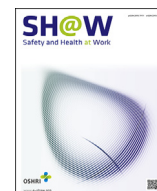




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## Original Article

## The Development of a Risk Management System in the Field of Industrial Safety in the Republic of Kazakhstan

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## ABSTRACT

**Background:** The purpose of the work is to develop a system that allows processing of information for analysis and industrial risk management, to monitor the level of industrial safety and to perform necessary measures aimed at the prevention of accidents, casualties, and development of professional diseases for effective management of industrial safety at hazardous industrial sites.

**Methods:** Risk assessment of accidents and incidents is based on expert evaluations. Based on the lists of criteria parameters and their possible values, provided by the experts, a unified information and analytical database is compiled, which is included in the final interrogation questionnaires. Risk assessment of industrial injuries and occupational diseases is based on statistical methods.

**Results:** The result of the research is the creation of *Guidelines for risk management on hazardous industrial sites of the Republic of Kazakhstan*. The Guidelines determine the directions and methods of complex assessment of the state of industrial safety and labor protection and they could be applied as methodological basis at the development of preventive measures for emergencies, casualties, and incidents at hazardous industrial sites.

**Conclusion:** Implementation of the information-analytical system of risk level assessment allows to analyze the state of risk of a possible accident at industrial sites, make valid management decisions aimed at the prevention of emergencies, and monitor the effectiveness of accident prevention measures.

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## 1. Introduction

Analysis of international practice in the field of industrial safety showed that the issues of hazard monitoring and risk prediction of emergencies of natural, natural–technogenic, and technogenic character have a special significance. The assessment of material and financial reserves necessary for localization and liquidation of emergency consequences depends on the reliability of hazard identification and assessment of territorial risks.

Emergencies in industrial projects have particularly dangerous consequences due to the detrimental impact not only on the staff but also, first and foremost, on the environment, due to oil spills and release of highly toxic substances on land and in water. In this way, in 2010 in the Gulf of Mexico the explosion on the Deepwater Horizon oil platform occurred as a result of oil release. The fire that lasted 36 hours happened after the powerful explosion. As a result,

the platform sank, the number of casualties amounted to 11 people, and 17 were injured to varying degrees. The result was a damaged pipeline, through which oil flowed from the seabed to the platform board. In total, 4.9 million barrels of crude oil spilled into the waters of the Gulf of Mexico over 86 days. BP has made numerous and mostly unsuccessful attempts to repair the leak. Prior to development of this oil deposit, experts in the BP company evaluated the probability of an oil spill as a result of this well drilling as “low.”

The disaster that occurred August 12, 2015 at Tianjin trade port in North China was named the largest non-nuclear emergency in the history of mankind. It is difficult to imagine a worse place for a fire. Reserves of oil and coal, cyanides, and other toxic substances were kept there. A series of new explosions followed after the first one, the power of which was estimated as equivalent to 3 tons of TNT; the largest one was estimated as 21 tons of TNT. As a result of the explosions, at least 145 people were killed and more than 800

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were injured. The cause of the explosions is considered to be a detonation of explosives in one of the containers. The explosion destroyed the hazardous chemicals warehouse. The Chinese authorities found about 700 tons of sodium cyanide in the epicenter of the destruction zone. This chemical, used to extract precious metals from ore, is not flammable, but it is extremely harmful for human health; its impact on the body is comparable to the toxicity of potassium cyanide. The emergency caused an ecological disaster in the area.

The current international normative framework in the field of risk assessment and management contains, as its basis, the general principles and directions, which have an advisory character for use in practice. The principles contained therein give an idea of the selection and application of systematic techniques for risk assessment; however, they do not present specific criteria for determining the need for risk analysis, and do not define the type of risk analysis method necessary for special application [1–7].

The increased technological complexity of accidents, the development and implementation of industrial and international standards, and a steady trend of transition of activities from emergency liquidation to their prevention and risk management were prerequisites for the development of the risk management information system in the field of industrial safety.

