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Study on the essential management system of the coal mines

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Abstract

Serious accidents occur continuously in China's coal mines in recent years, which have brought about huge economic losses and negative society impact. The signs have emerged before the happening of the coal accidents. The accidents occur mainly because of the management negligence. The essential safety management system is built for coal safety management in China in allusion to the safety management problem of coal mines. The system is composed of six sections, risk management, establishing the management standard and management measure, managing and controlling the human unsafe behaviors, safeguard management, evaluation system and information system.

Keywords: essential safety management system; risk management; closed-loop management

1. Introduction

1.1. The Connotation of coal mine essential safety management system

Suitable for the national condition of China, the coal mine essential safety management system (ESMS) is a sustaining, comprehensive, full process, and closed-loop management system with all staff participation. It takes the research on personnel unsafe behavior as feature. Its basic aim is to reduce serious coal mine accidents through eliminating the occurrence of known coal mine rules, through taking risk pre-control as core and cutting off the coal mine accident causal chain.

Compared with China's traditional coal mine safety management system, the coal mine essential safety management system (ESMS) is more effective, scientific and systematic. By the application of the system, China's coal mine safety situation will be basically improved to achieve international advanced level.

Through the implementation of the coal mine essential safety management system, coal mines can achieve the goal that no one is error, no equipment is broken-down, no system is defective and no management is leaky, and moreover, achieve the essential safety of the staff, machine equipment, environment and management and cut off the coal mine accident causal chain, finally, reach the safety target of eliminating the occurrence of coal mine accidents which are known rule and engender great casualty [1].

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1.2. General requirements of coal mine essential safety management system

In order to establish the coal mine essential safety management system, the coal mine should first select advanced equipment, use reasonable and practicable technology, make out scientific development and layout and carry out economical resource exploitation; Secondly, the personnel whole quality should be improved. Thirdly, each link should be scientific, reasonable and optimized. All these are helpful to construct the coal mine essential safety management system and to improve the reliability of it. The coal mine should also have the management basis of quality standardization based on which to build the essential safety.

① System target

The target of the essential safety management is, through the continuous, comprehensive, full process and closed-loop safety management activities with all staff participation and pre-control as core, to achieve the goal that no one is error, no equipment is broken-down, no system is defective and no management is leaky. Moreover, to achieve the essential safety of the staff, machine equipment, environment and management and to cut off the coal mine accident causal chain, finally to reach the essential safety target of eliminating the occurrence of coal mine accidents which are known rule and engender great casualty. It specifically embodies in four aspects, namely human essential safety, equipment essential safety, environmental essential safety and management essential safety.

② System orientation

The orientation of essential safety management is as follows: it is suitable for the national condition of China; take cutting off the coal mine accident causal chain as its basic aim; take risk pre-control as core; it is based on the identification of hazard sources and essential safety management standards and management measures; comparing with China's traditional coal mine safety management system, it is more effective, scientific, and systematic; it will fundamentally improve the coal mine safety situation of China, and make it achieve international advanced safety management level.

③ System document

The system document includes rules and regulations, management system manual, program file and record. The rules and regulations of essential safety management include target management system of essential safety management, production responsibility system, motivation and restriction system, expert advisor system, inspection and modification system for accident and hidden trouble, supervision and inspection system, mining equipment management system, personnel unsafe behavior management system and safeguard system for essential safety culture building.

The manual of coal mine essential safety management system mainly includes basic knowledge manual of essential safety management, risk management manual, management standards and management measures manual, personnel unsafe behavior control and management manual, safeguard measure manual and safety culture construction manual.

The program files of essential safety management includes working starting program, risk management program, program of establishing management standards and management measures, personnel admittance program, system operating program, safety culture construction and implementation program, internal evaluation program and so on.

According to the requirement, the coal mine should establish and maintain necessary safety record to prove that the safety management meets the requirement of essential safety management system and the actual achievement.

④ System composition

The coal mine essential safety management system is composed of six sections, i.e., risk management, establishment of management standards and management measures for the management object, management and control for the personnel unsafe behaviors, safeguard management, internal auditing system and information system.

2. Risk management of the coal mine essential safety management

Risk management is that through identifying and evaluating the risk in coal mine production and living, and based on these, optimizing and combining various risk management techniques, to control risk effectively in order to arrive at scientific management method which helps to achieve greatest safety with lowest cost. The aim is to achieve safe production of coal mine, to minimize the risk and finally to prevent responsibility accident and reduce non-responsibility accident.

