Reliability Analysis of Electrical Automation Control Equipment in Hydropower Plant

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Abstract: With the rapid development of the national economy, in order to make the industry adapt to the speed of development, equipment update is every industry must choose. Hydropower industry is an important industry in China, which occupies an important position in national power transmission. In order to adapt to the reality of social progress and high demand for electricity, the existing hydropower plant related equipment must gradually be replaced by electrical automation control equipment. Electrical automation control equipment can be set in advance in a good environment to complete the task of manual input, can greatly improve the relevant work efficiency, can improve the competitiveness of the hydropower plant itself, to ensure that the hydropower plant to maintain good economic benefits. This paper deeply analyzes the reliability of electrical automation control equipment in hydropower plant, including the detection method of equipment reliability and the existing problems of automation control equipment reliability to improve the automation reliability strategy. It is not only beneficial to the sustainable development of hydropower plants, but also provides some theoretical guidance for the future research.

1. Introduction

With the continuous progress of China's national economy, people's demand for electricity is constantly rising. Whether in daily life or in production, electricity consumption is greatly increased [1]. In order to provide a better and continuous power supply for residents' life and industrial production, the equipment of hydropower plant must be updated. At present, the trend of equipment renewal in hydropower plants is to move towards the direction of electrical automation control equipment, realize automatic operation of equipment with the help of the current brand-new information technology, and improve the operation efficiency of equipment [2-3]. Automatic control equipment can greatly reduce the production cost of hydropower, improve the production efficiency, so as to ensure that power plants can achieve relatively high benefits, so that hydropower plants in a dominant position in the market competition [4]. In this case, the focus is increasingly on the reliability of electrical automation equipment. The reliability of electrified automatic equipment is affected by various factors, including specific operating environment, operating temperature, electrical wave, etc. Therefore, it is necessary to conduct detailed and comprehensive reliability analysis of automatic equipment to ensure the normal operation of equipment [5-6]. At present, improving the reliability of automatic control equipment is a common concern in various industries. Improving the reliability of automation equipment can minimize the probability of equipment failure and improve the quality of power production, which is conducive to the sustainable development of the industry [7-8].

However, the automation control equipment in our country is faced with many problems, which have a negative impact on the reliability of the control equipment. For example, the quality of equipment components is not up to standard, the operating environment of automation equipment is poor, and the maintenance and maintenance in the later stage is insufficient. These problems will greatly reduce the reliability of the control equipment and increase the probability of equipment failure [9-10]. At present, many experts and scholars of automation equipment at home and abroad

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have carried out a lot of research on automation control equipment, as well as relevant reliability analysis [11]. However, the reliability analysis of automation equipment of hydropower plants is relatively few, and some of them are not coordinated with the development of China's hydropower industry, so the accuracy of reliability analysis may need to be improved. From this point of view, the reliability analysis of automation control equipment still has some theoretical gaps [12-13].

In order to fill this theoretical gap, this paper conducts an in-depth analysis on the reliability of electrical automation control equipment in hydropower plants, including the detection method of equipment reliability, the existing problems in the reliability of current automation control equipment and the strategies for improving the reliability of automation control equipment [14-15]. These are not only conducive to the sustainable development of hydropower plants, improve the benefits of the industry, and the relevant aspects of the future research also have a certain reference significance.

2. Test Method for the Reliability of Control Equipment

The premise of improving the reliability of the equipment is to make accurate and correct analysis of the reliability of the electrical automation control equipment. Scientific detection methods can provide effective data support for the improvement of equipment. Currently, relatively scientific and generally accepted detection methods mainly include the following. The algorithm commonly used in the experiment is as follows:

$$FOF = \frac{FOH}{PH} \times 100\% \tag{1}$$

$$EAF = \frac{AH - EUNDH}{PH} \times 100\% \tag{2}$$

Where, FOF represents the forced outage coefficient; FOH stands for forced shutdown hour; PH represents the statistical period hour; EAF represents the equivalent availability coefficient; AH represents available hours; EUNDH stands for reduced output equivalent transport hours. The formula for calculating the outage is as follows:

$$FOOR = \frac{FOT}{PH} \times 8760 \tag{3}$$

Where, FOOR represents the incidence of forced outage (times/year); FOT represents the number of forced suspensions; PH is available hours.

