

# Safety Production Management During the Construction and Operation Phases of Thermal Power Enterprises

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**Abstract:** In the energy industry landscape, thermal power generation stands as a critical energy supply method, and the safety of its construction and operation is paramount. Currently, all stages of the life cycle of construction projects have garnered widespread attention. Among these, the infrastructure construction and operation phases of thermal power generation enterprises pose numerous issues worthy of in-depth study in terms of safety production management. This article starts by examining safety production management during these two phases, analyzing characteristics such as management models, legal bases, and responsible entities. It explores the reasons behind these characteristics and elaborates on key management priorities, providing a comprehensive and insightful reference for safety production management in thermal power generation enterprises.

**Keywords:** Thermal power generation enterprises; Infrastructure construction phase; Operation phase; Safety production management

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## 1. Introduction

The life cycle of construction projects encompasses three closely interconnected stages: investment decision-making, construction implementation (i.e., the infrastructure construction phase), and operation and maintenance (i.e., the operation phase) <sup>[1]</sup>. For thermal power generation enterprises, each stage of this cycle plays a crucial role in the company's survival and development. Especially in terms of safety production management, the infrastructure construction and operation phases exhibit distinct characteristics and requirements. In the current context that emphasizes safety production and sustainable enterprise development, conducting in-depth research on safety production management during these two phases in thermal power generation enterprises has significant practical implications for ensuring the safety of employees, maintaining the economic benefits of the enterprise, and guaranteeing the stability of energy supply.

## **2. Characteristics of safety production management in different stages**

### **2.1. Management modes**

In the construction process of modern thermal power generation projects, common management modes include the Design-Bid-Build (DBB) mode and the Engineering-Procurement-Construction (EPC) mode. DBB is a traditional project contracting mode where the construction unit signs separate contracts with the engineering survey and design unit and the construction unit, reflecting specialized division of labor in the engineering field. It is one of the commonly used modes in thermal power generation project construction. Under the EPC mode, the general contracting unit is entrusted by the construction unit to take full responsibility for the entire project, including engineering survey and design, equipment procurement, construction installation, and other tasks. This mode not only involves simple task allocation but also extends to various aspects such as process flow design, project planning, and comprehensive management. Through these two integrated management modes, the efficiency and quality of project construction can be improved to a certain extent, but it also places higher demands on the management capabilities of the general contracting unit.

### **2.2. Legal basis**

In the process of safety production management, the legal basis serves as the cornerstone to ensure the effective implementation of various measures. During the infrastructure construction phase, the main focus is on laws and regulations related to building construction. These laws and regulations provide detailed provisions on safety norms for construction sites, qualification requirements for construction workers, and safety standards for construction equipment. For example, in terms of construction safety norms, they stipulate the setting standards for safety protection facilities on construction sites, such as the use of safety helmets, safety belts, and safety nets, as well as operational norms for hazardous activities like temporary electricity usage and hot work on construction sites. During the operation phase, safety regulations related to production and operation are primarily followed. These regulations emphasize equipment safety, operational norms, and environmental safety during power generation.

### **2.3. Responsible entities**

During the construction of engineering projects, construction enterprises bear direct responsibility for safety production management. This is because they are the direct organizers and implementers of construction sites, with the most direct management and control capabilities over factors like personnel, equipment, and the environment. However, the construction unit also plays an indispensable role in managing these responsibilities. The construction unit needs to fully leverage its role in overall coordination and strictly oversee and control the entire construction process. Regarding safety education and training for personnel, there is a clear division of responsibilities between the infrastructure construction and operation phases. During the infrastructure construction phase, the construction unit is responsible for providing safety education and training to construction workers upon their arrival at the site. The construction unit must conduct comprehensive safety education and training based on the actual conditions of the construction site and the work characteristics of the construction workers. During the operation phase, external personnel, as employees of the production and operation unit, undergo safety education and training led by the production and operation unit. This training includes operation safety for power generation equipment, safety precautions during the production process, and identification and prevention of hazardous factors in the production environment.

## **2.4. Management modes**

The management mode during the infrastructure construction phase revolves around project construction. In terms of construction site management, the construction unit typically establishes a comprehensive set of on-site management systems, including access control, material storage management, and construction machinery parking management. For construction schedule management, the construction unit develops detailed construction schedules and ensures their adherence through regular progress coordination meetings and monitoring of key construction milestones. On the other hand, the management mode during the operation phase emphasizes safety in production and operation. Regarding equipment operation management, the production and operation unit maintains equipment operation records, detailing parameters, maintenance logs, and fault histories for each power generation device. In terms of production operation management, the unit establishes strict operational procedures and provides training and assessments for production operators.

