Analysis and Evaluation of Safety Risks in Operation and Maintenance of Hydropower Station Groups Based on Real-Time Data Analysis

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Abstract: Equipment operation and maintenance is one of the important contents of hydropower station production management. Its management level directly determines the safe production and economic benefits of hydropower enterprises. How to manage power production in a complex market environment in order to obtain the most satisfactory benefits is an urgent research topic for power enterprises. Real-time data analysis adopts advanced equipment and computer monitoring system to carry out centralized and unified management of hydropower stations in the basin. The goal is to realize “no one on duty, few people on duty” of hydropower stations and realize safe, efficient and economic operation of hydropower enterprises. Based on real-time data, the hydropower station operation and maintenance assistant decision-making system will mainly realize the functions of real-time monitoring and evaluation of hydropower status, trend early warning, fault diagnosis, maintenance assistant decision-making and so on. A set of efficient and stable large data acquisition, monitoring, management, analysis and service system for hydropower stations has been established, thus providing guarantee for safe, reliable, economical and efficient operation of hydropower stations.

1. Introduction

Since the adjustment of the new competition policy in China's electricity market, the disadvantages of the traditional single hydropower station management mode have gradually become prominent, which has greatly weakened the competitiveness of electricity enterprises in the market and hindered their forward development. Customers want safe, stable and reliable power supply. Government departments hope that electricity supply can promote social stability and promote the development of other industries [1]. At present, with the rapid development and wide application of computer and communication technology, the technical requirements for realizing remote real-time data analysis for hydropower stations have been gradually improved, which also urges most hydropower stations in China to gradually realize real-time data analysis [2]. Traditional operation and maintenance personnel mostly use manual recording method to maintain information records, which has a large workload. It is not only difficult to ensure the integrity and accuracy of the recorded data, but also not conducive to data preservation and information sharing. With the enhancement of people's awareness of environmental protection and the demand for energy, more and more attention has been paid to the development and utilization of hydropower energy.

During the production and operation of the hydropower station, the management personnel shall make decisions on the production plan, operation management, accident treatment and daily maintenance of the hydropower station. The decision-making shall be based on the massive data provided during the production of the hydropower station [3]. For hydropower stations, it is of great significance to study the auxiliary decision-making system for hydropower station operation and maintenance based on real-time data to realize real-time monitoring and evaluation of hydropower status, trend early warning, fault diagnosis and maintenance auxiliary decision-making. Based on real-time data analysis, this paper analyzes and evaluates the operation and maintenance safety risks of hydropower stations in order to promote the overall level of equipment operation and maintenance with the help of modern advanced technology.

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2. Real-Time Data Analysis and Connotation Analysis of Hydropower Stations

Due to its own particularity, hydropower stations are generally located in remote mountainous areas, far away from cities, with relatively difficult transportation and living conditions. Due to the limitation of the scientific and technological level at that time, the automation level of hydropower stations is relatively low. However, in the process of hydropower station dispatching and operation, due to the influence of many factors such as environment, equipment and human factors, the safety of hydropower station has great hidden dangers [4]. There is a power connection between hydropower stations, that is, the power stations are closely connected through the power balance conditions of the power system. The control and operation management of hydropower station group equipment is to promote the standardization, routinization and scientization of professional operation and maintenance management by formulating standardized management system standards, technical standards, operation regulations standards, technical standards and quality standards. Advanced technologies such as computers are used to implement networked remote real-time data analysis, unified dispatching and management for multiple single hydropower stations in the basin. At the same time, a small number of operation and maintenance personnel are arranged in each single hydropower station to cooperate with the remote dispatching of the hydropower station cluster control center. The equipment maintenance work of centralized control center is mainly to check whether the software and hardware equipment and other auxiliary equipment are normal, to ensure the safe operation of network data and to coordinate the handling of accidents.

3. Real-Time Data Analysis, Diagnosis and Analysis of Safety Risks in Operation and Maintenance of Hydropower Stations

3.1 Real-Time Data Analysis of Operation and Maintenance Process and Characteristics of Hydropower Stations

Real-time data analysis of the operation and maintenance of hydropower stations is the basis for ensuring the safe and stable operation of hydropower stations. The operation and maintenance of hydropower stations with real-time data analysis involves the operation and maintenance of centralized control center machinery and equipment and the main electromechanical complex machinery and equipment of individual hydropower stations [5]. In terms of employee training, new employees are generally given induction and induction education, employees who do not perform tasks according to operation are given violation education, and all employees of the company are regularly given full education.