Risk management is the key and also the basis of the coal mine essential safety management, mainly to solve

what to manage in coal mine daily safety management. It includes identification of hazard source, classification of hazard source, and monitoring method determination of hazard source, dynamic evaluation of hazard source and risk pre-control.

2.1. Hazard source identification

The hazard source identification in a coal mine is to identify hazard factors for work activities and tasks in each unit and each system of the coal mine and analyze their way of production and possible effect. It is different from hidden trouble inspection and modification which aims to rectify and eliminate hidden trouble through checking the dangers existed. However the hazard source identification is to visualize all the hazard factors of probably causing and inducing danger for the purpose of controlling them in advance.

The hazard source identification aims to find out and identify the sources of hazard which probably leads to coal mine accident. Coal mines of China are so different from one another that their hazard sources also vary. Therefore, coal mine should synthetically apply the fault tree analysis method, security checklist analysis, questionnaire method, control as standard level method, work mission analysis and other ways to systematically and roundly identify the hazard sources in a particular coal mine according to actual conditions. Whether the identification of the hazard source is comprehensive directly related to the possibility of controlling the coal mine accident. The identification of hazard source includes: personnel unsafe behavior, unsafe state of machinery equipments, unsafe characteristic of environment, and faulty management system and hazard source with leak.

2.2. Hazard source classification

Hazard source classification is to classify the hazard sources that have been identified according to their frequencies and possible losses caused. After identifying, there may be thousands of hazard sources, so, it is not possible and necessary to manage all of them uniformly. However, through the classification of hazard sources, the coal mine can choose countermeasures with particular emphasis so as to successively, and eventually reduce risks.

2.3. Monitoring of hazard source information

For the reason that hazard source, risk and accident are potential, and hazard source, the reason of the happening of risk, is complicated and changeable and also its results are various, the coal mine should monitor them and collect their dynamic information in the production process to judge what aspects will have risk or is drawing near to risk and then to determine what measures to adopt to eliminate and control the potential hazard source for the purpose of preventing the risk.

Hazard sources monitoring is a process of monitoring and checking the hazard sources which human-machine-environment-management are not the same. So some of them need to be monitored continuously, for example, whether gas concentration exceeds the limitation, whether there are rule-breaking behaviors among workers; some of them need to be checking periodically or non-periodically, for example, whether machinery equipments are equipped with well, whether the installations of them are proper. In view of hazard sources characteristics, coal mine should dynamically monitor the hazard source real timely, periodically or non- periodically.

2.4. Dynamic evaluation of hazard source information

Because of the constant change of hazard information, the dynamic evaluation means that to evaluate possible harm of hazard sources according to their information monitored at different time and to judge their risk ranks in order to provide basis for pre-warning.

2.5. Risk pre-warning

Risk pre-warning for hazard sources in a coal mine is an activity of adopting dynamic monitoring to all kinds of hazard sources which have been exposed or latent in the production process of the coal mine, and then giving anticipated evaluation to risk scale and sending out directive of danger pre-warning to make the management team

adopt related measure timely.

3. Management standards and management measures of the coal mine essential safety management

Risk management is to solve the problem of what to manage in coal mine safety management, however, the establishment of management standard and management measure is to solve the problem of how to manage and what degree we manage for hazard sources without accident. Management standard is the degree of management and a size. Management measure is the method of management.

3.1. Goal of establishing standard and measure

The establishment of management standard and management measure for essential safety aims at abstracting management objects based on hazard sources identification and controlling the hazard sources by managing them. Through compiling the relative management standard and management measure of controlling and eliminating hazard sources for management objects, to cut off accident causal chain and make the employees understand how to do every task, consequently, to eliminate and reduce risk or control it within an acceptable range, finally, to prevent the happening of accident.

3.2. Connotation of standards and measures

Management standards in essential safety management are the condition of safety state, the criterion of measuring whether management work is eligible or not and also the minimum requirement. With management standards, relative management measures are also needed to explain how to do to achieve the requirement and to determine each worker's responsibility and authority by appropriate method. To some extent, they are guidelines for personnel safe behavior. Management standards and measures should cover all kinds of hazard sources in coal mine according with the request of essential safety management. And concretely the establishment of standards ought to do well the following work: each one of the known causes of the risks should have the corresponding management standards to eliminate them; as long as employees do dutifully in accordance with the requirements, each management standard can be implemented.

The main contents of management standards and measures include: personnel standards and measures of standardizing operation behavior; measures and standards of guaranteeing equipment good conditions and normal operation; environment measures and standards of guaranteeing environment safe conditions; measures and standards of management system aspect in guaranteeing measures and standards completeness.

