

Establishing Work Safety Emergency Preparedness System Based on Risk Management

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Abstract:

Emergency preparedness is the elementary component of emergency management, which is involved throughout the whole emergency management process. The fundamental effect of risk management thinking during emergency preparedness and the internal relation of them was discussed based on depth analysis of basic attributes of risk and basic elements of risk management. On the basis of demonstration of risk and emergency preparedness, we analyze the internal relationship between risk and emergency preparedness. The objective consistency and guidance function of risk management to emergency preparedness was then demonstrated, and the basic tasks of four stages of emergency preparedness work, which includes planning, doing, checking and action (PDCA), was raised. The basic “risk-incident-scene-task-capability” procedure of emergency preparedness and universal content including planning, monitoring, early warning, response mechanism, emergency resources and trainings were elaborated in this article.

Risk is the object and foundation for emergency preparedness, to make efforts on work safety emergency preparedness based on risk management will clearly identify goals, core tasks and resource allocation needed for emergency preparedness, and help

enhance pertinence and effectiveness for emergency preparation efforts, significantly improve emergency management capacity for accidents. Thus it is fundamentally important to study work safety emergency preparedness based on risk management, and to clarify basic philosophy, major contents and procedure with regards to reality of work safety emergency management in China.

I. Internal connection between risk management and work safety emergency preparedness

(1) Logical connection between concepts

Generalized definition to term *risk* is affects posed to objects by uncertainties. By this definition, risk can be positive and negative. When it comes to work safety risk, we narrow it down to a combination of likeliness and severity of harm(ISO/IEC Guide51:2014,Safety aspects-Guidelines for their inclusion in standards) . For a company or an institution, there are always multiple work safety risks that cannot be eradicated changing along with differing of other factors. For a specific safety risk, work safety accidents are bound to be caused due to defects in personnel, equipment, technology, environment and management, resulting in casualties and property damage, and though development trend, consequences and effects of accidents can be predicted via technical means, but difference may be posed by the environment, region or the operating mechanism of the enterprise. In addition, safety risk can also be derived, often a security risk could be derived from other risks.

Risk management refers to coordination activities for guiding and controlling organizations with regard to risks. (ISO/IEC Guide51:2014,Safety aspects-Guidelines for their inclusion in standards, MOD) , including procedures such as environmental information identification, risk analysis, risk responding and

inspections (《Code and practice guide for risk management》ISO/DIS 31000)。

Safety risk management means to effectively control and properly mitigate safety risks by undertaking safety risk evaluation, choosing and optimize combination of risk management technologies, in order to prevent accidents。

Emergency preparedness usually takes place before emergent incidents, where improvements in organization, mechanism, equipment, training and evaluations are made in continuous cycles focusing on in order to aid and support prevention, surveillance, responding and recovering for emergent incidents, attempting to reduce and avoid possible fatality and loss of property. Work safety emergency preparedness, on the other hand, is made by governments or employers against possible work safety accidents through planning, efforts, evaluation and improvement, resulting in series of preparation in awareness, organization, mechanism, personnel, equipment, drills and training in order to reduce possible fatality and loss of property resulting from accidents.

(2) Interconnection between concepts

Same object, same foundation. Risks and emergent incidents are both objects for emergency preparedness and risk management. Effective evaluation to risk is a most important step of emergency preparedness, it is also foundation for emergency preparedness and effective emergency responds, directly affects quality of emergency preparedness. Meanwhile, outcomes of risk evaluation could be applied for all the responsible stakeholders to understand their roles in emergency preparedness and the risk they were posed against. Hence identification and evaluation for emergent incident directly affects effectiveness of risk management and emergency preparedness.

Shared principle. Emergency preparedness demands vast historical data accumulation under certain conditions, following scientific approach to analyze and plan, and make changes where conditions of environment and risks vary. Hence Eight Principles, including management of the loss, organizational management process, support the decision-making process, the application of the structured approach to information-based, environmental dependence, broad participation and communication, and continuous improvement, applies also to emergency preparedness. Such as emphasizing environment is the starting point of risk management, determine the target through a identifying environment, to determine the internal and external parameters related to the organization, and set the scope of risk management and guidelines. In the same way, it is also the starting point of the emergency preparedness, and it is clear that the internal and external environment of the emergency liability body can accurately analyze its vulnerability, clarify its objectives and determine the emergency capability required.

