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# Research on the Application of Information Management System in the Laboratory of Power Generation Enterprises

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**Abstract.** Information management systems have achieved many application results in the management of metrological calibration and chemical testing laboratories facing society, but there are few research and application cases that combine the two information systems. The power generation enterprise is equipped with both a metrological calibration laboratory and a chemical testing laboratory. Huadian Laizhou Power Generation Co., Ltd. and Huadian Electric Power Research Institute Co., Ltd. have jointly developed an information system that can manage both laboratory businesses simultaneously. Starting from practical cases, this article discusses the development feasibility of this information system, its differences from conventional laboratory information systems, and the innovation points implemented in the project from the perspectives of information technology and software function settings.

**Keywords:** Metrological Calibration; Chemical Testing; Information Management System.

## 1. Introduction

The laboratories of thermal power generation enterprises are mainly divided into metrological calibration laboratories and chemical testing laboratories, among which the chemical testing laboratory is mainly divided into water and oil testing laboratories and coal testing laboratories. The metrological calibration laboratory mainly undertakes the calibration of temperature, pressure, and electrical energy meters, while the chemical testing laboratory mainly undertakes the detection of water, oil, and coal in power plants. In grassroots power generation enterprises, laboratories generally use traditional offline and paper-based methods for management and information flow. However, laboratories often face the problem of heavy workload, and laboratory personnel have more part-time jobs, which further increases the workload and often leads to work errors.

Traditional management methods can no longer effectively manage the increasingly complex laboratory business and surrounding services, and information management systems have emerged. The laboratory information management system deals with various types of problems, including non-standard experimental processes, statistical issues with instruments and equipment, quality management supervision issues, and laboratory resource management issues. Multiple issues cross check and balance, jointly promoting the professionalization of laboratory information systems. The management information system is combined with the characteristics of various industries and departments to form a proprietary business system with industry characteristics. [2,3,4]

The laboratory management of thermal power generation enterprises also faces various problems, but few domestic power generation enterprises have established laboratory information management systems. In response to this situation, Huadian Laizhou Power Generation Co., Ltd. and Huadian Electric Power Research Institute Co., Ltd. jointly studied and built an information system for laboratory management of thermal power plants that is suitable for both metrology and chemical testing. After the system was designed and built, it has been running stably in the laboratory for a period of time. This article focuses on the system operation, To discuss the feasibility of applying information technology to simultaneously manage metrology and chemical testing work in thermal power generation enterprises.

## 2. Technical Foundation of Information Systems

Based on the overall direction and construction goals of the power generation enterprise laboratory business, and based on a systematic analysis of the technical route, a multi-layer technical service platform has been determined to modularize the business functions and establish a program technology architecture. Develop programs through a structured and systematic software development approach, ultimately forming a laboratory management system. The technical architecture of the laboratory information system is shown in the following figure:

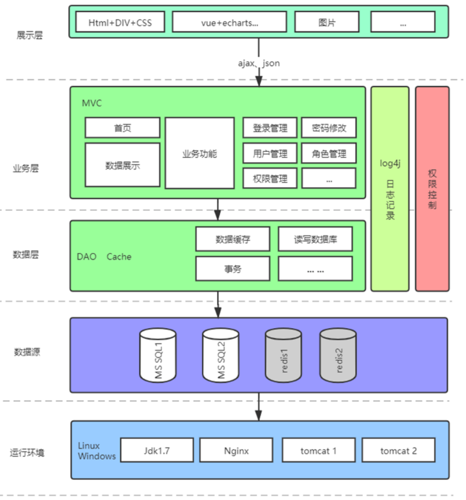


**Figure 1.** System Architecture

### 2.1. Platform Layered Architecture Design

The platform is divided into four layers: display layer, business layer, data layer, and data source.

#### 2.1.1 Display Layer

The platform display layer is a human-computer interaction interface that uses technologies such as HTML, CSS, Vue, etc. to achieve functions such as inputting, outputting, and displaying analysis results of business data. The interface display adopts a multi window approach, and application function access can be processed in parallel, achieving data tables, display of various curve analysis results, and data input and output.

The data analysis interface in the platform uses visual design for curve graph display. In response to the problems of large data volume and different data types in curve analysis processing, such as unfixed numerical ranges and large spans, methods such as data source classification, data table partitioning, and index creation were carried out to optimize and improve program utilization, improve data analysis speed, and improve graphic display effect.

#### 2.1.2 Business Layer

The business layer is the core layer of the platform, which reflects the final results of business data processing and processing in the presentation layer. The business layer is the intermediate link between the display layer and the data layer, managing and controlling the data of each module. The processing speed and method of the business layer directly affect the effectiveness of the platform and the speed of responding to user operation requests.

We have written a project business class library based on business requirements, achieving the business functional requirements of each module. By using a popular WEB framework to manage the class library of each module and the association between each module and the display layer, this technology can achieve good scalability and reduce the coupling strength between the business layer and the display layer.