## **3. Analysis of the reasons for safety production management in different stages of thermal power generation enterprises**

### **3.1. From the perspective of project nature**

- (1) Infrastructure construction phase: The main task is to complete the construction of thermal power generation projects, with the focus on transforming various building structures and power generation equipment from design to reality through construction according to design requirements. There are many construction activities on the site, such as earth excavation, concrete pouring, and steel structure installation, which are dangerous. Therefore, safety production management focuses on the safety of personnel, equipment, and the construction environment during the construction process.
- (2) Operation phase: The core is to carry out power generation, with the main work being to convert fuel into electrical energy and transmit it to the power grid. The production process involves complex power generation equipment operation such as boiler combustion, steam turbine rotation, and generator power generation. These equipment operations must be carried out strictly according to operating procedures. Improper operation can easily cause equipment damage, shutdown, and even more severe safety accidents.

### **3.2. From the perspective of personnel composition**

- (1) Infrastructure construction phase: The personnel are mainly construction workers from different construction teams. Their professional skills are concentrated in the field of construction, such as masons, steel workers, and scaffolders. The working environment is mainly the construction site, facing safety risks related to construction. Since the construction unit has a better understanding of their work content and safety requirements, it is more appropriate for the construction unit to provide safety education and training for them.
- (2) Operation phase: It involves internal production operators and external personnel. External personnel enter the enterprise's production site to complete specific production or equipment maintenance tasks, and their work content is closely related to power generation. As the main body of production site management, the production and operation unit are familiar with the production environment and operation process. Therefore, it can better ensure the safety of external personnel during the production process by leading their safety education and training.

### **3.3. Considering management objectives**

- (1) Infrastructure construction phase: The management objective is to ensure that the thermal power generation project is completed on time, with quality and safety. To this end, safety production management focuses on safety control during the construction process, including controlling construction progress, ensuring construction quality, and safeguarding the safety of construction workers. For example, in construction schedule control, it is necessary to reasonably arrange the construction sequence to prevent safety being overlooked due to rushing. In construction quality control, it is necessary to ensure that the building structure and equipment installation meet the design requirements to avoid safety accidents caused by quality problems.
- (2) Operation phase: The management objective is to ensure continuous, stable, and safe power generation. This requires that safety production management focuses on ensuring the long-term stable operation of power generation equipment, ensuring standardized and safe production operations, and timely identifying and addressing potential safety hazards that may arise during the production process.

## **4. Analysis of management priorities**

### **4.1. Supervision and management**

#### **4.1.1. Key points of supervision and management**

During “Infrastructure Construction Phase” with the development and advancement of “Industry 4.0,” the safety production management of thermal power generation enterprises is facing higher requirements <sup>[7]</sup>. To implement the spirit of legal and regulatory documents such as the “Construction Law” and “Safety Production Law,” supervision and management are crucial links in the process of safety production management. During the infrastructure construction phase, the construction unit needs to conduct comprehensive supervision of the safety production work of the construction unit. On one hand, it is necessary to review the safety management system of the construction unit, such as checking whether the construction unit has established a sound safety production responsibility system and whether the safety responsibilities of management personnel and construction workers at all levels have been clarified. On the other hand, on-site supervision and inspection of the construction site should be carried out to check whether the safety protection facilities at the construction site are complete and effective, such as whether the protective railing around the deep foundation pit is secure.

#### **4.1.2. Key points of supervision and management during operation phase**

- (1) Supervision and management of production operations and power generation equipment: During the operation phase, the supervision and management of the production process first need to focus on production operations. By installing monitoring equipment on the production site, real-time monitoring of the operation process of production operators can be achieved, focusing on checking whether they strictly follow the operation procedures and whether there are any violations <sup>[8]</sup>. At the same time, regular verification of production operation records should be conducted to confirm that the operating parameters are within the normal range and that the operation records are complete and accurate. Additionally, attention should be paid to the supervision and inspection of power generation equipment. For example, a sound equipment inspection system should be established, and dedicated personnel should be arranged to conduct regular inspections of power generation equipment, carefully checking the equipment’s operating status. Moreover, real-time monitoring and analysis of the operating data of power generation equipment should be carried out. With the help of data analysis, potential equipment failures can be detected in a timely manner. Based



on the analysis of data such as oil temperature, water temperature, and vibration of the generator set, possible failures can be predicted ahead of time, and corresponding preventive measures can be quickly taken.

- (2) Supervision and management of external contractors' work: During the operation phase, the supervision and management of external contractors' work cannot be ignored. Specifically, it is necessary to strictly review the qualifications of external contractors to ensure that they have the corresponding engineering construction or equipment maintenance qualifications and meet the legal requirements for undertaking related work <sup>[9]</sup>. During their construction or maintenance process, continuous supervision should be conducted to check whether external contractors follow contract agreements and safety regulations, and whether they have equipped and implemented adequate safety measures to ensure the standardized and safe execution of external work.