Continuity of goals. There is an extension relationship between the risk management and the emergency preparedness. The risk management focuses on taking various measures to eliminate, reduce and transfer risk as much as possible under the principle of "the most reasonable and feasible". Risk prevention forms the first line of defense, and emergency preparedness refers to the adoption of risk response measures, control measures to restore the unidentified potential risk or possible failure, functioning as the second line of defense.

Results affect each other. Because risk management and emergency preparedness form two lines of defense for the risk, the reliability of the risk control measures directly affect the contents of the emergency preparedness. Similarly, due to

the emergency preparedness of the emergency response capability will reduce the loss caused by the emergency incident, it can be said, and viability of emergency preparedness is also one of the important parameters of the risk assessment. As Brian Ward (2000) proposed, "risk = harm* vulnerability / capacity to respond to disasters " formula directly used risk assessment as a risk parameter to the disaster resistance capacity.

II. Main content in establishing work safety emergency preparedness system based on risk management

To establish work safety emergency preparedness system based on risk management is to follow a bottom-line philosophy that “risks shall not be eradicated”. Following the "risk to determine the accident, the accident determines the emergency task, the task determines the emergency capability needs, the ability to determine the core needs of the emergency preparedness" internal logic relationship, from understanding of risk to analyze hazards for emergent respond (emergency preparedness object), combined with vulnerability and emergency response status of the main liability system, and then identify the signs of occurrence, emergency rating, emergency action scale and other key emergency elements. From which, what mechanism to establish, emergency resources allocation, what measures to take incident to deal with shall be determined. A complete emergency preparedness system should include an emergency preparedness target, object, scope, responsible subject, capacity building and basic methods. Work safety emergency preparedness follows both the principles of emergent incident emergency management and the specific attributes of work safety management.

(1) Basic philosophies in work safety emergency preparedness

“Accidents will happen for sure ”.Due to the restriction imposed by level of economic and social development and safety management, there is a possibility where known safety risk prevention and control measures may have sudden failures, coupled with a large number of unknown risk in the field of work safety still exists, we must consider the bottom line when preparing for emergency, that is based on unpredictable and the worst consequences of accidents, that the accident cannot be avoided; But adequate emergency preparedness and quick response and recovery action after the accident can effectively reduce the impact of accidents and loss, thus to ensure that preventive measures are taken for better.

“Adapt to subjective body and environment”. Work safety emergency preparedness is highly relevant to the duty holder, the difference in hierarchy and accountability determines different goal and task for emergency preparedness. Work safety emergency preparedness shall have to adapt to social economic development level and position in the emergency responding of the duty holder. Take Chinese accidents classification standards for example, duty holders for safety administration include provincial, municipal and county level governments. This determines that local governments may have different arrangement for emergency plans, emergency forces and resource allocation. On the other hand, considering the difference can be made by management level and environment to same safety risk, the accident evolution and loss scale may be different, and the emergency capacity needed shall be different too. Thus emergency preparedness must adapt to social environment that safety risks are exposed to.

(2) The object and target of work safety emergency preparedness

Due to the complexity of safety risk, derivativeness and other characteristics, as

well as vulnerability composed by production and business activities in the process, environment, and equipment coupling with management, work safety emergency preparedness not only have to consider the risk assessment results for high probability, accident and its derived risk that may cause other emergent incident, but also have to consider the consequence for extremely high risk, occurrence of low probability of non-routine accidents and its derivative risk that may cause other emergent incident. At the same time, we should also consider the work environment accidents that may arise from the basic social environment in which the emergency liability body is located and the limited level of its cognitive level. The goal of work safety emergency preparedness is to enhance the ability to cope with safety risk and its own risk and reduce vulnerability of the system.

(3) Work safety emergency preparedness planning

Planning is the most important content of work safety emergency preparedness, which is the basis of emergency preparedness, including understanding the environment, determining goals, setting and selecting programs, implementing programs, and assessing effects. Work safety emergency preparedness planning should follow the basic principles of risk management, should also pay attention to several key areas, including adhering to the basic principles of emergency preparedness, as well as the basic experience of the specific accident; must integrate single work safety accidents emergency preparedness plans to cope with multiple accidents; planning cannot cover all possible contingencies associated with future work safety accidents, but it must take full account of conventional work accidents and non-routine hazards; it must address cross-organizational Coordination issues; training must be carried out to test viability, and focus on its effectiveness in

responding accidents.

