

Pre-control of Operational Hazards in Thermal Power Plant Centralized Control

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Abstract: Pre-control of operational hazards in thermal power plant centralized control is crucial to ensure the safe and stable operation of thermal power plants. This article first outlines the concept and importance of centralized control operation in thermal power plants, then analyzes in depth the hazards such as equipment failures, human operational errors, and environmental factors. Addressing these hazards, this article proposes pre-control measures at the technical, managerial, and environmental levels, aiming to enhance the safety of centralized control operation in thermal power plants. Through optimizing monitoring systems, strengthening equipment maintenance, improving automation levels, combined with rigorous operational procedures, safety training, emergency response measures, as well as environmental improvements and enhanced environmental monitoring, it is possible to effectively pre-control the hazards in the centralized control operation of thermal power plants, ensuring the safe and stable operation of these plants.

Keywords: Thermal Power Plant; Centralized Control Operation; Hazard; Pre-control

Introduction: With the rapid development of the power industry, centralized control operation in thermal power plants has become an important model of modern power production. However, during centralized control operation, various potential hazards may threaten the safe and stable operation of power plants. To ensure the operational safety of thermal power plants, pre-controlling the hazards in centralized control operation is crucial. This article will conduct an in-depth analysis of the hazards in the centralized control operation of thermal power plants and explore effective pre-control measures. By strengthening preventive measures at the technical, managerial, and environmental levels, the aim is to enhance the safety level of centralized control operation in thermal power plants, providing strong support for the sustainable

development of the power industry.

1. Overview of Centralized Control Operation in Thermal Power Plants

Centralized control operation in thermal power plants, as an important model of modern power production management, aims to achieve centralized monitoring and scheduling of various production processes in power plants through integrated control systems. This approach enhances production efficiency, ensures operational safety, and reduces operational costs. At the core of this operational model is "centralized control," which integrates monitoring and operational functions scattered across different production processes onto a unified platform, enabling information integration and sharing to comprehensively control the overall



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operation of the power plant. Centralized control operation represents a modernized management model in thermal power plant operation. It consolidates control rooms, operator consoles, and other equipment into a control center, where centralized monitoring and scheduling of power generation units, auxiliary equipment, and the entire process flow are achieved through highly automated control systems. This operational mode not only improves the efficiency and safety of thermal power plants but also helps reduce manpower waste and operational costs. The centralized control operation system mainly consists of hardware and software components. The hardware includes control consoles, computers, communication equipment, sensors, etc., for data collection, transmission, and processing. The software comprises real-time monitoring systems, data analysis systems, alarm systems, etc., for comprehensive monitoring and scheduling of the thermal power plant's operational status. In terms of workflow, the centralized control operation system continuously monitors the operational status of various equipment in the thermal power plant through sensors, transmitting the collected data to the control center. The control center analyzes and processes this data using specialized monitoring software to generate intuitive operation screens and control commands. Operators remotely control power generation units, auxiliary equipment, etc., based on the monitoring screens and control commands to ensure the smooth operation of the entire process. Additionally, the system provides early warnings for potential anomalies based on preset alarm thresholds, assisting operators in promptly identifying and addressing issues to prevent accidents. The core of centralized control operation lies in its robust monitoring and control capabilities. In terms of monitoring, the system generates operation screens containing information such as equipment status and process parameters through real-time data collection and processing, providing operators with intuitive operational information. In terms of control, the system automatically generates control signals based on preset control logic and algorithms, as well as the current operational status and input from operators, to remotely control power generation units, auxiliary equipment, etc. Moreover, the centralized control operation system possesses powerful data analysis capabilities. By mining and analyzing historical data,

the system helps operators understand the operational patterns of the thermal power plant, optimize operation strategies, and improve power generation efficiency. Furthermore, based on equipment operational status and maintenance records, the system predicts potential failures, providing data support for preventive maintenance of equipment. In summary, centralized control operation in thermal power plants is a highly automated and integrated operational mode. It comprehensively controls the overall operation of the power plant through centralized control, improving production efficiency, safety, and reducing operational costs. With the advancement of technology and the continuous development of the power industry, centralized control operation will play an even more significant role in the future.