In order to meet the requirements of multi-level deployment of data centers, data synchronization function should be included in data center functions. According to this function, real-time data synchronization between two homogeneous data centers can be easily realized to ensure synchronous data storage between data centers of different levels. The data center should support user-defined source end and target end to realize data synchronization between two homogeneous data centers. Fig. 1 is a one-to-many synchronization.

The objects of horizontal integration include formulation of electric power production plan, management and monitoring of production process quality, evaluation of safety and economy, management of production equipment and production site, management of production cost and continuous improvement of quality management, etc. The real-time data analysis mode of hydropower stations has incomparable advantages over traditional single hydropower stations in economy, management controllability and other aspects, which can ensure the efficient and economic operation of hydropower stations. Loss in series impedance of transmission line and transformer increases with the increase of transmission power, which is the main part of power grid loss. Any lack of materials and excessive accumulation will hinder the development of the enterprise, so the reasonable management of daily used materials is the necessary basic guarantee to ensure the normal operation of the enterprise [6].

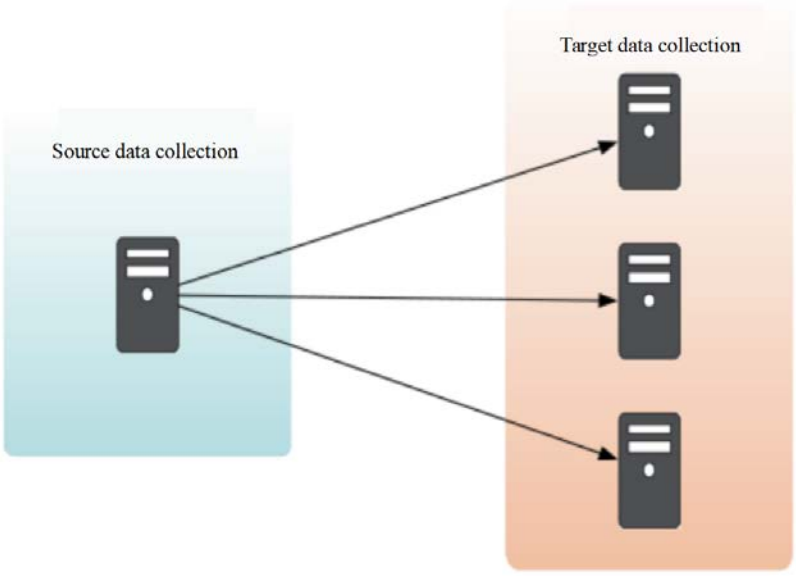

Fig.1 One-to-Many Synchronization

3.2 Security Risk Analysis and Assessment Status Analysis

People are the most active and potential factor in production activities, but they are also the most unstable factor. The expected operation and maintenance mode of centralized control hydropower station group is to realize “unattended” or “few people on duty” [7]. Therefore, the quality management mode of its power production must also meet the operation and maintenance requirements of “nobody on duty” or “few on duty”. The centralized control center is equipped with a large number of monitoring equipment, good communication equipment and other automation systems. Operation and maintenance personnel can grasp the operation status of the hydropower stations under their jurisdiction in real time through electronic monitoring screens, so as to realize centralized management and optimal dispatching of the hydropower stations. The safety guarantee of one post and multiple responsibilities is emphasized for the Sinotrans maintenance project, requiring employees to be familiar with various safety regulations. There are many unsafe factors in the electric power production environment. The risk of hydropower stations mainly refers to the safety risks in operation, repair and maintenance directly related to the production, operation and maintenance of hydropower stations. In order to implement unified management of cascade hydropower stations, road traffic, management technology and communication facilities need to be fully considered. Real-time data analysis there are some deficiencies in the analysis and evaluation of the operation and maintenance safety risks of hydropower stations, which are in the stage of continuous improvement. Emphasis should be placed on the identification, analysis and evaluation of potential safety risks, so as to prevent in advance and improve the operation and maintenance safety level of hydropower stations.

