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Informatization and intelligentization of safety and environmental management in engineering laboratories of universities--taking Central South University as an example

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Abstract: This paper digs into the contradictory points in the safety and environmental protection of engineering laboratories in colleges and universities, and clarifies that the construction and implementation of an informatized and intelligent laboratory management platform is a necessary way to improve the safety and environmental protection management of laboratories. In addition, it focuses on the specific contents of safety and environmental protection management of engineering laboratories. The informatization and intelligence of the safety education module, such as laboratory monitoring and alarm, safety inspection, control of dangerous sources, full-cycle management of hazardous chemicals and environmental monitoring, should be built with priority.

Key words: engineering laboratory; safety and environmental protection; informatization; intelligentization

1 Introduction

To ensure the safety of laboratories and personal safety of teachers and students is a necessary condition and solid foundation for the construction of "double first-class" universities, and laboratory safety work is an important support for the construction and development of universities. There is a diversified trend of engineering laboratories, and the safety of experiments involves the whole process of managing dangerous chemicals, toxic substances and explosives, as well as laboratory fire safety, electricity safety, safety education and environmental protection. With the increase of social demand for professional talents, modern engineering disciplines in colleges and universities also integrate a variety of cross-disciplines [1][2]. Each discipline experiment has its own characteristics and dangers, so it is difficult to implement unified standard management in the actual operation process, and objective factors such as experimental conditions, experimental projects and experimental environment also increase the difficulty of laboratory management in different degrees.

With the development of modern information means and the Internet of Things, various intelligent management platforms have emerged, and the digital network platform built by them can effectively solve the problems of fragmentation and randomness in the management of projects or programs; at the same time, through data docking and intermediate library association, information silos can be opened to achieve the interconnection of information and

improve the efficiency of work [3]. Laboratory informatization and intelligent management are very important to strengthen laboratory safety management.

2 Deficiencies in the safety and environmental protection management of university laboratories

In recent years, safety accidents in engineering laboratories have occurred frequently in colleges and universities, and laboratory workers have been looking for effective and powerful management ways, while strengthening safety education and increasing safety inspections have become the main means. However, the contradiction of many laboratories and few full-time laboratory managers in engineering-based institutions has led to a lack of obvious results [4][5]. In addition, engineering laboratories in colleges and universities involve many and complex sources of hazards, and the workload in safety and environmental protection is huge and complicated in terms of procurement and access to hazardous chemicals, disposal of waste gas substances, use of high temperature, high pressure and radiation equipment, which requires corresponding experimental operators to have sufficient safety awareness and knowledge and be able to standardize and unify in the specific operation process. At the same time, the laboratory safety management personnel are required to have solid professional knowledge, clearly understand the characteristics of laboratory consumables and instrument safety management of different disciplines so that they can deal with various emergencies in the actual work process. In reality, the universities in China are generally characterized by uneven theoretical levels and insufficient professional knowledge of laboratory operators and managers, as well as a lack of professional management personnel, which undoubtedly increases the difficulty of laboratory safety and environmental management.

3 The necessity of laboratory informatization and intelligent construction

The advent of "Internet+" era has posed a great challenge to the innovation and development of university laboratory management, and also provided an important opportunity for the leapfrog development of laboratory. The Informatization and intelligent platform management can break through the limitation of resources and space distance, so that laboratory management is not restricted by personnel, time and distance. It improves management efficiency, and breaks through the bottleneck of many laboratories and few managers [6][7]. In addition, the application of digitalization and networking makes some management operations more convenient and flexible, and computer artificial intelligence can solve the problem of varying levels of professional knowledge and theory between operators and managers to some extent. It can be said that the construction and implementation of information technology and intelligent laboratory management platform is a necessary way to improve the level of laboratory safety and environmental management. The construction of an information management system that can achieve comprehensive resource management of laboratory personnel, instruments, samples, materials, standards, and environment is very necessary for the overall optimization of laboratory safety and environmental management [8]. It can enhance the efficiency and productivity of the laboratory management, and improve the efficiency and productivity of laboratories.

4 The construction content of informatization and intelligentization in safety and environmental management of engineering laboratories

The urgent need for efficient laboratory management, the development pressure of open and shared laboratories, the effective supervision system of laboratory safety and the effective allocation of laboratory resources all put forward higher requirements for the informationization and intelligence of laboratory management. The development and application of integrated laboratory management system, the interconnection of PC and mobile terminal, and the integrated management and decision making of big data platform are important modules to realize the intelligent management of laboratory informatization [9][10][11]. Among them, the integrated management system is the foundation, which can integrate the

needs of laboratory safety and environmental management in many aspects. For engineering laboratories in Central South University (abbreviated to CSU), the following information technology construction, which is the foundation and the focus of informatization and intelligentization in safety and environmental management, has been built and optimized.

4.1 Intelligent technology of laboratory monitoring and alarm

With the rapid development of high-definition cameras and various sensor functions, the intelligent synchronous monitoring and alarm system based on Wi-Fi communication has gradually been used for laboratory safety monitoring and protection. There are many engineering laboratories in CSU, especially metallurgical laboratories, which often use high temperature and high pressure equipment, and some of them also use flammable or combustible gases such as hydrogen, carbon monoxide and oxygen.

By integrating image acquisition, flammable gas sensors, temperature sensors, flame sensors, etc. into one server, real-time monitoring of the experimental site conditions, as well as the precise detection of flammable gas concentration and ambient temperature can be achieved. Thus it can efficiently prevent key accidents such as fire, explosion, harmful gas and pollutant leakage. Sensors can also be connected to alarms and controllers. In the event of dangerous situation, Wi-Fi communication will be used in a timely manner to achieve some emergency operations, such as remote alarm, power failure and alarm evacuation. This will be our focus of the next safety and environmental construction work. Laboratory monitoring and alarm intelligence can greatly reduce the incidence of accidents and reduce the severity of accidents.