3.3. Establishment principles of measure and standard

The establishment of measure and standard in essential safety management should follow these basic principles: the principle of combing with the "up-down" and "bottom-up", the principle of comprehensiveness, maneuverability, applicability, dynamic characteristic and whole-process property, etc.

4. Personnel unsafe behavior management of coal mine essential safety management

Personnel unsafe behavior is also a kind of hazard source. Personnel unsafe behavior management is to manage and control in classification to the identified hazard sources of personnel unsafe behavior according to the generation mechanism and occurrence regularity of it, which includes establishing the relative management ways, control measures, matching evaluation mechanism of personnel admittance and training before going on duty, personnel stimulation, rewards and penalties system and rectification institution for personnel unsafe behavior [2].

4.1. Main contents of control and management for personnel unsafe behavior

Unsafe behavior management of mine should include at least seven aspects: ① establishing the tasks, processes, functions, behavior criterions, rules and regulations for workers; ② identifying unsafe behaviors or behaviors of out

of duty that possibly happen; ③ adopting preventive measures to eliminate or reduce unsafe behaviors or behaviors of out of duty that possibly happen; ④ checking behavior state and working condition of workers in site; ⑤ supervising, guiding and rectifying working behavior in site; ⑥ taking urgent measures to prevent accident happening caused by behavior problems; ⑦ summing up occurrence regularity of unsafe behavior and behaviors of out of duty and constantly improving the level of management.

4.2. Basic ways of controlling and managing for personnel unsafe behavior

Personnel unsafe behavior management of coal mine ought to be systematic and comprehensive. Comprehensive behavior management means that the coal mine should manage and control personnel behavior from all aspects, which includes at least three aspects: control of self- behavior, control of horizontal behavior and control of vertical, namely three basic ways of control.

5. Assistant safeguard management of coal mine essential safety management

For the purpose of guaranteeing effective implementation and operation of the coal mine essential safety management system, the coal mine must establish a set of effective matching measures based on the hazard sources identification, risk pre-warning, management standards and measures to make sure the sustaining implementation of the work for coal mine essential management.

Safeguard management of coal mine essential safety management system includes organization guarantee, system guarantee and culture guarantee.

5.1. Organization guarantee

Because of the complexity and diversity of coal mine production safety management, the governors must pass a certain organizational structure according to certain management methods and job responsibilities to better optimize the allocation of resources and bring the overall organization into full play, thereby, enable management level of coal mine safety improved continuously. Organization guarantee of coal mine essential safety management system requires that the organization setting is sound and the responsibilities are clear to ensure the essential safety management system in normal operation.

5.2. System guarantee

In order to improve standardization, normalization and reutilization of coal mine production safety management and make it evidence based, the relative management system must be established. The system guarantee includes: Improve fund investment and using systems of coal mine safety, and strengthen the supervision mechanism of coal mine essential safety management and staff incentive and restraint mechanisms based on the essential safety management, establish the inspection and improvement for coal mine safety management system.

5.3. Culture guarantee of coal mine essential safety

Culture of coal mine essential safety, taking risk pre-control as core and embodying the spirits of “safety first, prevention first and comprehensive treatment”, is a general name for safety production values, safety production belief, code of conduct of safety production, behavior way and material expressive of safety production, and is also the soul of safety production for enterprise.

① Construction goals

The construction goal of culture for coal mine essential safety is as follows: form the good atmosphere of “I want to be safe, I need to be safe, and I know how to be safe”; form the self-management and self-restraint mechanism of “can’t violate rules, dare not violate rules, and not willing to violate rules”; gradually form complete and safety system for enterprise safety management; construct safety ideology with features of coal mine; through creating a good humanities atmosphere of safety and harmonious relationship between human, machine and environment, form the impact on concept, consciousness, attitude and behavior of human from invisible to visible.

② Construction contents

The construction contents of culture for coal mine essential safety include taking on caring about people, cherishing people, respecting people, treasuring life, improving safety culture quality of personnel as core, adopting the methods of safety propaganda, safety education and safety management, presenting the safety ideas and the safety values in the attitudes and actions of decision makers, managers and personnel and carrying out them in the coal mine management system, fulfilling the safety regulations and systems in the behavior way of makers, managers and personnel, implementing safety standards in technology and process of production, attaching importance to external factors and physical state conditions, such as human behaviors, safety devices, technology and process, production facilities and equipment, tool materials and environment, etc..

③ Construction mode

The construction mode of culture for coal mine essential safety is designed from the aspects of the concept culture of enterprise safety production, management culture, behavior culture and physical state culture.

