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Discussion on Accident Management Based on Foreign Accident Investigation

ZHAO Dianmin[a],*

[a]Sinopec Shengli Petroleum Engineering Co., Ltd., Drilling Technology Research Institute, Dongying, Shandong, China.
*Corresponding author.

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Abstract
This paper summarizes the main characteristics of foreign accident investigation through the in-depth analysis of typical cases of foreign accident investigation. This paper contains the process and methods of accident investigation abroad and the suggestions given in the accident investigation report. Through analyzing the relationship between accident investigation and accident management, this paper is going to give some suggestions for industrial accident management in domestic from the aspect of investigation.

Key words: Accident investigation; Accident investigation methods; Accident management

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1. BASIC CONCEPTS
Accident management is an important work of safety management, including the report, investigation, treatment, analysis and statistics of accidents. Accident investigation is an indispensable part of accident management, which can provide a lot of effective information for accident management and is a strong support to improve the accident management system[1].

The main purpose of accident management in domestic and overseas is:

(1) Through accident investigation and research, we can understand the process and causes of the accident, find out the weak links of safety management, and provide a precaution to prevent similar accidents happen.

(2) Through accident statistical analysis, we can understand the accident law and trend, including accident category, accident area, accident cause, accident consequence, etc., which can provide basis for major decision-making.

(3) Provide the basis for the formulation of relevant laws, regulations and standards。

There is an important difference between modern safety management concept and traditional safety management concept [2-3]. Modern safety management belongs to “preventive type”, rather than the traditional “afterwards type”. The main purpose of accident investigation is to find out the causes of accidents and put forward preventive measures, so as to provide a way for the change of “post event” to “preventive” safety management.

The depth of accident investigation determines the effectiveness of accident management and even the whole safety management. In some countries or international well-known companies with high safety management level, they have made progress through in-depth accident investigation, analysis and summary after experiencing painful accident

lessons. Analyzing some classic accident investigation cases abroad can provide some useful methods or experiences for accident investigation and accident management in domestic.

2. FOREIGN ACCIDENT INVESTIGATION CASES

In recent years, large-scale accidents occur frequently in petrochemical industry at home and abroad, and the typical accidents are as follows：

(1) In March 2005, BP's Texas refinery exploded. The accident is the most serious disaster in the United States in nearly 20 years, resulting in 15 deaths and more than 170 injuries (1).

(2) In December 2005, an explosion occurred at bunsfield oil depot in England, which injured more than 40 people. The surrounding commercial and residential areas were seriously damaged, and a large number of residents were evacuated. The fire caused by the explosion continued to burn for more than 60 hours, with a direct economic loss of 250 million pounds (2).

(3) In April 2010, an explosion and fire occurred on the Deepwater Horizon platform in the Gulf of Mexico, resulting in 11 deaths, 17 injuries, collapse and damage of the drilling platform, massive oil leakage and marine pollution (3).End to july 2015, the compensation has reached more than 14 billion US dollars.

Combined with the above three accidents, the accident investigation abroad is summarized from the following aspects.

2.1 Investigation Process

Texas refinery explosion accident: after the accident, the US chemical safety and Hazard Investigation Bureau (CSB) immediately established an accident investigation team on March 26, and officially entered BP's refinery in Texas on April 1. CSB issued a press release on 17 May 2005, announcing the preliminary results of the accident investigation. Under the strong recommendation of CSB, BP established an independent accident investigation team, which held a public hearing in December 2005 and submitted a formal investigation report.

Bunsfield oil depot accident: in January 2006, the official accident investigation team was established to take full charge of the accident investigation. The accident investigation is carried out simultaneously in multiple ways, covering mechanical engineering, fire and explosion, process engineering, instrumentation and control engineering, environmental impact assessment, etc. The investigation team issued the first stage accident investigation report on February 21, 2006, the second stage accident investigation report on April 11, 2006 and the third stage accident investigation report on May 9, 2006. Subsequently, from 2007 to 2008, the investigation team conducted a number of special investigations and finally released the final accident investigation report on December 11, 2008, which lasted for three years.

Gulf of Mexico oil spill: immediately after the accident, the United States set up an accident investigation team, with members from the U.S. Coast Guard (USCG) and the Marine Energy Administration (boem). The investigation team held seven public hearings from May 2010 to early April 2011, involving emergency response, operational decision-making, government supervision, safety management system, safety culture, etc In 2011, the Department of the interior submitted to the president of the United States an investigation report entitled "deep water: the oil disaster in the Gulf and the future of offshore drilling". In April 2011, the US Coast Guard submitted the final accident investigation report. In May 2014, the US chemical safety and hazards investigation Bureau also issued an investigation report on the fire and explosion accident in the Gulf of Mexico. At the same time, BP oil company also set up an independent accident investigation team to investigate the accident, and released the accident investigation report on September 8, 2010.

2.2 Investigation Methods

Based on the comprehensive analysis of the investigation process of the above three accidents, the following methods are mainly used in the accident investigation：

(1) Accident consequence simulation: restore the accident situation as much as possible through consequence simulation, so as to analyze or verify the cause and development process of the accident with the aid of consequence simulation. This method has the most obvious application effect in the investigation and analysis of the explosion accident of bunsfield oil depot, and finds out the cause of the big explosion shock wave.

(2) Safety barrier analysis: analyze according to the accident process or operation procedure, find out the location, structure, main function, function and failure form of the barrier, identify the hazard factors related to the accident and the protection function to prevent the accident. This method is particularly prominent in the analysis of fire and explosion accidents in Dezhou refinery.