4.2 Informationization of laboratory safety inspection

CSU attaches great importance to laboratory safety and environmental protection. Since 2022, laboratory safety inspection with daily reporting has been carried out across the university. The inspections focused on indicators such as safety facilities, implementation of rules or regulations, environment, organizational system, utilities and personal protection. In the past, teachers and inspectors usually used the original paper inspection method to record, which was prone to omissions and incompleteness, and was not easy to archive query system.

Since last year, the university has built a laboratory inspection system, which can be used to issue inspection tasks through mobile terminals. It can be associated with the display of hazard levels and specific lists of inspected laboratories, remind historical problem records, and record inspections in real time through text and photos. Moreover, it can automatically generate inspection reports. The person responsible for the laboratory can see the inspection and rectification notice on the app or applet, and upload the rectification result in time after eliminating the safety hazards. It effectively standardizes the inspection criteria of laboratory safety, making laboratory safety inspection more targeted and information feedback more quickly.

4.3 Informationization of hazardous sources controlling

The identification and control of hazardous sources is very complex. Manual judgment can cause problems such as inconsistent standard and untimely updating. With the development of information technology, the identification and evaluation of hazardous sources can be realized through the combination of big data comparison and computer artificial intelligence [12][13][14]. CSU has 103 undergraduate majors, each with different laboratory hazardous sources. The university has increased investment in safety and environment protection to build a platform for identifying and controlling hazardous sources, which has procedures for identifying and assessing hazardous source. It mainly includes identification, evaluation, form approval, expert review, and regular risk evaluation. Based on the above, it can output a list of hazardous sources and establish a unified hazardous source file. In addition, it can also establish a basic ledger of hazardous sources by extracting basic information such as room numbers, responsible persons, attributed teams and colleges. The

classification list of hazardous sources is also established according to the types and degrees of danger, so as to realize the classification and control of hazardous sources, and formulate targeted emergency plans.

4.4 Intelligent full life cycle management of hazardous chemicals

The process of procurement, warehousing, use, storage, inventory, transfer and waste disposal of hazardous chemical requires real-time dynamic supervision. It can ensure that the source of procurement is traceable, the process management is standardized and complete, and the disposal is scientific and safe [15]. In the past, we used manual records to manage chemical ledger, which was prone to omissions and incorrect posting, and was not conducive to inventory and allocation. In recent years, CSU has gradually improved the establishment of hazardous chemical management system, which can standardize the procurement channels, ensure that the supplier with sound purchasing qualifications provides the service, and complete the corresponding approval process for controlled reagents in a timely and effective manner. Meanwhile, the electronic management mode is more convenient to record the dynamic ledger accurately in time, simplifying the repetitive works, visualizing the statistical information, and realizing the dynamic management of full life cycle management of hazardous chemicals.

4.5 Informatization of laboratory environmental monitoring

In order to protect the health of teachers and students and the ecological environment, CSU has made more efforts to equip the engineering laboratory with sewage treatment, solid waste disposal and ventilation purification system. The corresponding environmental monitoring system should be implemented in conjunction with it. At present, CSU is still working hard in this aspect. According to the research [16][17][18], informatization of environmental monitoring can realize the summary, sharing and in-depth mining of environmental data information. Big data can help competent department pinpoint pollution sources, and carry out key monitoring and environmental governance in key areas. In addition, it can analyze the time-space change pattern of environmental quality in a specific area, screen the purification system failures in time, and collect a large amount of environmental quality index information about solid, liquid, gas, noise and other polluting environmental factors into artificial intelligence analysis, providing guidance for the development of environmental management plan.

4.6 Multi-dimensional informatization of security education

With more than sixty thousand students enrolled at CSU, the university attaches great importance to the safety and environmental education of students. We regularly or irregularly carry out special training sessions every year, but the stacking of knowledge makes the effect of training limited. Recently, the laboratory safety publicity and education carried out by means of multi-dimensional information technology has obtained good result. At present, the school's environmental safety management system provides information platforms such as community websites and Wechat public accounts. We have also carried out publicity and education on laboratory safety culture, so that the safety values of "safety first" and "people-oriented" can be deeply rooted in students' minds, enhancing the safety awareness and forming a good atmosphere of "everyone talking about safety, everything is safe, thinking about safety all the time, and be safe everywhere". Thus, the safety and stability of the campus can be maintained. The system is set up in the laboratory safety examination system, which is divided into general and professional categories of safety education and testing. It is convenient to evaluate the effect of safety education.

5 Summary and outlook

In recent years, there has been a high incidence of accidents in laboratories of engineering majors in colleges and universities. Laboratory safety and environmental protection have received more and more attention and focus. The state and universities have increased the investment in human, financial and material resources. Colleges and universities have

also carried out different degrees of laboratory information construction according to their own characteristics, which has alleviated some of the relevant conflicts. However, at this stage, most university laboratories still have some problems such as mismatched hardware and software, missing basic modules, poor integration of multiple modules, poor intelligent operation and insufficient interactive experience, and the informationization level of managers also shows an unbalanced state. Nowadays, the state and the ministry of education strongly support the standardized construction of university laboratories. In the context of the new infrastructure construction, the engineering laboratories of CSU break the original management mode and consider rebuilding the laboratory safety and environmental protection management system from the IOT layer, the interconnection layer and the application layer. The informatization and intelligent management of laboratories has been realized to a certain extent. In the next key work, we will continue to improve this work, comprehensively protect teaching and research safety of teachers and students, and build a world-class safe campus.

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Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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