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Practical Implementation of the Concept of Industrial Safety Culture on the Example of the Largest Mining Enterprises

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Introduction. Currently, there are a number of different concepts for reducing occupational injuries. One of the most important mechanisms for reducing the number of potentially dangerous events and injuries at hazardous production facilities is the formation of an industrial safety culture. However, there are currently no studies devoted to the effectiveness of the use of the occupational safety and health management system.
Problem Statement. The objective of this study is to analyze the state of industrial safety culture based on occupational injury statistics.
Theoretical Part. As the basic information, statistical reports on cases of industrial injuries provided by the Kola Mining and Metallurgical Company Joint Stock Company (JSC Kola MMC), a subsidiary of PJSC "MMC "Norilsk Nickel", were used, on the basis of which an analysis of the state of industrial safety culture was carried out.
Conclusions. The results of a detailed analysis of the effectiveness of creating a favorable environment for the formation of industrial safety culture on the example of the concern PJSC "MMC "Norilsk Nickel", which includes the largest mining enterprise in the region, Kola Mining and Metallurgical Company (JSC Kola MMC), indicate the effectiveness of the measures taken.

Keywords: industrial safety culture, potentially hazardous facility, injury rates, occupational safety.

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Introduction. In Russia, the concept of "safety culture" appeared in 1986 in the course of analyzing the causes and consequences of the accident at the Chernobyl nuclear power plant. The IAEA, following the investigation of a man-made accident at the nuclear power plant, named the lack of safety culture among personnel (hereinafter referred to as SC) as one of the main reasons. In accordance with the requirements of Federal Norms and Rules in the field of atomic energy use "General Provisions for Nuclear Power Plant Safety Assurance" (NP-001-15), approved by Order of the Federal Service for Environmental, Technological and Nuclear Supervision of December 17, 2015 No. 522, safety culture is one of the fundamental principles of safety management, which is determined by a set of "characteristics and

features of the activities of organizations and the behavior of individuals" [1]. Therefore, these characteristics are of high importance and they need to be paid close attention.

Problem Statement. Currently, key safety requirements based on the concept of safety culture for domestic nuclear power plants are most fully formulated and presented in a number of regulatory documents, of which we highlight the most important ones [2]:

– IAEA Safety Requirements No. SF-1 and SSR-2/2 [3, 4];

– IAEA Safety Guides No. GS-G-3.1, NS-G-2.11 [5, 6];

– IAEA Guidelines on Operating Experience at Nuclear Power Plants [7, 8–14];

– WANO NPP Manual on operating experience at NPP GL 2003-01 [15];

– Company standards of Concern Rosenergoatom JSC Company Standard 1.1.1.04.005.0797-2012 and Company Standard 1.1.1.01.002.0646-2012 [16, 17].

A detailed practical presentation of the SC concept for nuclear power plants is given in sources [18, 19]. It should be noted that according to source [20, paragraph 5], the category of hazardous production facilities (HPF) also includes facilities where "mining, mineral processing, as well as underground operations are carried out". Nowadays, society has come to understand that safety culture goes far beyond its use only on the HPF. It is equally important that the safety culture in everyday life is applicable to each individual and to society as a whole. Vorobyov Yu. L. under the safety culture understands such a state of development of a person, a social group, a society that has a stable need to ensure a safe life and work. In addition, at this stage in society there is a need to reduce the level of hazard [21].

Thus, the SC must be formed in the conditions of a certain state of the environment, to achieve which it is necessary to form a personality. This personality must carry certain specific qualities [22]. In order to form the methodological foundations of a safety culture, it is necessary to identify objects and choose methods of influence.

These methods should allow obtaining the necessary qualities and properties [21]. The state and society are at the top stage of the formation of a safety culture. Social and state values and priorities act as the main system-forming factor of ensuring safety. The leading role in the formation of a safety culture in the relevant areas is assumed by the federal executive authorities and the Ministry of Emergency Situations of Russia [22]. The formation of a culture of life safety is usually divided into three levels: individual, corporate and public-state [22].