(4) Work safety emergency preparedness implementation

The main contents of the implementation of work safety emergency preparedness include safety risk analysis, monitoring and forecasting, contingency plans, training exercises, command and decision, medical rescue, coordination and media, etc., in order to minimize the unknown risk, guide. In the process of implementation, it should be based on the main body of emergency liability and the safety risk it faces, the evolving process of the work and the environment it may lead to, and the characteristics of the environment. Regarding China's development level at present, the core of the work safety emergency preparedness should include safety risk assessment, emergency preparedness assessment, emergency preparedness theoretical system construction, major hazard monitoring capabilities, multi-sector coordination and linkage, complex accident handling key technology research, state-of-art equipment and so on.

(5) Assessment of work safety emergency preparedness effect

Assessment of work safety emergency preparedness effect is to undertake assessment for all necessary resource of effective accident responding through training or scenario establishment. Emergency assessment indicators for local governments and employers must cover all the procedures of work safety emergency management, including assessment for preparedness capacity. Yet, the major content and weight function should be adjustable as safety risks and actual circumstances vary. Qualitative analysis should be used for preparedness assessment in local governments, including Grade I indicators such as laws and regulations, emergency agencies, risk assessment, education and training, emergency drills, funding and security;

Qualitative analysis should be combined with quantitative analysis for responding capacity assessment, including Grade I indicators such as Emergency response organizations, emergency response teams, emergency duty, emergency facilities and supplies, emergency information system, monitoring and early warning, emergency response, critical infrastructure and key resource protection, restoration and reconstruction.

III. Steps for establishing work safety emergency preparedness system based on risk management

Work safety emergency preparedness is a systematic approach that follows PDCA cycles, including planning, emergency capacity building, monitoring and assessment, and continuous improvement. Considering fundamental ideas of work safety emergency preparedness, it is determined that emergency preparedness work safety accidents evolution situation for different subjects under certain social environment, and the matching emergency tasks and needs for capacity. Thus it is quite effective and targeted to establish work safety emergency preparedness system following “risk analysis—scenario establishment-task identification -capacity integration” manner.

(1) Safety risk analysis.

Risk analysis should cover safety risks as comprehensively as possible, reduce unknown risk, and identify safety risks that may induce major work safety accidents by the principle of “believable worst situation”. When choosing safety risk assessment technologies, preferably one should take technologies that may quantitatively or qualitatively analyze likeliness and severity of work safety accidents induced by certain risk via scientific approach. Meanwhile, considering emergency nature of

work safety accidents and secondary accidents, It is also important to comprehensively consider importance and vulnerability of system components, enhance safety risk coupling effect analysis in the safety risk assessment process.

(2) Work safety scenario establishment

Scenario establishment is a combination of historical cases and risk simulation of the future for a certain period of time, thus carry out a panoramic description of major work safety accidents may occur. "Scenario" is not the result of the results caused by disaster, carried out a full range of analysis and research through the interrelated safety risk fragment and the disaster process, trying to find the key link to the development of appropriate response strategies. It is needed to consider the level of safety risk, the level of economic and social development, the vulnerability of the duty holder of emergency liability, the mechanism of emergency management and other factors on the possibility and consequences of scenario.

The process of scenario establishment usually includes scenario filtering, evolutionary process construction, consequence estimation, action analysis, scenario description and presentation. When screening scenarios, we should choose scenarios based on following principle: that the duration of the accident is long, the scope of influence is large, the demand for resources is large, and the emergency capability is high. To research evolution and likely causality of accident scenario, it takes case study, computer simulation, expert empirical reasoning. Through which to all probable situations in work safety accident scenario, we shall establish multiple sub-scenarios following order of sign period, development period, abatement period and recovery periods.

As a link between emergency scenario and emergency capability building,

emergency action analysis is both a consequence of scenario and a basis for capacity requirements and improvement. For each scenario, we need to develop appropriate emergency tasks and responding processes, and through the task of each task system size, configuration, work efficiency and other aspects of the development of the corresponding task model, we may identify need of action, who should do it, with what, and what ability is needed to complete the task and so on.

A comprehensive accidents scenario list should include: brief description of the scenario, social environment, meteorological conditions, geographical environment and other factors, early warning monitoring, emergency response and recovery and reconstruction phase of the task list, as well as casualties, facilities and workplace damage, evacuation, economic losses, and cause multiple accidents Possibility, recovery period, possible social impact and public opinion, etc..