2. Analysis of Hazards in Centralized Control Operation

In the centralized control operation of thermal power plants, due to the high integration and complexity of the system, there are multiple hazards. These hazards can lead to safety accidents, affecting the stable operation of power plants and the safety of personnel. Therefore, conducting an in-depth analysis of the hazards in centralized control operation is an important aspect of ensuring the safe production of power plants.

- (1). **Equipment Failure Hazards:** Equipment failure is a significant hazard in centralized control operation of thermal power plants. Factors such as prolonged operation, insufficient maintenance, or aging of equipment may lead to performance degradation or failure. For example, wear of critical components in power generation units, sensor failures, or valve sticking may affect the accuracy of the control system and even trigger major accidents. Additionally, human operational errors are common hazards, such as misoperations or unauthorized operations, which may result in equipment damage or safety accidents.
- (2). **Human Operational Hazards:** Human factors are also significant hazards in centralized control operation. Non-standard operations and weak safety awareness may lead to misjudgments, misoperations, or overlooking potential dangers by operators. For instance, failure to follow procedures, ignoring alarm signals, or delayed handling of abnormal situations may lead to accidents. Moreover, factors like fatigue or lack

of concentration can contribute to operational errors. (3) Environmental Hazards: The environment in which centralized control operation takes place in thermal power plants is complex, with high temperatures, high pressures, and potential leaks of hazardous substances posing significant risks. High temperatures and pressures may lead to equipment performance degradation and heat-related illnesses among personnel. Meanwhile, leaks of hazardous substances can result in fires, explosions, and other severe consequences. These environmental factors pose serious threats to the safety and stability of centralized control operation and require high attention. In conclusion, hazards in centralized control operation in thermal power plants are diverse, including both internal factors such as equipment failures and human operational errors, and external factors such as environmental hazards. To ensure the safe and stable operation of power plants, it is essential to conduct in-depth analyses of these hazards and implement corresponding pre-control measures. Only by doing so can the safety, reliability, and cost-effectiveness of centralized control operation in thermal power plants be ensured.

3. Measures for Pre-control of Hazards

In the centralized control operation of thermal power plants, effective pre-control measures must be taken to ensure a safe and stable production environment. These measures encompass technical, managerial, and environmental aspects to comprehensively enhance the safety and reliability of centralized control operation in thermal power plants.

3.1 Technical Measures for Pre-control

Technical pre-control is a crucial strategy to ensure the safety of centralized control operation in thermal power plants, involving various technical and managerial measures. (1) Optimization of Monitoring System Functionality: Continuous optimization of the monitoring system is essential to enhance the safety of centralized control operation in thermal power plants. This includes upgrading existing monitoring software and hardware to adapt to the latest technological standards and operational requirements. For instance, introducing higher-performance servers and advanced sensor technology can improve data processing speed and monitoring accuracy. Moreover, refining data collection and processing mechanisms ensures real-time

and accurate transmission of information from field equipment to the control room, enabling operators to make timely and informed decisions. (2) Strengthening Equipment Maintenance and Overhaul: Routine equipment maintenance and regular inspections are crucial for ensuring the safe and stable operation of thermal power plants. Establishing a comprehensive maintenance system with clear maintenance cycles, content, and standards ensures that all critical equipment undergoes systematic checks and maintenance. Through regular preventive inspections, potential issues with equipment can be promptly identified and addressed, preventing minor problems from escalating into major accidents. Additionally, equipment repairs should be conducted by professional technicians to ensure maintenance quality and extend equipment lifespan. (3) Enhancing Equipment Automation Level: With the development of automation and intelligent technology, there is significant potential to improve the automation level of equipment in thermal power plants. Introducing intelligent control systems enables precise control of equipment, reducing uncertainties associated with human operation. For example, employing advanced automatic control algorithms can optimize boiler combustion, enhancing combustion efficiency while reducing harmful gas emissions. Automation technology can also automatically take emergency measures when equipment abnormalities occur, reducing the risk of accidents. In summary, through technical pre-control measures, thermal power plants can enhance operational efficiency while ensuring safety. This requires not only advanced technological support but also strict management and standardized operating procedures to ensure the effective implementation of all technologies and measures.

