysis, so as to reduce operation and maintenance maintenance costs and maintenance time. For the operation process, it emphasizes timely and effective control and quick disposal and handling, and emphasizes clear responsibilities, clear functions, proper authorization and reduction of excessive horizontal adjustment.

4.3 Specialized Management of Information

Cascade dispatching and optimal operation system of hydropower station. Automatic detection and trend analysis of reservoir rainfall, inflow and outflow, water level, etc. Ensure effective monitoring of equipment; To establish redundant dual communication channels, the channel error rate, reliability and switching time should meet the basic requirements of real-time monitoring response time and data volume. Accurately and timely grasping the overall situation of hydropower stations not only ensures that the data of each hydropower station can be timely and accurately collected into the data center of the centralized control center through the remote data transmission function, but also can give correct and clear analysis results in the first time. Hydropower enterprises should formulate unified technical management standards and implement them in accordance with relevant national and power industry standards. It is also necessary to improve the safe and reliable effect of the whole channel by constructing a dual communication channel, and to judge the real-time monitoring data quality in time. Effective measures to improve the overall quality and quality of life of employees, consolidate and enhance the management advantages of enterprises, and create the core competitiveness of enterprises. The remote operation and maintenance of the secondary equipment of the intelligent station is realized by using MMS protocol and SNMP protocol, so that maintenance personnel can configure specific IED equipment, modify parameters and query historical event record information in the station.

5. Conclusion

To sum up, in the process of management, the centralized control center should give full play to the centralized monitoring and dispatching of reservoirs and power plant units to improve the economy, quality and safety of power plant operation. It can improve the quality and level of the whole operation equipment scheduling, promote the safety and stability of equipment operation,

improve the basic quality of personnel, and ensure the overall effect of remote centralized control. Based on real-time data analysis, the remote centralized control technology is put into operation, the remote centralized control center is established, and the Internet and automatic control technology of hydropower stations are utilized, so that the purposes of safety and efficiency improvement of hydropower stations, efficiency reduction by staff, basin water quantity dispatching and unit optimal operation efficiency improvement can be completely realized. It provides a good reference for exploring the operation and management mode of hydropower stations.

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References

[1] Cai Lin. (2019). Research on the remote centralized control on-site operation and maintenance management mode under the integrated operation and maintenance mode of the hydropower station. East China Science and Technology (General), no. 1, pp. 0177-0177.

[2] Yang Kuan, Jiang Zhiwen. (2017). Discussion on remote centralized control and operation and maintenance mode of hydropower station. Real Estate Guide, vol. 000, no. 035, pp. 134.

[3] Wu Xiaofang, Wang Shen, Shi Yun. (2017). Discussion on remote centralized control and operation and maintenance mode of hydropower station. Information System Engineering, no. 11, pp. 128.

[4] Cai Xiaolong. (2015). Talking about the professional management of the equipment operation and maintenance of the centralized control hydropower station. China Machinery, vol. 000, no. 004, pp. 66-67.

[5] Liu Zihua, Che Xiangbei, Liu Weibo, et al. (2019). Design of remote operation and maintenance system based on secure connection network. Automation Technology and Application, vol.038, no. 004, pp. 177-180.

[6] Hu Guochao. (2016). the current situation and suggestions of the construction of skilled talents in Jinghong Power Plant. Human Resource Management, vol. 000, no. 012, pp. P.125-126.

[7] Tu Wenxue, Lin Ping. (2016). Long-distance operation and maintenance of Chicheng Station. Henan Electric Power, vol.157, no. 01, pp. 28.

[8] Lu Xueli. (2015). Design and Application of Unified Video Surveillance Platform in Central Control Center of Gutianxi Hydropower Station. Electrical Engineering Technology: Theory and Practice, vol. 000, no. 011, pp. P.253-253.

[9] Zhang Wei. (2018). Discussion on the integrated operation and maintenance management of small hydropower stations. China High-tech Zone, vol. 000, no. 018, pp. 193.