3.3 Analysis of Problems in Risk Analysis and Assessment

Real-time data analysis hydropower station group is composed of multiple hydropower stations, which is a more complex man-machine-environment system than a single hydropower station, making it more difficult to identify risks in operation and maintenance. Since the cycle of power production is almost instantaneous, hydropower stations must have a controllable and responsive quality management mode to meet the quality requirements of the market. Equipment operation management personnel are mainly responsible for equipment operation, inspection tour and work permit formalities. Equipment repair and maintenance personnel are mainly responsible for the elimination of equipment defects, regular maintenance, equipment failure handling, regular equipment maintenance and other work. If the whole cascade is located in the same power grid, the relationship is relatively simple. If different cascade hydropower stations are located in different power grids, the centralized management of the cascade will inevitably lead to serious conflicts of

interest, requiring reasonable adjustment [8]. From the point of view of power station operation, the form of cascade connection changes with the changes of operation and seasons, and the connection form of the same cascade is not the same. In terms of management, there is no full-time safety supervision personnel and detailed division of labor safety assurance measures, emphasizing the adoption of a one-post and multi-responsibility safety assurance and safety supervision system. The man-made safety risk management and control of hydropower stations embodies the safety concept of “all accidents can be prevented”. At the same time, it pays attention to the risk analysis and assessment in advance, pre-controls risks in advance, moves the safety prevention threshold forward in the operation and maintenance process, and realizes dynamic, active and advanced safety risk management.

Due to the influence of the environment, real-time data are always mixed with noise, burrs and other invalid data that affect the normal use of the data, and must be filtered before entering the actual analysis. Fig. 2 is a data preprocessing process.

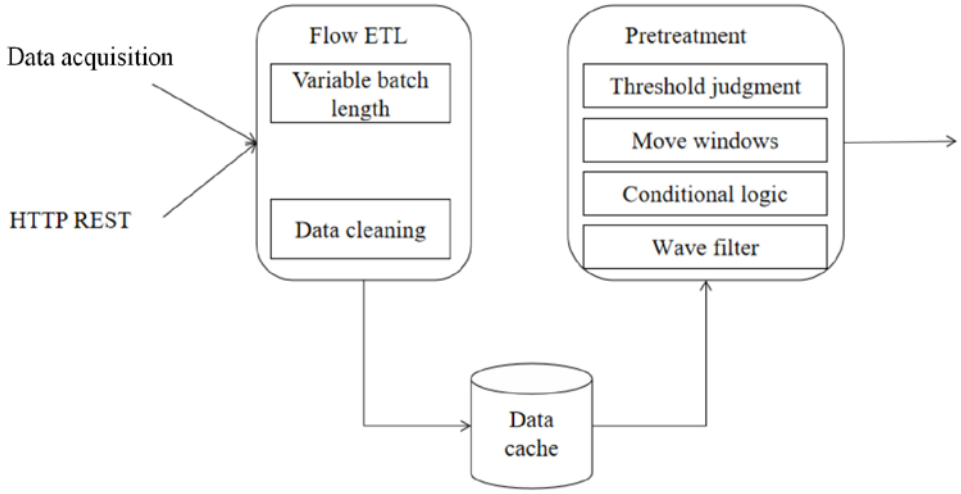

Fig.2 Data Preprocessing Process

Compared with the traditional single hydropower station, the composition of centralized control hydropower station group should generally include two or more hydropower stations, several reservoir groups and a centralized control center. The operators of centralized control center complete the real-time monitoring and information exchange of multiple hydropower stations under their jurisdiction through advanced monitoring equipment and good communication equipment. In the whole process management of equipment life, adhere to the principle of combining maintenance with planned overhaul, combining professional management with mass management, and combining repair, renovation and renewal. The characteristics of accidents include causality, contingency, inevitability, regularity and predictability. Causality indicates that the occurrence of things is related. Contingency refers to its unpredictable characteristics. Through safety meetings, network platforms and other means, the public will be informed of violations and special activities will be carried out for serious violations, seasonal violations and violations with production rules [9]. Real-time data analysis of the operation and maintenance of hydropower stations has become more complicated in four aspects: human, machine, environment and management, which increases the probability of occurrence of risks in the whole system and increases the difficulty of risk identification in the operation and maintenance process.