Development of measures to prevent emergencies, reduce the risk of accidents, improve safety and working conditions require from enterprises' managers the ability to manage industrial safety, to implement organizational action on the system human being—industrial process with the aim of achieving a safe level of enterprise functioning. In solving industrial safety management issues, a lot of information, expressed by a number of indexes of different nature and structure, is used. It is necessary to use a well-developed system that allows organization and processing of information for analysis and industrial risk management, to monitor the level of industrial safety in order to respond rapidly to changing factors affecting the protectiveness state of hazardous industrial sites, and fulfillment of necessary measures aimed at the prevention of accidents, casualties, and development of professional diseases for effective management of industrial safety on hazardous industrial sites.

Timely planning and implementation of measures to reduce risks and mitigate the consequences of accidents and casualties at hazardous industrial sites is impossible without analysis of statistical data on the casualties, theoretical research of the technological processes' reliability, modeling of risk situations, assessing the risk of casualties. All this is an important part of the measures aimed at improving protection of population and territories from emergencies of technogenic character.

Currently in the Republic of Kazakhstan, increasing attention is paid to the issue of improving control of the safety level at industrial sites of various branches of industry. Modern requirements of the legislation of the Republic of Kazakhstan, harmonization with the international system of labor safety standards, and the development and implementation of regulatory documentation allow to increase the level of industrial safety.

According to the Decree of the President of the Republic of Kazakhstan from February 27, 2014 No. 757 *On cardinal measures to improve conditions for entrepreneurial activity in the Republic of Kazakhstan*, a transition to organizing inspections of industrial enterprises based on risk assessment is necessary.

There is an active effort in the Republic of Kazakhstan in this direction, to create a unified system of risk control in the field of industrial safety.

For many years, our research team has carried out a retrospective analysis of statistical data in the field of industrial safety and professional sickness rate in the Republic of Kazakhstan. The amount of data obtained (statistical data for the last 10 years were

analyzed) allowed us to reliably reveal the number of regularities that formed the basis of the represented methodology, which was reflected in the articles and conference materials devoted to the problems of accidents [8–11], industrial trauma [12–14], and professional sickness rate [15–18].

According to the data of the Emergency Management Committee of the Republic of Kazakhstan, in 2016 in the Republic of Kazakhstan, the share of technogenic emergencies of the total number of emergencies was 88%. Enterprises of the mining and metallurgical complex take the second place after the building industry in terms of the number of traumatized employees. The issues of occupational safety, accident rate, and high level of occupational trauma are especially important for mining industry because about 35% of all registered victims of casualty in the course of labor activity in the country worked in the coal and mining industry. In this regard, despite the need to create a universal methodology for enterprises in various industries, research was focused primarily on the mining industry.

This article summarizes the research carried out and presents the main principles of the methodology for risk management at hazardous industrial sites of the Republic of Kazakhstan. The basis of the methodology is monitoring, allowing to assess the state of accident rate, trauma and professional sickness rate at industrial sites, and to make a motivated and objective conclusion about the degree of hazard and insalubrity of an enterprise.

## 2. Method of assessment of the state of industrial sites safety Q2

Risk assessment of accidents and incidents is based on expert evaluations, the essence of which is an organized collection of opinions and assumptions of experts with the subsequent processing of their answers and compiling of results. The method of expert evaluations is less sensitive to inaccuracies and imprecision of the input data and promotes simultaneously the ability to consider dozens of disparate input parameters. Based on the lists of criteria parameters and their possible values, provided by the experts, a unified information and analytical database is compiled, which is included in the final interrogation questionnaires.

A rating system in the form of universal linguistic scale is used for questionnaire survey and represented in Table 1. The scale allows us to unify both qualitative and quantitative initial data. The experts use their own experience, intellect, and represented scale spread criterial parameters according to degree of their influence on the possibility of accident beginning.

Risk assessment of industrial injuries and occupational diseases is based on statistical methods.

An integrated analysis and assessment of the risk of a possible accident, injury, and labor conditions' insalubrity of an industrial enterprise is performed based on calculation results.

The main objective of the analysis and assessment of hazard levels at the industrial site is to provide:

- objective information about the state of industrial safety and occupational safety;
- information about the most dangerous, "weak" spots from the point of view of industrial safety and labor protection;
- evidence-based recommendations for risk reduction.

A consolidated analytical report, which includes detailed information on the state of industrial safety and labor protection, at separate industrial subdivisions, and at the industrial enterprise as a whole, is formed according to the results of the calculations. Each section of the report contains tables that allow to provide clear and detailed information for the development of risk reducing measures.

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