An Intelligent Threshold Alarm Model Based on Abnormal Judgment of Logic Indicators

Jianhua Huang*, Xinlin Liu
Shenzhen Power Supply Bureau, Shenzhen, Guangdong 518001, China

*Corresponding author: jiang_wenjie@126.com

Abstract. In order to improve the information sensitivity of power transmission and transformation environment, this paper establishes the threshold alarm model of condition monitoring data of power transmission and transformation equipment based on the abnormal judgment method of business logic index. This paper extracts the necessary alarm transaction of condition monitoring data of power transmission and transformation equipment. According to the extraction results, the specific data level of authority threshold is determined by means of data cleaning, and the smooth application of power transmission and transformation equipment condition monitoring data threshold alarm model is realized. The experimental results show that, compared with the local state processing model, the accuracy of directional electronic transfer is more than 75% and the threshold can reach the standard authority threshold level. The problem of low sensitivity of original power transmission and transformation information has been effectively solved.

Keywords: Power Transmission and Transformation, Information Sensitivity, Business Logic Index, Threshold Alarm Model

1. Introduction

With the rapid development of power grid, a large number of power equipment are put into power grid operation, which provides a very sufficient power supply for regional economic development [1-2]. At the same time, due to the quality of manufacturing, transportation, installation and maintenance and other factors, the failure of local power equipment not only affects the transmission capacity of power system, but also may cause large-scale blackout of power system, bringing huge losses to power system and national economy [3]. Therefore, it is of great significance for the safe and reliable operation of the whole power grid to improve the reliability and maintenance level of power equipment, especially the main equipment of power grid, such as main transformer, all kinds of switches, arresters, etc. [4-5].

If the equipment is not defective and can operate normally, it will be stopped for maintenance or even replaced, just as a person who is not ill will be admitted to hospital for surgery, which will inevitably lead to a huge waste of human, material and financial resources [6]. At the same time, this regular maintenance management mode also has the problem of "insufficient maintenance". Due to the problems of test methods and test equipment, or some equipment defects are not found, or due to heavy maintenance tasks and tight time, the equipment that should be repaired is not repaired, or the
equipment that should not be repaired is repaired, which leads to the equipment failure. Therefore, it is necessary for modern electric power enterprises to study and explore how to change the existing maintenance mode and establish a predictive maintenance mode of "compulsory maintenance" instead of "compulsory maintenance" [7-9].

It is not easy to do a good job in the condition evaluation and fault diagnosis of power equipment. There are many kinds of power equipment, and the equipment is complex. To objectively evaluate its operating conditions, it is necessary to collect a lot of monitoring information on the equipment line. In addition, the equipment's own account information, environmental data and equipment operation and maintenance records, etc., the amount of data is very large. If manual evaluation is used, it is not only time-consuming and laborious, but also easy to make mistakes. Therefore, it is necessary to have information system as a supporting tool to implement equipment status management effectively.

2. Research Summary

2.1. Enterprise profile of F Power Supply Bureau
F Power Supply Bureau is a super large power supply enterprise directly under g power grid company. It is responsible for the power grid planning and construction, power grid operation and maintenance, power supply and power supply service of F City. At present, there are more than 2.7 million power supply customers and more than 6000 employees. In 2014, the maximum load of power grid in F City was 10.053 million kilowatts, and the completed power supply was 55.631 billion kwh [10].

F City power grid is an important hub of G power grid and an important gateway of West to East power transmission. By the end of April 2015, there were 4340.22km transmission lines of 110kV and above, 210 substations (5 500kV, 32 220kV, 172 110kV and 1 35kV), 524 main transformers with a capacity of 51396 MVA in F City.

| Equipment type       | Cumulative | 500kV | 220kV | 110kV | 35kV |
|----------------------|------------|-------|-------|-------|------|
| Transformer substation | 212        | 5     | 32    | 172   | 1    |
| Transformer          | 524        | 42    | 84    | 396   | 2    |
| Circuit breaker      | 1030       | 25    | 101   | 681   | 133  |
| Isolating switch     | 3210       | 62    | 715   | 2227  | 206  |

2.2. Problems in current equipment status management
After three months of on-the-spot investigation and analysis, 18 demand investigation meetings and 58 on-the-spot interviews were held, with more than 120 interviewees. A large number of questionnaires, interview records, meeting minutes and other documents were formed. After summarizing and combing these data, the problems existing in the equipment status management of municipal power supply bureau are summarized, which can be roughly divided into two categories.