## **4.2. Basic management**

### **4.2.1. Key points of basic management during infrastructure construction phase**

- (1) Establish a construction safety management system: During the infrastructure construction phase, it is of great significance to establish a sound construction safety management system. Apart from the existing systems, it is necessary to cover key systems such as a safety training system for construction workers. This system should clarify corresponding training content for different types of work, with specific focus areas for each type such as scaffolders and electricians. Simultaneously, the training schedule should be reasonably determined, and the training methods should be standardized to ensure that all construction workers receive comprehensive education. Additionally, a safety risk assessment system should be established to regularly conduct assessments using scientific methods, comprehensively identify potential risks such as those related to deep foundation pit construction, and develop matching measures for various risks, such as preventative measures for falls from heights, to fully ensure infrastructure safety.
- (2) Plan and manage the construction site: In terms of area division and identification settings, reasonable zoning should be carried out according to the construction process and equipment parking requirements. Areas for material storage, mechanical equipment parking, and construction worker rest should be clearly delineated. Materials should be stored in categorized areas with identification signs, and prominent signboards should be set up to facilitate the distinction of functional areas <sup>[10]</sup>. For temporary electricity and water planning, proper planning should be done to ensure safety and reliability, such as setting up dedicated distribution boxes with grounding and leakage protection devices installed according to regulations, reasonably arranging water pipelines, and conducting regular inspections to prevent water leakage and avoid accidents such as electrical short circuits caused by water damage.
- (3) Manage construction worker information and health status: In the management of construction workers, information registration, certificate management, and health check control are key aspects. For information registration and certificate management, detailed collection and proper management of various information such as name, gender, age, type of work, ID number, and contact information of construction workers are required. Concurrently, exclusive work permits should be issued and worn by workers to facilitate orderly personnel management and identification on the construction site. In the health check control aspect, strict checks on the physical health status of construction workers should be conducted. Based on the characteristics and requirements of different types of work, it should be determined whether workers meet the physical conditions for the corresponding construction tasks.

#### 4.2.2. Key points of basic management during operation phase

- (1) Establish safety operation procedures for production and operation: During the operation phase, it is necessary to establish comprehensive and detailed safety operation procedures for production and operation, covering all aspects of power generation. There should be clear regulations on equipment startup, operation, shutdown, equipment switching operations, and operational adjustments under different operating conditions. For the startup operation of generator sets, items that need to be checked before startup, such as lubricating oil level, cooling water level, and fastening of various connecting parts, should be listed in detail. The startup sequence should be clarified, such as which auxiliary equipment to start first and then the main engine, to ensure that operators strictly follow the specifications and guarantee safe production and operation.
- (2) Conduct safety training and emergency drills for production personnel: In the safety production management during the operation phase, the content and objectives of safety training cannot be ignored. Production personnel need to be regularly organized to participate in safety training, covering production safety knowledge such as safety rules and regulations, identification meanings, equipment operation skills, including correct operation and emergency troubleshooting, and safety accident case analysis to help them understand the hazards of violations. Through this systematic training, the level of personnel safety and operation skills can be improved. In terms of emergency drill organization and implementation, various emergency drills involving fire, explosion, power outage, and other unexpected accident handling should be carried out in a planned way.
- (3) Manage power generation equipment and evaluate the production environment: Establishing equipment safety files is of great significance for the management of power generation enterprises during the operation phase. A detailed file should be constructed for each power generation equipment, comprehensively recording various information, including basic information such as model and specifications, installation and debugging, operation and maintenance, and fault repair records. With the help of these files, the equipment operation status can be clearly grasped, providing strong support for subsequent maintenance and repairs. Safety evaluation of the production environment is also indispensable. It is necessary to comprehensively inspect the structural safety of the power generation plant building, checking for hidden dangers such as cracks and deformations.

Due to the different contracting models adopted by engineering projects, the management functions undertaken by the construction unit also vary, and there are certain differences in their safety production responsibilities, as shown in **Table 1** below.

**Table 1.** Differences in safety production responsibilities of construction units

Category	DBB mode	ECP mode
Supervision subject	Construction unit + supervision unit	Construction unit + supervision unit
Coordinating subject	Construction unit	General contractor
Implementation subject	Project owner	General contractor / Construction unit
Safety responsibility	Main responsibilities of construction units and management responsibilities of project owner	Main responsibility of the construction unit, management responsibility of the general contractor, and supervision responsibility of the investors in construction projects

## 5. Conclusion and outlook

Due to various factors, thermal power generation enterprises exhibit different characteristics in terms of safety production during the infrastructure construction and operation phases. The management focus revolves around supervision and basic management. In the future, technological advancements and high demands will coexist. Although the application of new technologies brings new risks such as network security and software failures, it also provides opportunities. Thermal power generation enterprises need to update their concepts, strengthen research and application of new technologies, improve institutional measures, actively respond to challenges, and ensure continuous improvement in safety production.

## Disclosure statement

The author declares no conflict of interest.

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