2.1 Field Experiment Method

In the process of control equipment purchase, the reliability of the equipment is tested on the spot. In general, the detection methods of field experiment mainly include the following methods: online equipment detection, offline detection and shutdown detection. But this kind of detection method often has certain limitation, the trial experiment object is some technical level higher, the quality and the equipment component comparison standard equipment manufacturer; For those small scale, lack of normality of small factory are not suitable, some potential control equipment quality problems are not easy to find, control equipment reliability analysis results will be inaccurate to a certain extent.

2.2 Guarantee Experiment

Guarantee the experimental method of detecting object is for those who have the production process has been completed but has not yet been formally entered the market of electrical equipment, not into circulation in the control equipment in the field of buying and selling, on a small scale on the reliability of the control equipment of detection, only in the guarantee the reliability of the control equipment without any problems, equipment to formally enter the circulation market. This detection method can detect the deficiencies in the equipment and ensure

the normal operation of the control equipment when it is put into formal production. However, this detection method also has certain limitations, that is, the accuracy of equipment inspection also needs to be improved.

2.3 Laboratory Test Method

The laboratory test method can make up for the shortcomings of the first two experimental methods to some extent. In contrast, the laboratory test method can detect and detect the potential subtle problems existing in the equipment. In the testing environment of the laboratory, the operating environment of the control equipment can be simulated and restored in the most real way, and then the equipment can be tested comprehensively and some subtle problems can be analyzed and detected accurately. Generally, the application object of laboratory test method is the equipment that has been formally put into production operation. When there are strict requirements on the operation of control equipment, this method can be used. The advantage of laboratory test method is that it can guarantee the authenticity and accuracy of test results. However, this detection method is not applicable to those automation control devices with lower requirements for equipment due to the relatively high cost of testing, and it is often difficult for the operating manufacturers of such devices to pay high test costs.

3.Experiment

3.1 Selection of Experimental Methods

The selection of experimental methods should not be generalized and blindly copied, but should be based on different experimental subjects to choose appropriate detection methods. Each kind of experimental method has a certain object orientation, so only by making clear the experimental object and using accurate experimental methods can the experimental results be scientific. At the same time, in the process of experimental detection must pay attention to reduce external interference factors, carefully do the test data records.

3.2 Experimental Procedures

The first step is the determination of experimental objects and the selection of experimental methods. Three experimental subjects were selected according to the above three different experimental methods. Different experimental methods are selected for different experimental subjects to ensure that there will be no exclusivity between experimental methods and experimental subjects.

Second, the control of experimental factors; Try to reduce the interference of other variables on the equipment experiment, maintain the consistency of three kinds of experimental test items and test time, and conduct multi-directional test on the reliability of the equipment, such as environment, internal components and other aspects, so that the experimental results have sufficient data support;

The third step is to calculate and record the experimental data. Use the above formula to substitute the relevant experimental data into the calculation, and accurately record the data results, on the basis of which the reliability of the control equipment is analyzed.

4. Discuss

4.1 Analysis of Experimental Results

According to the above experiments, we can easily find that the current automation equipment running process, it is easy to run the fault, which indicates that the reliability of China's current automation control equipment needs to be improved. Specific experimental data results are shown in table 1 and figure 1. The data are the results sorted out by the author.

Table 1. Operation data of automatic control equipment

	Data	Testing Number	Error	Effectiveness
FOF	52.69%	150	2.10%	87.61%
EAF	61.27%	150	3.65%	89.34%
FOOR	32.68%	150	1.74%	91.27%
Reliability	73.21%			
*Data came from the experimental collation				