The individual level of SC is aimed at forming a worldview of safe activity in all spheres of human activity, recognition and acceptance of the priority of one's own safety, which is inextricably linked with the safety of other people and the environment. The individual level should also include:

– formation of patterns of safe behavior based on the development of natural qualities and acquired human abilities aimed at the possibility of effective prevention and protection from potential hazards;

– formation of the ability to create and maintain safe living conditions in everyday life and in professional activity.

The individual level certainly also affects the issues of protection and preservation of the natural environment, understanding the importance of solving environmental problems and the global nature of negative impacts associated with anthropogenic activities.

At the corporate level, the culture of life safety should be one of the highest values of the organization (company) itself. This is achieved by creating a sense of personal responsibility in matters of safety and psychological commitment to the safety of each employee. This requires control by the administration, organization of the process of hazard identification and risk assessment in the workplace, professional selection, training of personnel in each field of activity in the organization that affects the safety of all the staff members [23]. There should be an understanding in the team that the reduction of production risks, incidents and accidents consists of compliance with labor discipline and

clear regulations for safe actions of each employee. Moral and material stimulation of the staff plays an important role in the SC issue.

At the public-state level, the safety culture is implemented through the formation of social consciousness and a certain system of social values (priorities) in the field of life safety aimed at ensuring sustainable development of society. This should be facilitated by: the development of the regulatory legal field; insurance mechanisms for ensuring safety; the development of science and art; public and state incentives; purposeful promotion of safety policy in professional activities, in the social sphere and in everyday life.

In matters of safety culture, propaganda, social advertising and education play an important role, which should be based on the spiritual, moral and patriotic education of a person. The main objective of the study is to evaluate the effectiveness of the occupational safety and health management system, the formation of an industrial safety culture among the employees of PJSC "MMC "Norilsk Nickel".

Theoretical Part. In the process of transforming the corporate safety culture, socially responsible organizations (companies) focus on personnel training in safe techniques and work skills and on reducing occupational injuries. Thus, the leading mining companies have long come to the need for the practical implementation of the safety culture concept in the workplace. Let us have a look at PJSC "MMC "Norilsk Nickel, where the approach to the formation of SC among employees is implemented, and where they strictly observe the rules of industrial safety, actively conduct educational work on labor protection issues and apply innovative solutions. PJSC "MMC "Norilsk Nickel has 17 corporate standards for risk minimization. One of them is the corporate standard for industrial accidents investigation.

The specifics of the ore mining sector is a high degree of mechanization, where a large number of large-sized machines and huge volumes of raw materials are simultaneously moving in the working area of mines, which can cause injuries.

Article 219 of the Labor Code of the Russian Federation states that an employee has the right to refuse to perform work in case of danger to his life and health [24]. The Department of Industrial Safety and Labor Protection of PJSC "MMC "Norilsk Nickel" not only promotes this article of the Labor Code among its staff, but also insists on its application. The practical implementation of the concept of safety culture requires understanding that ensuring safety is not only the control of production risks, but also the introduction of innovative equipment and new organizational and technical measures. For example, in order to optimize the safety of the work area and prevent possible accidents, all mechanized equipment is equipped with video recorders, parking sensors with an "anti-hit" system notifying the driver about people being in the "blind zone".

In order to monitor and record production processes online, video surveillance and electronic gadgets are installed at workplaces. Such innovative solutions make it possible to monitor the compliance with sanitary and hygienic and fire safety standards, industrial safety rules. Video monitoring makes it possible to check the compliance with various protocols and apply administrative methods to influence the situation, and as a result, increase the responsibility of the employee himself and reduce industrial injuries.

At the Zapolyarny Mine of Medvezhy Ruchey LLC, an IT project of a dispatching system has been implemented with the creation of an underground positioning system for personnel and equipment, which is based on the recognition of individual employee tags and micro-cellular communication by personal phone with it.

