Construction and Application of Metal Equipment Supervision Management Information System

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Abstract. Thermal power plant contains a large number of metal equipment. The data of construction, overhaul, maintenance and operation of metal equipment can fully reflect the safety status of the equipment. Aiming at a large number of metal supervision data of thermal power plants in Inner Mongolia, according to the requirements of national and industrial standards, a metal supervision and management information system including various data of metal equipment design, manufacturing, installation, use, inspection, transformation and repair, life assessment and other stages is established to realize the whole life cycle management of supervision equipment in thermal power plants. At the same time, make full use of the big data retrieval function of the system, realize the big data comparison of the same type of equipment or the same type of fault, provide sufficient information for the technical supervision and failure analysis personnel, and further improve the technical supervision and technical service quality.

1. Introduction

The boiler, pressure vessel and pressure pipeline of thermal power plant belong to the equipment which is related to life safety and has great harm. At the same time, the state and industry also put forward strict requirements for the design, manufacture, installation, use, inspection, transformation and repair, and life assessment of boiler, pressure vessel, four major pipelines, turbine metal equipment and generator metal equipment in thermal power plants, and implement the whole process technical supervision and management. Timely finding problems and taking effective technical supervision measures can reduce and avoid the failure of metal monitored parts in the above processes [1].

The metal supervision of power station is an important technical supervision work related to the safe operation of generator set, and it runs through the whole process of installation, production and decommissioning of generator set. During unit installation, product performance and quality inspection before installation and technical supervision during capital construction period are required; after the unit is put into operation, not only technical supervision and special technical supervision are required on a regular basis, but also failure analysis of a large number of equipment and components, periodic inspection of boiler and pressure vessel, comprehensive inspection of four pipelines, inspection of supervised components of steam turbine and generator are required; after the unit equipment is aged, It is often necessary to carry out life assessment according to the accumulated data
during unit operation. For a unit, a large number of equipment information will be generated during the installation and operation stage, a large number of equipment health status information will be generated during the technical supervision process, and a large number of unit and equipment test, maintenance, failure, maintenance and replacement information will be generated during the technical service process.

2. Principle and method of system development

2.1. System development architecture

The system development framework "metal supervision equipment information system of thermal power plant" is developed by B/S mode, and the metal supervision equipment information system of thermal power plant adopts B/S structure, with browser and server separated. At present, Java language with high security, good scalability and the most perfect framework technology is used as the system development language in the server side. Spring framework technology is adopted to enable the system to be developed in layers, with clear logic between layers and interface between layers to realize business and data communication, which makes the system highly scalable. Based on component technology, we strive to encapsulate changes in the components [2]. Corresponding components can provide restful API interface. At the same time, the modular design makes the system easy to expand in both vertical and horizontal directions: on the one hand, it can upgrade the system to a larger and more powerful platform, and on the other hand, it can appropriately increase the scale to enhance the network application of the system. When the function is expanded and modified, the stability of the original structure will not be damaged. Lucene, an independent full-text retrieval system, can provide services for different systems, so it does not need to develop its own full-text retrieval engine for other systems. Browser side adopts the react development of international advanced Facebook [3].

The system uses cloud server for data management, multi task, distributed operation, and CDN for task deployment, fully reflecting the efficiency of cloud services [4]. System advantages: the business system does not conduct real-time data processing, and the back-end service calls batch to process data according to the submission of the business system, so that the user's interactive physical examination during operation is greatly improved, without waiting for the completion of the system operation. Each module of the system is low coupling, and each module exists independently, which greatly reduces the difficulty of using the system, and can use the least steps to complete the business. The system saves multi-dimensional business data, which can be analyzed from multiple dimensions in the future [5].

2.2. Lucene full text search

Lucene full-text retrieval metal supervision equipment will produce a large number of data in different stages of its life cycle, and these data formats are different. If statistics, analysis and retrieval are carried out for these different formats of data, an effective tool is needed to carry out full-text retrieval and analysis for these different formats of rich text. After comparing different platforms and combining with the system requirements of "power plant metal supervision equipment information system", Lucene is selected as the full-text search engine of the platform.

3. Design of metal supervision system

3.1. Structure of metal supervision system

Based on national and industrial standards, supported by equipment technical supervision data, inspection data generated during maintenance, failure analysis data, maintenance and replacement data, and guided by relevant technical supervision standards, supervision and evaluation methods, inspection and analysis methods, maintenance and inspection plans and quality acceptance standards, the "information system of power station metal supervision equipment" comprehensively records the
The process data (including equipment defect records, accident records, inspection records, replacement records, over temperature records, over pressure records, and life assessment based on the wall thickness reduction data) generated in various stages of the life cycle of design, manufacturing, installation, inspection, maintenance, etc., establish a standing book for the health status of the unit equipment, and provide details for the life assessment of the unit equipment after aging. Real and accurate data. The overall function of "information system for metal supervision equipment of power station" is shown in Figure 1.

The main functions of the system are as follows:

Procedure standard. Query, update and void management of national and industrial standards and regulations involved in the scope of technical supervision. According to the actual situation of the metal Institute, the regulations and standards are divided into four categories: thermal power, power grid, new energy and special equipment, which are convenient for technicians to use.