4. Research on Security Measures for Operation and Maintenance of Hydropower Stations

4.1 Perfect Organizational Measures

To strengthen the improvement of the assessment system, through the formulation and improvement of the grass-roots assessment system, accidents will be classified and graded, at the same time, the formulation of a special electrical safety assessment system, based on the relevant standards. Its core is the establishment of a balanced market in which all power producers, suppliers

and users can participate in maintaining the safe operation of the power grid through bidding in the balanced market. For the rectification of the accident, it is necessary to find out the cause of the accident, at the same time, to formulate preventive measures for the accident, to clearly implement the responsibility of the accident to the relevant personnel, to seriously deal with the relevant responsible personnel, and to make the vast number of employees receive in-depth education through accident notification and other means. Due to the reduction of personnel, it mainly depends on the evaluation of basic operation and maintenance personnel, and the knowledge level of evaluation personnel is uneven, so it is difficult to comprehensively and systematically evaluate the safety level at this stage. When front-line operation and maintenance workers work, they use graphic audio-visual resources produced by experts in the field as operation guidance. When the operation guide cannot assist the workers in completing the operation, the experts in the connection field ask for help. Field experts assist frontline operation and maintenance workers to complete operation and maintenance work remotely. The management of various factors affecting the power production quality of the hydropower station group has the advantages of less personnel demand and high management efficiency, and is suitable for the operation and maintenance requirements of “unattended” or “few people on duty”.

4.2 Implement Standardized Management

In order to make the operation of the heat engine more standard, it is necessary to carry out corresponding training for the staff, with professional engineers to guide them, and correct the irregular operation on the spot, so as to promote the formation of good habits of the staff. The operation and maintenance personnel of hydropower station equipment belong to the company, which is beneficial to the company's management and control of equipment operation and daily maintenance. Through competition, power enterprises are urged to continuously improve efficiency and reduce costs, thus achieving the dual purpose of promoting the improvement of power industry technology and management level and protecting the interests of power consumers. On the whole, the formation of full participation in safety risk management, all-round supervision, supervision of the whole process, and continuous improvement of the control mechanism, in order to achieve fine, accurate, precise, lean and exquisite operation and maintenance safety objectives, to avoid accidents. In different periods, people's scientific and technological level, cognitive level and production mode are different, which makes people have different understanding of the causes and essential laws of accidents. The operation and maintenance information system provides a learning platform for the operation and maintenance workers, mainly providing relevant resources for the operation and maintenance workers to learn when they are not working on the site. It is necessary to ensure that the operation and maintenance workers can access the system anytime and anywhere for learning and feedback.

4.3 Implementation of Dynamic Management and Monitoring

The construction of electricity market model must be in order to realize the goal of electricity market optimally. For this reason, the hydropower station group has established a relatively complete safety training system, including factory entrance education, post education, full staff education and violation education. In the same working environment, the work content is the same, but in different employees, the accident probability is different, some people are always easier to cause safety accidents than others. The goal of saving water and increasing electricity can be achieved by examining the reservoir dispatching chart, verifying the operating water level, comprehensive output coefficient, load rate of the power station, tail water level-flow curve of the power station and other influencing factors, and then by means of overall optimization, centralized coordination and unified marketing of the power generation plan. Therefore, it is necessary to collect the basic information of employees and enter it into the system by the manager. Moreover, due to the possible increase, decrease and deployment of employees, employee information needs to be updated at any time. With full visual management as technical support, the visibility of power production quality status under this mode is strong. Therefore, in the process of constructing its safety evaluation system, it is necessary to study its operation, management and other

characteristics. Only in this way can the practicability and scientificity of the whole safety evaluation system be guaranteed.

5. Conclusion

Real-time data analysis method of hydropower station group equipment is more and more widely used in current hydropower station management work, and equipment operation and maintenance play an important role in hydropower station management work. Safety evaluation technology can effectively analyze and evaluate the current system safety situation, find potential safety hazards and weak links, and promote the improvement of safety level. Based on the analysis of real-time data, the safety management and economy of centralized control hydropower station group's power production are comprehensively studied, so that centralized control hydropower station group can obtain the lowest quality cost on the premise of ensuring the safety of power production. The reason and influence degree of vibration value, frequency and vibration trend can be analyzed respectively, and the stable region of unit operation is proposed. In actual operation, the characteristic analysis and optimal scheduling are combined to make the unit operate in the stable region as much as possible.

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