1) Business management issues
At present, the vast majority of power supply bureaus lack a perfect organizational structure of condition monitoring, and the post configuration does not fully consider the requirements of condition management, and there is no special person responsible for the equipment condition management business. The corresponding business process, technical standards and operation standards of equipment condition management have not formed a mature system, which is not conducive to the systematic development of condition management.

At present, the data needed for equipment condition evaluation come from production management system, SCADA system, oil chromatogram, neutral point DC, partial discharge and other online monitoring systems. There are too many data sources. It takes a lot of time and energy to obtain these data quickly and accurately, and the condition evaluation personnel simply cannot obtain these data in real time. As a result, the workload of equipment evaluation is very large, and some operation and maintenance personnel even perfunctorily evaluate the equipment status, unable to quickly and
accurately complete the evaluation of equipment status.

At present, although regular equipment condition evaluation has been carried out, the results of equipment condition evaluation are only applied to the preliminary delimitation of power grid risk and the rating of equipment risk, and are not organically integrated with production planning, defect management and other business. On the one hand, the equipment condition evaluation becomes a mere formality; on the other hand, the closed-loop management is not realized, so that the equipment inspection, overhaul and other operation and maintenance work can only be carried out according to a fixed period of time, which can not achieve the goal of operation and maintenance based on the equipment condition.

2) Technical problems of monitoring and diagnosis

In the past, due to the low level of scientific and technological development, there are few or no online monitoring devices installed in the power facilities and equipment. Even if there are monitoring devices, the monitoring quality is not high. Abnormal online monitoring devices often occur, leading to the failure of monitoring function and false alarm. As a result, the monitored equipment can not be timely informed and handled under abnormal conditions, and even lead to equipment failure, shutdown and damage.

Existing equipment condition management, in the case of evaluation results or equipment defects, will carry out preliminary analysis and diagnosis of equipment. However, due to the lack of knowledge base support to diagnose equipment defects, defect analysis often depends on the experience and technical level of operation and maintenance personnel, and does not form the knowledge system of analysis and diagnosis, which affects the efficiency and accuracy of diagnosis.

Lack of effective information system support, resulting in equipment condition assessment and equipment risk analysis using manual processing, time-consuming and labor-consuming. The basic data is not accurate enough, the data is in arrears after the new project and the new replacement equipment, and the data update is not timely, which greatly affects the application of the later state detection decision system.

2.3. Problem solving ideas and measures

In order to solve the above problems, we need to change and upgrade on the existing basis, and solve the problem thoroughly. After detailed demand investigation, business interview, demand analysis and internal discussion, the main measures to solve the problem are summarized as follows:

(1) Integrate resources, unify organizational structure, set up condition monitoring center, allocate multi-level talent team and supporting incentive mechanism of condition maintenance, and assign special personnel to be responsible for equipment condition monitoring.

(2) Optimize the business process, improve the relevant technical standards and operation standards of condition based maintenance.

(3) Actively carry out the research and application of new technology of condition monitoring, increase efforts to promote live test technology, and steadily promote online monitoring technology.

(4) Strengthen the management and analysis of condition monitoring data, realize the centralized monitoring and processing of condition monitoring data.

(5) The decision support system of condition based maintenance is constructed. The system is regarded as the most important support platform of condition based maintenance management system. The equipment condition monitoring, condition early warning, fault diagnosis and auxiliary decision-making are carried out around the system. The system is effectively connected with the production system to realize the implementation of evaluation results and provide a strong guarantee for the effective operation of condition based maintenance management system.

3. Function planning of equipment condition based maintenance decision support system

3.1. Overall business analysis

The decision support system for condition based maintenance of power equipment will obtain various
real-time and non real-time data from SCADA system, online monitoring system, asset management system and other systems to realize the collection and display of equipment status information. According to the evaluation guidelines and diagnosis model of equipment status, the automatic evaluation and diagnosis of equipment status are realized, and the early warning information of equipment abnormal status is sent out; the risk assessment and maintenance suggestions are further obtained, which can be referred by equipment operation Department and management department.