(3) Work safety emergency preparedness task identification

Work safety emergency preparedness based on scenario means to clarify mechanism, team, technology, capital, resources needed during sign period, development period, abatement period and recovery period of accident responding based on scenario analysis, demanded standards and emergency level of scenario. A task list shall be established to identify emergency preparedness targets for the stakeholders. The list usually contains safety risk analysis, contingency planning, education and training, emergency assessment and the required system construction, technology support, and financial supports.

Take local governments for example, the list may include accident pre-warning and monitoring during sign period; Survivor searching, resource mobilization, critical facility protection, on-site emergency evacuation etc. during development period;

Media response, local people resettling affairs, etc. during abatement period; and victim management, site assessment, accident impact mitigation etc. during recovery period

(4) Work safety emergency responding capacity integration

Local government and employers have to cope with multiple safety risk hazards that may exist in various circumstances, thus it is essential to optimize and integrate emergency responding capacity. Such integration and optimization can usually be done by setting plans and organizing drills.

Work safety emergency plans can usually be categorized into comprehensive emergency plans, specific emergency plans and site management plans. comprehensive emergency plans integrates universal capacities from aspects of organization and command system, operational mechanism, division of responsibilities and resource allocation; Specific emergency plans integrates emergent responding measures and capacity to certain accidents; Site management plans integrates primary responding capacity for certain type of accidents.

IV. Establish coal mine work safety emergency preparedness in China following the manner of “risk analysis—scenario establishment-task identification -capacity integration”

(1) China coal mine safety risk analysis

97% of Chinese coal mines are underground, their reserve condition for production is complicated. Coal and gas outburst hazards worsen as mining depth increase, different hazards tend to compile; most of small coal mine have less efficient safety condition, simple equipment, low quality of miners and professional skills. Especially the small mines with high tendency of coal and gas outburst, they basically

have no capacity to prevent hazards, newly integrated small mines fail to perform risk analysis, having high accident tendency.

(2) Coal mine safety scenario establishment in China

In recent years, the Chinese government has vigorously promoted the progress of safety science and technology, carried out the construction of coal mine enterprise work safety standardization and investigation and management system of hidden hazards, consolidated the foundation of coal mine safety, promoted the major disaster management and emergency rescue capability, which helped to ensure continuous turning for better in coal mine work safety situation. However, 294 major work safety accidents occurred in China between 2011 to 2016, coal mine took 80 of the total, accounting for 27.2%。 Gas accidents are dominating in coal mine accidents.

(3) Coal mine safety emergency preparedness task identification

Analyze coal mine gas accident evolution characteristics, compare between work safety and emergency management situation in China, coal mine work safety emergency preparedness core elements include safety risk assessment capacity building, monitoring and pre-warning capacity establishment, emergency responding capacity in primary stages and gas accident responding capacity promotion.

(4) Coal mine safety emergency responding capacity integrity

Enhance coal mine safety risk assessment. Promote coal mine employers to shoulder safety responsibility, encourage governments purchase professional service, refine relevant systems, introduce safety risk assessment performed by third- party, implement coal mine major accident risk assessment; Implement assessment analysis to management, technology and craft/material of the mine site according to hazard

situation and hidden risks.

Enhance IT system establishment for surveillance and pre-warning in mines.

Establish integrated management for coal mine production, safety and coordination; Promote upgrading of coal mine safety surveillance systems, realize real-time monitoring and pre-warning for gases.

Enhance emergency responding capacity of coal miners. Improve the rules and regulations and emergency rescue plan. Establish and improve the mine safety hedging system, personnel location monitoring system, emergency communication system; strengthen the emergency knowledge training and training to improve the underground operating personnel self-help and rescue, as well as safety and emergency management and rescue decision-making level.

Enhance emergency responding forces. To explore ways to establish the coal mine rescue team based upon social service bodies and operation management model under market economy, cultivate market-oriented, professional rescue organizations; strengthen national and regional mine rescue team capacity building, strengthen the use of large professional equipment.

Improve technical development for gas-relevant accidents countermeasures.

Undertake evolution mechanism studies for gas-relevant accidents, establish major scenarios for gas accidents in coal mines. Coordinate studies on key technologies including accident relief communication equipment, detection and analyzing equipment, as well as life detection equipment.