(3) Analysis of accident time series: according to the development process of the accident, the relevant activities during the accident occurrence period are considered, and the causes of the accident are preliminarily analyzed.

(4) Safety management system analysis: find out the main problems in safety management through personnel interviews.

(5) Deviation analysis: find out the relationship or difference between the accident and deviation by analyzing the deviation in the operation of the system, and analyze on this basis.

2.3 Investigation Suggestions and Impact

The fire and explosion accident investigation report of Texas refinery puts forward 10 suggestions on process safety, including process safety leadership, process safety management system, process safety knowledge and professional technology, process safety culture, process safety audit, etc. Through the accident, BP conducted a global re audit of its process safety.

The investigation report of explosion accident in bunsfield oil depot comprehensively gives a series of suggestions from the aspects of land planning, design, operation, regional and plane layout, emergency preparation, analysis and research after the accident, and provides reasonable suggestions to ensure the effective implementation of these suggestions. After the accident, the UK amended the relevant laws on land planning to ensure the effective implementation of the rectification measures from the national legal level

After the Gulf of Mexico oil spill, BP put forward 26 corrective measures for the accident, including drilling contractors, service providers and equipment suppliers, covering design, management, equipment, operation, risk, change and other aspects, and implemented them all over the world. Major global oil organizations such as the international petroleum and Natural Gas Association (OGP) and international drilling contractors (IADC) have given specific suggestions and measures.

2.4 Summary of Foreign Accident Investigation

It can be found from the procedures, methods, implementation and influence scope of accident investigation that the accident investigation abroad has the following characteristics：

(1) The accident investigation is detailed and thorough, and the accident consequence simulation is used to restore the development process of the accident as far as possible, find out the direct and indirect causes of the accident, and dig out the root causes of the accident from the aspects of legal system and management system.

(2) The accident rectification and prevention suggestions are detailed and specific, involving many aspects such as technical problems and management problems, and have strong operability and extensibility.

(3) The accident investigation procedure is transparent, the process is traceable, the accident investigation report is open, and the investigation conclusions and suggestions can be widely learned and used for reference in the industry.

(4) We should pay attention to the theoretical research and experimental research in the process of investigation, and adopt a large number of system theory methods in accident investigation, such as comprehensive application of accident control theory, human factor analysis, risk analysis, reliability theory, etc. through accident investigation, we can further promote the theoretical research.

(5) There is a wide range of accident investigation participants and convenient information collection channels. Grassroots operators, managers and relevant witnesses can submit information to the investigation team through open channels.

3. HOW TO IMPROVE THE LEVEL OF DOMESTIC ACCIDENT MANAGEMENT

The gap between China and foreign countries in accident management is still exist. To improve the level of accident management, we need to start with accident investigation and analyze and uncover the deep reasons. Through the summary of the characteristics of foreign accident investigation, the accident management level should be improved from the following aspects：

(1) Strengthen the knowledge of system theory. At present, most of the safety management theories come from the West. In the past 30 years, China has made more achievements by absorbing and practicing these theories. However, there is still a big gap in the theory of accident management, and the application of system theory is relatively backward. Therefore, we should strengthen the research and application of system theory, popularize relevant system theory knowledge for enterprise personnel, such as accident cause theory, cultivate a group of personnel with knowledge of hazard identification, strengthen accident management and further improve the level of safety management

(2) Pay attention to the application of system theory. There are few theoretical achievements in accident management in China's industrial enterprises, most of which are experiences and practices. Although these experiences and practices do eliminate some unsafe factors and prevent accidents to a certain extent, most of them are just individual cases of enterprises, which do not form a theoretical system and have no universal guiding value. The best practice method with universal guiding significance can be summarized and refined by using system theory method for accident management, so as to promote and avoid single experience preaching.

(3) Trace the root cause of the accident. The purpose of thorough investigation of the root cause of the accident is to find out the most fundamental deep-seated causes of the accident. In this regard, our "four don't let go" requirements

for accident handling already have this kind of formulation. However, the general feeling given by years of practice to the society is that we attach importance to the responsible person's handling and neglect the lessons learned. After the accident happened, mostly is using empirical management, requiring accident notification and requiring the corresponding rectification, but there is no practical rectification measures or program guidance. Thorough investigation of the root causes of the accident is helpful to find out a series reasons of human factors, environmental factors, process factors, management factors and other reasons leading to the accident, and provide the basis for proposing more specific rectification measures.

(4) We should pay attention to the role of risk management. The main purpose of risk management is to find out the weak links of safety production and take measures to strengthen the protection to avoid unexpected events. Many enterprises believe that they can work safely and boldly if they have obtained the safety production qualification. It is unknown that there are many hidden dangers behind the seemingly safe. Without a perfect risk management system, the hidden dangers will cause accidents. Therefore, we should pay full attention to risk management, especially risk analysis, and give full play to the role of risk analysis in accident investigation and accident management.

4. CONCLUSION

The comprehensive use of system theory knowledge, combined with modern computer consequence simulation and risk analysis and other advanced means to carry out accident investigation can improve the industry safety from the aspects of intrinsic safety, design concept, technical means, management measures, etc., and at a higher level, it can improve the laws, regulations and standards, so as to standardize the safety production management more effectively. Good accident investigation can improve accident management and HSE management system, provide reliable major risk base and prevention and control measures for safety production, further reduce the possibility of accidents, and continuously improve safety production performance.

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