3.2 Managerial Measures for Pre-control

Managerial pre-control measures are crucial factors in ensuring the safety of centralized control operation in thermal power plants. To improve operational safety, management must implement a series of comprehensive measures, including but not limited to: (1) Establishment of Strict Operating Procedures: Management must establish comprehensive operating procedures that detail standard processes and steps for various operations, as well as safety standards to be followed during operations. These procedures should cover all possible operational scenarios, from daily

monitoring and equipment startup/shutdown to fault handling and emergency responses. Clear procedures ensure that every operator understands how to operate correctly under different circumstances, thereby reducing the risk of operational errors and accidents.

(2) **Enhancement of Operator Safety Training:** In addition to establishing operating procedures, management should provide regular safety training for operators. These training sessions should include theoretical knowledge learning and practical operation exercises to ensure that operators not only understand the procedures but also can proficiently apply them in their work. Additionally, organizing skill competitions and simulation exercises can stimulate operators' learning interests, improve their professional skills, and enhance teamwork capabilities.(3) **Establishment of Emergency Response Mechanisms:** Thermal power plants may encounter various emergencies during operation; therefore, management needs to establish effective emergency response mechanisms. This includes developing detailed emergency plans that outline response strategies and procedures for different types of accidents. Emergency plans should include initial assessment of accidents, emergency evacuation, accident handling, resource allocation, information reporting, and subsequent recovery processes. Conducting regular emergency drills can assess the effectiveness of emergency plans and improve operators' ability to respond to emergencies.(4) **Strengthening Safety Supervision and Inspection:** Management should regularly supervise and inspect the work of operators to ensure that procedures are effectively implemented and to promptly identify and correct unsafe behaviors or potential safety hazards. Additionally, installing monitoring systems and alarm devices enables real-time monitoring of equipment operation status and working environment, allowing immediate action to be taken upon detecting anomalies.(5) **Fostering a Safety Culture:** Management should strive to foster a culture that emphasizes safety within the organization. This can be achieved through disseminating safety knowledge, recognizing safety role models, and encouraging employees to propose safety improvement suggestions. A good safety culture enhances employees' safety awareness, ensuring that they voluntarily comply with safety procedures in their daily work and actively prevent accidents.

Through the implementation of the above measures, management can effectively pre-control risks in thermal power plants, improve the safety of centralized control operation, ensure the safety of personnel and equipment, and contribute to the stable operation and sustainable development of the enterprise.

3.3 Environmental Measures for Pre-control

Environmental pre-control measures play a crucial role in the centralized control operation of thermal power plants. To ensure the safety of operators and improve the efficiency of the entire power generation process, the following are some key measures that can be taken:(1).**Improvement of Working Environment:** Optimizing ventilation systems is an essential step in improving the quality of the working environment. Installing efficient ventilation equipment and regularly maintaining air circulation systems can effectively reduce indoor temperatures, minimize the accumulation of pollutants such as dust and smoke, and provide operators with a healthier and more comfortable workspace.

Conclusion:

After a detailed analysis of the hazards in the centralized control operation of thermal power plants, we recognize the importance and urgency of pre-control measures. At the technical level, we will continuously innovate monitoring systems, strengthen equipment maintenance, and enhance equipment automation levels to ensure efficient and safe system operation. At the managerial level, we will improve operating procedures, enhance employee safety training, increase emergency response capabilities, and ensure the safety and reliability of human operations. Additionally, we will focus on improving environmental factors, strengthen monitoring and management of the operating environment, and create a favorable external environment for the centralized control operation of thermal power plants. Through comprehensive and multi-level pre-control measures, we firmly believe that we can ensure the safe and stable operation of centralized control in thermal power plants and contribute to the sustainable development of the power industry.

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