The system is divided into six business subsystems, and the framework is as follows:

3.2. Risk assessment

1) Business description

The dispatching department releases the risk situation of power grid through the monthly report of power grid operation mode, and the equipment operation and maintenance department regularly carries out risk assessment on the equipment according to the risk assessment guidelines and work requirements.

When calculating the grid risk, the professional staff hope to know the condition assessment of the equipment, so as to better formulate countermeasures. The operation and maintenance department needs to understand the risk of the equipment and the importance of the equipment in the current power grid operation when making the equipment operation and maintenance plan. Therefore, the equipment risk from the power grid risk assessment is an important basis for making the equipment operation and maintenance strategy.

It is planned that the dispatching mode professional staff will input the power grid risk into the condition based maintenance decision support system every month as one of the factors of equipment risk assessment. The condition based maintenance staff will comprehensively evaluate the equipment risk according to the asset value of the equipment, the condition based evaluation conclusion and the power grid risk, which will be one of the bases for formulating the equipment maintenance strategy.
2) Data analysis
The data entities involved in risk assessment include control measures, time level, risk level, power grid risk, equipment risk, asset loss degree, equipment assets, control measures list, average failure rate, etc. The relationship between specific data entities is shown in Figure 2.

3) Scene analysis
The application scenarios of risk analysis business are mainly carried out between the two roles of scheduling and laboratory, and the business is relatively simple. The business use case is shown in Figure 3.

Figure 3 Business use cases for risk assessment

4. System functional requirements

4.1. Functional structure diagram
The system obtains the required data from the external business system, solidifies the mature models such as equipment condition evaluation guidelines, condition early warning rules, and equipment fault tree, and gives different prompts for the equipment status based on data analysis, including early warning, evaluation, fault diagnosis, and maintenance strategy:

Figure 4 Functional structure diagram of condition based maintenance decision support system

4.2. Overall function flow
The main function of the system is to obtain and process the basic information of power equipment, real-time / historical data of power equipment and other characteristic parameters reflecting the health
status of the equipment, evaluate the current health status of the equipment, and predict the future development trend. Timely release status warning message for equipment with bad status and trend, and effectively analyze failure mode and cause. Finally, through the analysis of the comprehensive optimization maintenance strategy model, the maintenance decision suggestions are put forward, and the decision suggestions are transmitted to the safety production management system to effectively support the implementation of condition based maintenance.

Figure 5 Data flow diagram of condition based maintenance decision support system

4.3. System boundary
The equipment condition based maintenance decision support system obtains the equipment inspection records, maintenance records, equipment accounts and other information from the production system, and obtains the equipment online monitoring data from the remote diagnosis center. After data analysis, the equipment maintenance operation plan is formed, and then returned to the production management system and asset management system to assist the development of equipment operation and maintenance, overhaul and overhaul technical transformation projects. The system boundary is shown in the figure below.

Figure 6 Boundary of condition based maintenance decision support system

4.4. Data Integration
Data acquisition and processing is mainly to obtain the equipment life cycle data representing the equipment status from the equipment status subject database of the remote monitoring and diagnosis center, mainly including the following data. For the data content and specific format required in this chapter, please refer to the data model specification for equipment condition based maintenance decision support system and Safety Production System v1.0.

- Basic data: equipment account;
- Operation records: inspection records, defect records, test and maintenance records, bad condition data, SCADA data, etc;
- Online monitoring: all kinds of online monitoring data.
Establish the equipment information resource directory system, map the data model based on CIM model in the resource directory system with the data of remote monitoring and diagnosis center platform, and obtain and update the data by timing, triggering, timing or manually.

5. Conclusion
Due to the long cycle and heavy workload, condition evaluation of power equipment has been one of the main factors restricting the comprehensive development of condition based maintenance. The introduction of condition based maintenance decision support system will free the staff from the complicated test data analysis and evaluation work, which will greatly improve the work efficiency and reduce the work cost. The decision support system for condition based maintenance of power equipment based on information system has the advantages of standardized and comprehensive test data, fine and efficient analysis results, objective and accurate equipment evaluation and unified workflow standards, which promotes the deepening of condition based maintenance. The system is mainly based on computer automatic periodic evaluation, supplemented by effective intervention of professional management personnel, introduces expert knowledge base and analysis and diagnosis model, further realizes lean production, comprehensively expands the business of condition based maintenance, and provides a strong support platform for comprehensively deepening equipment condition based maintenance and condition based operation management.

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