Learning garden. This module is mainly used for technical personnel to exchange and study, and its content is extensive and not limited, such as equipment data, new process, new material, new technology, production experience, etc.

Instruments. This module is used to manage the internal instruments and equipment of the metal Institute, and recommend the use experience for the power plant professionals. It is convenient for technicians to use the equipment and instruments within the validity period of verification during the inspection, avoid using the instruments beyond the validity period, and improve the inspection quality.

Institutional system. At present, the work of metal institute involves many management systems. The inspection of access materials and general component metal shall follow the quality management system of the Institute of electrical science, and shall meet the requirements of CNAs and CMA system, which have different requirements for the implementation of procedures and standards, report format, test block use, etc. The regular inspection of boiler, pressure vessel and other special equipment in thermal power plant follows the comprehensive inspection organization system of the State Administration of quality supervision, which is quite different from the previous system requirements. This module is mainly for internal personnel to learn and master the quality system requirements of different parts testing.
Bulletin board. This module is used to announce some technical supervision, regulations and standards and other domestic and regional equipment failures, regulations and standards updates, technical hot spots and other contents.

Supervision Management. The module is divided into two parts, one is used for the thermal power plant professional upload monthly and quarterly reports. After the professional engineer fills in the report in the system, the system automatically generates the report, and can analyze the data of different months or different power plants in the same month. It is used to manage technical supervision reports, supervision service reports, test reports, etc.

User management. This module is used to manage user rights.

System management. This module is used for the administrator to manage the system, including authority distribution, data management, system maintenance, data dictionary management, etc.

4. Test result of metal supervision system

4.1. Function realization

Data security management function. The user role is divided into supervisor, power plant specialist and system administrator. The data security management adopts the mature Tencent cloud database management platform in China, and adopts the layered module development technology to ensure the data security.

User and device information management function. The system administrator can query users, enter new users, manage roles, manage unit and equipment types and basic information. Different users or roles have different operation permissions. Authority of system administrator: basic information management, organization management, unit management, equipment management, supervision report, query supervision report, upload supervision report, supervision report, query supervision report, upload supervision report, data management, learning garden, rules and standards, management system, user management, role management, announcement management, full-text retrieval. Authority of staff of CET: supervision report, query supervision report, upload supervision report, supervision report, query supervision report, upload supervision report, study garden, rules and standards, management system, full-text search. Power plant professional authority: basic information management, unit management, equipment management, supervision report, query supervision report, upload supervision report, supervision report, query supervision report, upload supervision report, management system, user management, role management, announcement management, full-text search. Basic information management is to manage some basic parameters of the system, including organization management, unit management and equipment management. The information of the unit is related to the organization, and each power plant needs to establish its own unit; the equipment is not related to the organization, but is shared by the whole system.

Business functions. Business functions are mainly divided into supervision report, supervision report, data management, learning garden, procedures and standards, management system, full-text retrieval. Data management is mainly to manage the information of learning area, regulations and standards, and management system. Click enter to search all data in the database. The new data entry module is used to enter new data. The data types are learning garden, procedure standard and management system; the data types are thermal power, new energy, power grid, welding technology, materials, non-destructive testing, physical and chemical testing, CMA, CNAs, special equipment quality system, etc. The supervision report module is to manage all supervision reports of the power plant. The power plant can upload its own supervision report and query its own supervision report. Power plant users or users of Electric Power Research Institute upload the report and enter the database for filing after being approved by the system administrator. Batch upload is supported. Multiple files can be selected for batch upload. If the name of the supervision report is not filled in, the system will automatically add it according to the attachment name. The supervision report can be queried according to the report name, supervision type, report type, company name, supervision unit, supervision equipment and report status. The supervision report module is to manage the metal
supervision report submitted by the power plant every month. The metal specialist of the power plant can upload the supervision report of the plant and query his own supervision report. The supervision report module is not only a simple management of data, but also can analyze equipment over temperature or track and monitor defects through accumulated historical data.

4.2. Retrieval test
Through the retrieval of two documents, the efficiency of Lucene retrieval engine and traditional retrieval method (string matching method) is compared and analyzed. The number of words in the first document (Format: txt) is about 500000. It takes 120 ms for the former and 389 MS for the latter to retrieve the target vocabulary. The traditional retrieval method takes about three times as long as Lucene. When the number of words in the document increases to about 25 million words, the second test document (in the format of txt) is used. The system using Lucene takes about 300ms, while the traditional retrieval method takes nearly 4000ms. Lucene is better than string matching in retrieval. It can be imagined that when the amount of data reaches TB level, the retrieval speed of traditional retrieval method will be unbearable. In fact, Lucene does not specify the format of data source, it provides a general structure to accept the input of index, so the input data source can be database, word document, PDF document, HTML document, as long as the corresponding analysis converter can be designed to construct the data source into document object for index.

Through the above comparative test, Lucene search engine used in the system can meet the retrieval requirements of metal supervision mass data.

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