### 2.1.3 Data layer

The platform data layer is the direct operation layer of data, which implements data operation, integration, and preprocessing. This layer extracts data from multiple data sources for integration. When extracting data from the data source in the data layer, operations such as data cleaning and classification, problem data correction, unified format processing, data association integration, data calculation, etc. are performed first. Then, these data are centrally stored, and the processed data can be directly analyzed and processed in the business layer.

### 2.1.4 Data Sources

According to the classification supported by business scenarios and technology, multiple data storage and computing technologies are used as data sources to ensure the efficiency of data storage, reading, and calculation.

## 2.2. System Topology

Considering the working environment of power plant laboratories, some laboratories cannot or are difficult to deploy PCs or laptops, which requires the system to be compatible with Android or IOS based mobile clients. The system is deployed using a microservices distributed architecture, with interface services such as gateways as load balancing, and the database is deployed synchronously from master to slave. The client uses a browser or app to access the system. This topology structure has high scalability and availability, which can ensure current business applications and face future business changes.

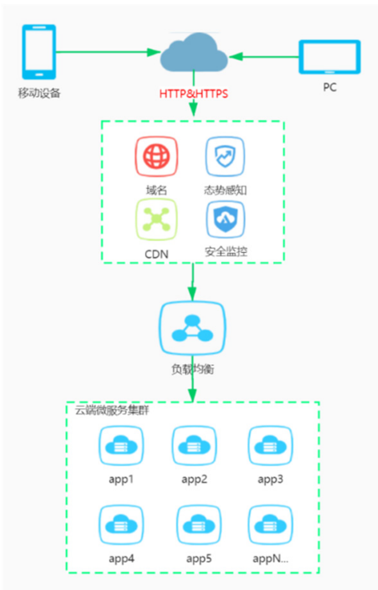


**Figure 2.** System Topology

## 3. Common Modules of Laboratory Information System

In the daily management of measurement laboratories and chemical testing laboratories in power generation enterprises, there is a large amount of overlap in personnel management, equipment management, environmental condition management, sample flow management, and form management. The following introduction and demonstration demonstrate that it is feasible for two different laboratory management systems to share common modules, and it is feasible and convenient for the two laboratory management systems to be managed on the same platform.

## 3.1. Employee Management

The management of laboratory employees mainly includes personnel information ledger, personnel ability authorization, personnel workload statistics, and other aspects. Among them, the personnel information ledger is generally managed uniformly by the personnel department of the power generation enterprise, which can achieve standardization. There are some differences in personnel competency authorization in metrology and testing laboratories, which requires the establishment of two different competency parameter databases. The databases are associated with different metrology and testing process entrances, and personnel with corresponding personnel management permissions are granted parameter authorization in the management system. After obtaining parameter authorization, the personnel can enter the corresponding metrology and testing pages from the management system to work. In personnel workload statistics, measurement personnel generally use the number of samples to represent their workload per unit time, while testing personnel mainly use the number of testing tasks to represent their workload. The testing tasks will be introduced in the report certificate production process. Establish a personnel management module in the laboratory management system, equipped with personnel ledger, which can dynamically manage personnel's testing and calibration capabilities, calculate personnel workload, and allocate tasks.

### 3.2. Electronic Equipment Ledger

The equipment related to power generation enterprises and laboratories is mainly divided into three types: measurement laboratory standards, on-site measurement sensors, and testing laboratory equipment. Through practical exploration, these three types of devices can be placed in a unified management system electronic ledger for management, achieving functions such as reminder of inspection cycle, information query, and equipment usage frequency statistics. The equipment within the entire system is uniquely identified by an S/N code. At the same time, the main technical parameters and measurement calibration information of the device are stored on the corresponding device page. After logging into the system through the mobile terminal, device information can also be easily obtained through scanning codes, querying device codes, and other methods, facilitating work.

### 3.3. Laboratory Business Management

Unlike traditional measurement management KOA systems, there is no sampling link in the laboratory management system of power generation enterprises, and all testing and calibration business initiation is automatically generated by the system. The system will regularly generate a calibration plan for measuring instruments and a water and oil technical supervision plan based on the annual development of the production management department of the power generation enterprise. Therefore, the calibration plan for measuring instruments is generally determined based on the last calibration date and calibration cycle in the electronic ledger of the equipment, which is confirmed by the production management department at the end of the previous year and published in the system. The technical supervision plan for water and oil testing is relatively complex, which requires specifying the unit, sampling location, oil type, water sample type, testing parameters, and testing frequency based on technical supervision guidelines for thermal power generation enterprises and other documents. The system needs to regularly push testing tasks to the corresponding team members based on this schedule, and store the testing data of the team according to this structure for subsequent analysis.

### 3.4. Data Collection

Due to the significant differences in work nature and content between metrological verification and calibration laboratories and chemical testing laboratories, there is a significant difference in the automation and informatization level of equipment. In fact, there is also a significant difference in the informatization level of equipment within the two laboratories. Some devices use a bus data management system that can easily obtain structured data, while others can only collect data manually. This creates significant difficulties for the data collection module of the system. After conducting research and preliminary practice, the management system has set up a total of four data collection forms. According to the degree of convenience, they are database data collection and reading based on network bus, import methods of general data files, handheld device input, and manual PC input.