6. Internal auditing of coal mine essential safety management

The internal auditing is to supervise the operation conditions of management system for coal mine essential safety and evaluate them periodically and a periodically to make sure that management system can reach the requirements of coal mine essential safety. It is also to inspect the operation effect of management system for coal mine essential safety, to evaluate and distinguish whether they achieve the targets of coal mine essential safety management, simultaneously, to find out the existed problem of coal mine essential safety, and then to put forward some improvement suggestions according to the problem. The purposes of them are to continuously improve the management system of coal mine essential safety, to eliminate the accidents caused by factitious factors, the known rules and controllable factors, to gradually reduce the happening of super coal mine accident, and finally to achieve a long-term safety of coal mine [3].

6.1. Auditing flow

In general, internal auditing flow includes: first- phase preparations; identification and analysis of danger and harmful factors; division of evaluation units; field survey of safety; qualitative and quantitative evaluation; putting forward countermeasures, measures and suggestions; drawing conclusions of safety evaluation; compiling report of safety evaluation.

6.2. Auditing contents

The main auditing contents include:

① Whether the coal mine risk pre-control is suitable and available; whether the hazard sources identification is comprehensive; whether the classification and evaluation methods for hazard sources identification are right; whether the information detection of the hazard sources is timely; whether the pre-control measure of the hazard sources is comprehensive; whether the risk pre-warning method of the hazard sources occurrence is correct; whether the pre-warning is prompt; whether the pre-control is proper.

② Whether the organization management system is perfect in coal mine essential safety management which includes: whether the related structural establishment is perfect; whether the stimulation, rewards and penalties mechanism is perfect and sound; whether the management operation system is closed loop; whether the post duty is clear; whether supervision mechanism is perfect and sound; whether the coal mine culture reflects essential safety thoughts; whether the coal mine culture management is proper; whether the coal mine essential safety management supervision is proper.

③ Whether the personnel unsafe behavior management in coal mine essential safety management is accurate and proper which includes, whether the analysis of generation mechanism for the personnel unsafe behavior is reasonable and whether the control management means of the personnel unsafe behavior is reasonable and effective.

④ Whether safety elements of production system in coal mine essential safety management are managed properly; Whether the elements are perfect and sound; whether they can be managed; whether the management measures are scientific and reasonable.

⑤ Whether the coal mine essential safety management assistant parts keep up with including whether coal mine emergency rescue system is perfect; Whether emergency management and accident management are scientific; whether the construction of worker's health guarantee system is perfect; whether the coal mine environment achieves the demand of the coal mine essential safety management.

6.3. Auditing structure

The internal auditing system of coal mine essential safety management is composed of five-level evaluation indexes. It consists of five secondary management plates and twenty-eight third level management systems. The third management systems have more than two hundred fourth level indexes which are suitable for all coal mine system evaluation. During the internal auditing, the coal mine should accord with their actual situations to disassemble the fourth level index and list the fifth level index.

7. Information system constructions for coal mine essential safety management

7.1. Target of system construction

The general targets of information system construction are as follows: according with the established management systems and standards, utilize advanced computer technology, communication technique and automatic control technology to construct the information management system, gathering security, advancement and maturity in integral whole, with the functions of input and identification of hazard sources, classification and gradation of hazard sources, establishment and input of management standards and measures, monitoring, pre-warning and evaluation for hazard sources, input for evaluation indexes, internal evaluation, external auditing and evaluation, monitoring and evaluation for evaluation index, privilege management and basic data management [4].

7.2. System function

① Establish information platform to achieve integrate information and hyalinization for coal enterprise safety management.

② Establish basic data and archives database to provide staff with convenient and fast way to consult and learn hazard sources, management standards, management measures and rules and regulations for safety management, etc.

③ Enable risk pre-control to be timely and accurate. By means of reading real-time monitoring data of underground mine and according with pre-warning algorithm of essential safety system, actualize real-time monitoring and pre-warning for gas, carbon monoxide, temperature of chamber, fan and other hazard sources. After inspector inputs the record, the system will automatically determine the current alarm level and send out pre-warning information, and inform managers of the existing dangers to adopt treatment in time.

④ Achieve high efficiency and convene evaluation. According with the evaluation method of coal mine essential safety management, auditors give scores for the fifth level index, and then the system will automatically calculate the final score of coal mine, which give mine a clear understanding of their present level of safety; the system will also automatically extract the evaluation indexes of all units and departments, and automatically calculate scores of each unit based on the scores gave by appraiser.

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