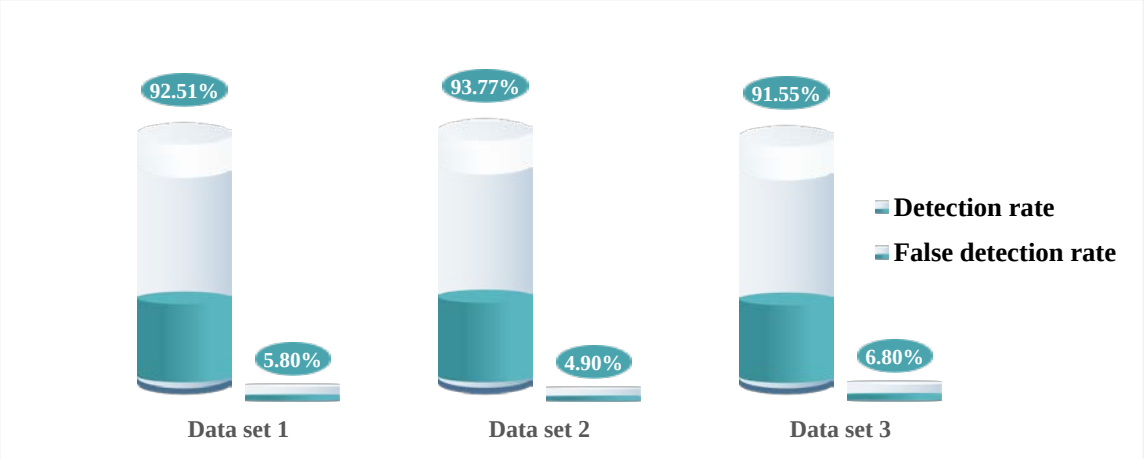

Figure 1. Comparison of equipment detection rate and error rate

4.2 Problems Existing in the Reliability of Electrical Automation Control Equipment

(1) The quality level of components of automatic control equipment is low

because of lower starting point of the electrical automation in our country started late, development is also a relatively short time compared with the developed countries, the current level is relatively low in the automation and control equipment and related production standard is not perfect enough, it is to a certain extent, caused the current components production lack of necessary supervision of qi equipment, components production level is low, there are a lot of manufacturers in order to obtain economic benefit even at lower equipment components production standards. The component of control equipment is an important part of the whole equipment, which plays a key role in the quality of the whole equipment, and has a direct impact on the reliability of automatic control equipment. With the development of economy, the competition of automatic control equipment industry is becoming more and more fierce. In order to obtain more economic benefits, many equipment manufacturers usually reduce the quality of components to compress the production cost.

(2) The working environment of electrical automation control equipment is poor

The reliability of the equipment is closely related to the operating environment of the equipment. The operating environment of the equipment mainly includes the following aspects: firstly, the climate factor, the temperature and humidity of the equipment operating, etc. If it is not compatible with the conditions required for the operation of the equipment, the equipment may fail and reduce the reliability of the control equipment. For example, due to high temperature caused by the equipment circuit short circuit; Secondly, the function of mechanical environment will cause interference to the reference data of equipment operation, making the reliability of equipment more or less affected. Finally, the effect of electromagnetic waves. Electromagnetic interference is an unavoidable factor in the operation of automatic control equipment.

(3) Lack of scientific use and maintenance of control equipment

The correct use and daily maintenance of automatic control equipment are related to the normal operation of the equipment. At the same time, if the maintenance method of the equipment is wrong, it will also reduce the service life of the automatic control equipment and cause interference to its reliability.

4.3 Strategies for Improving the Reliability of Electrical Automation Control

(1) Improve the production design level of the equipment

The most important thing to improve the reliability of the equipment is to solve the problem fundamentally first. For this reason, we should pay attention to the reliability control of backup when designing and manufacturing. At the beginning of design, it is necessary to make clear the production type, application way and specific operating environment of the equipment. In the process of equipment production, we should closely supervise each link of production, resolutely reduce non-standard production operations, improve the overall level of production, and ensure the quality of equipment production.

(2) Strictly control the quality of equipment components

Each component quality of the equipment should be strictly controlled, according to the specific operating environment and the way of equipment component grade selection and processing. Temperature will affect the work of the components and interfere with the reliability of the equipment. Therefore, the selection of components must ensure that they have good heat dissipation, so that the components will not be damaged due to high temperature and affect the normal operation of the equipment.

(3) Regular test of equipment

To improve the reliability of the control equipment, we must first grasp the problems of the equipment comprehensively and carefully. Therefore, it is necessary to test the automatic control equipment frequently and find out the problem of the equipment. Three specific methods for equipment reliability analysis and testing have been introduced in the paper above. In order to select appropriate testing methods for different experimental objects, it is necessary to pay attention to reducing external interference factors in the process of testing and carefully record the testing data. According to the test results, make specific solutions to improve the reliability of equipment.

5.Conclusion

Through the analysis of this paper, it is not difficult to find that there are still many problems in China's electrical automation equipment, which also poses a threat to the reliability of the control equipment. Must, therefore, a comprehensive analysis of equipment, from all aspects to find more subtle issues that exist in the automation equipment, and in a timely manner to solve these problems, so as to ensure the normal operation of control equipment, reduce the rate of automation control equipment malfunction, promoting the comprehensive industry competition ability of power plant, also in a certain extent to ensure the quality of electric power production.

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