The database data collection and reading of network bus refers to highly informationized devices that come with standard data interfaces or network interfaces and can automatically transmit data to the server-side database for storage. The laboratory management system analyzes the database format, extracts experimental data, automatically calculates and fills in reports; The import method of universal data files refers to some devices equipped with data output software that can output experimental data in file formats such as TXT and Excel. The laboratory management system pre-sets the data extraction mode, extracts and calculates experimental data results, and fills them in the corresponding record table; Handheld device input refers to some devices that do not have the function of outputting electronic data and can only be manually read. Experimental personnel can log in to the system through handheld electronic devices and collect laboratory data. After receiving the data, the system automatically calculates and fills in reports; Artificial PC input is the most traditional form, where experimental personnel transcribe data on paper, transcribe it on the computer, and the system calculates and fills out reports after obtaining the data.

During the design and development phase of the laboratory management system, it is necessary to fully explore the equipment data interface, collect data as conveniently as possible, avoid the use of inefficient methods, and maximize the efficiency of laboratory work.

### 3.5. Report Certificate Production Process

The system establishes a standardized verification and calibration process, as well as standardized original records and report texts. All verification and calibration certificates generated within the system ensure the standardization of their approval process, personnel qualifications, equipment used, and verification process.

### 3.6. Management of Laboratory Environmental Conditions

Due to different business operations and equipment, each laboratory has different requirements for environmental conditions, mainly temperature and humidity, and a large number of laboratory records require filling in the temperature and humidity at the time of the experiment. To save labor and standardize laboratory management, information systems can use Internet of Things technology to automatically collect, monitor, and fill in laboratory temperature and humidity data in forms. The specific implementation method is as follows: online temperature and humidity meter recording, regularly transmitting laboratory temperature and humidity data to the data server through the network. The data server stores it in the database, and then the data is read by the laboratory platform backend for monitoring. When laboratory staff issue reports online in the system, they fill in the experimental location and time, and the background automatically matches the temperature and humidity data to fill in.

## 4. Comparison of Metrological Calibration and Chemical Testing Laboratory Information Systems

The third chapter of this article mainly discusses the similarities between metrological calibration management and chemical detection management, which is the common part of the combination of the two management systems. This chapter mainly analyzes and discusses the differences between the two management systems, as well as how to combine and place these differences on the same platform for management.

### 4.1. Different Task Initiation Methods

The calibration task of metrology laboratory verification is automatically generated by the equipment ledger based on the equipment verification time and validity period, and pushed to the corresponding personnel. The chemical testing task is generated by the technical supervision plan and requires the integration of data from different units, sampling locations, sample types, and testing parameters to be pushed to the staff for operation. The main difference between the two lies in the basis for initiating tasks and the different data formats of tasks, which require the establishment of different task databases.

### 4.2. Different Correspondence between Samples, Parameters, and Reports

In the measurement management system, the relationship between samples, parameters, and reports is a one-to-one correspondence. In other words, a measurement record corresponds to a standard or parameter used for testing, and the report issued is also the only correspondence. In measurement calibration institutions facing society, there are situations where multifunctional meters are used to detect multiple parameters, which were not encountered in the development process of laboratory management systems in thermal power plants. In the chemical testing management system, there is rarely a one-to-one correspondence between samples, parameters, and reports. Generally, the correspondence is between a single testing task, multiple samples, multiple parameters, and a single report.

This non-uniform correspondence makes it difficult for the two management systems to share the detection process, and at the same time, high restrictions cannot be set on the correspondence.

### 4.3. Different Subsequent Processing Methods for Samples

In the measurement management system, samples need to be returned to the team, and a return process and corresponding record forms need to be set up. In the chemical testing management system, after the completion of sample testing, destruction processing needs to be set up, and the retention and destruction record stages need to be set up.

After analyzing the differences between the two laboratory management systems in practice, the new information system has set up two different sample processes, namely the metrological sample process and the chemical sample process. There are differences in process node settings, but they can interface with the common part introduced in Chapter 3 and achieve data transmission and processing, thereby reducing system complexity and improving stability. At the same time, separating the public and differential parts also facilitates statistical analysis of data.

## 5. Innovation Points and Promotion Value of Laboratory Informatization System

Establishing an information management system within a thermal power generation enterprise to simultaneously manage metrological calibration laboratories and chemical testing laboratories is an unprecedented attempt. Starting from the implementation of actual projects, this article discusses the feasibility and difficulties encountered in the construction of this new information system, and provides ideas and methods to solve these difficulties.

This article is based on the actual situation of laboratory management informatization in thermal power plants. In society, production enterprises similar to thermal power plants are also equipped with metrology laboratories and chemical testing laboratories, which also face the same management difficulties. This information system that integrates two laboratory systems for unified management has the value of promoting to production enterprises. It can solve practical management problems, improve management efficiency, and improve the overall information level of enterprises.

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