The SC organizational activities include working with specialists of different levels and profiles, in order to change the attitude, behavior and style of thinking of the employee, the active involvement of each employee. So, in order to conduct mass high-speed testing of the control of knowledge of SC and safety of workers before the start of

each shift, a computerized complex using text questions, interactive video files and 3D-computer models was launched in a test mode at the non-state educational establishment "Norilsk Nickel" Corporate University.

In the future, this will help to improve the interaction between the employees, maintain constant contact between the administration and the employee (monitor and respond to requests, as part of feedback), thereby forming a sustainable safety culture at work. This process takes quite a long period of time and requires active involvement of management at different levels. But it is worth it, since the formed corporate SC leads to an improvement in working conditions in organizations and the achievement of high production efficiency.

The implementation of the safety culture concept should be based on an objective comprehensive and systematic approach due to properly structured and integrated processes of the management system in the field of occupational safety and health protection in the company.

We will analyze the effectiveness of the implementation of the stated SC design at the enterprises of PJSC "MMC "Norilsk Nickel", for which we will consider the change in the number of various types of industrial injuries based on data on industrial injuries published in the company's annual statistical reports. As the main analyzed indicators, we take:

– FIFR (Fatal Injury Frequency Rate) —an indicator of the frequency of fatal accidents at work. It is calculated as the number of deaths per 1 million hours worked;

– LTIFR (Lost Time Injury Frequency Rate) — the total working time lost as a result of injuries. It is calculated as the number of cases of loss of working time (LTI) attributed to the total working time worked in a division or organization (Work Hours — WH) for the reporting year and normalized by 1 million people/hour:

$$\text{LTIFR} = \frac{\text{LTI*1000000 (чел/час)}}{\text{WH}},$$

where LTI — the number of victims of accidents at work with disability for 1 working day or more, including fatal accidents;

WH — the total working time worked in the department or in the organization for the reporting year in hours;

– Total number of accidents related to production;

– Number of microtraumas;

– Number of potentially dangerous incidents (the number of recorded violations of labor protection and industrial safety standards).

As the statistical reporting in the field of occupational injuries of the All-Russian monitoring of the social and labor sphere shows, since 2000 there has been a positive trend, which does not fully reflect the real picture in the field of occupational safety for workers of industrial facilities (Table 1) [26].

Table 1

Key injury indicators for PJSC "MMC "Norilsk Nickel" for 2016-2020

Indicator	2016	2017	2018	2019	2020
FIFR (since 2013)	0.11	0.08	0.05	0.09	0.08
LTIFR (since 2013)	0.35	0.44	0.23	0.32	0.29
Total number of insured accidents	56	61	32	44	30
Number of fatal insured accidents	13	9	6	9	8
Number of microtraumas	611	719	842	873	791
Number of potentially dangerous incidents	1976	1845	2139	2074	1963

The analysis of data on occupational injuries of PJSC "MMC "Norilsk Nickel" for the period shows that the percentage of fatal accidents at PJSC "MMC "Norilsk Nickel" varies from 14.8% to 26.7% of the total number of insured accidents.

It should be noted that over the period from 2016 to 2020, there has been a sharp increase in the number of microtraumas (since March 2022, mandatory accounting according to Article 226 of the Labor Code of the Russian Federation, Chapter 36.1, Section X) and potentially dangerous incidents. The increase in the values of the indicators "Number of microtraumas" and "Number of potentially dangerous accidents" is due to the fact that a new corporate standard for the organization of the investigation of all accidents at work has been introduced in the organization [24]. In this situation, explanatory work among employees played an important role, which allowed the staff to form an understanding of the importance of timely informing the administration about potentially dangerous incidents and microtraumas. The new approach of active safety management based on the SC principles has allowed reducing the number of cases with more severe consequences.

Figure 1 shows the histograms of the production safety index for PJSC "MMC "Norilsk Nickel", where the production safety index is the ratio of the number of the identified inconsistencies to the time spent by the audit team to conduct the audit.

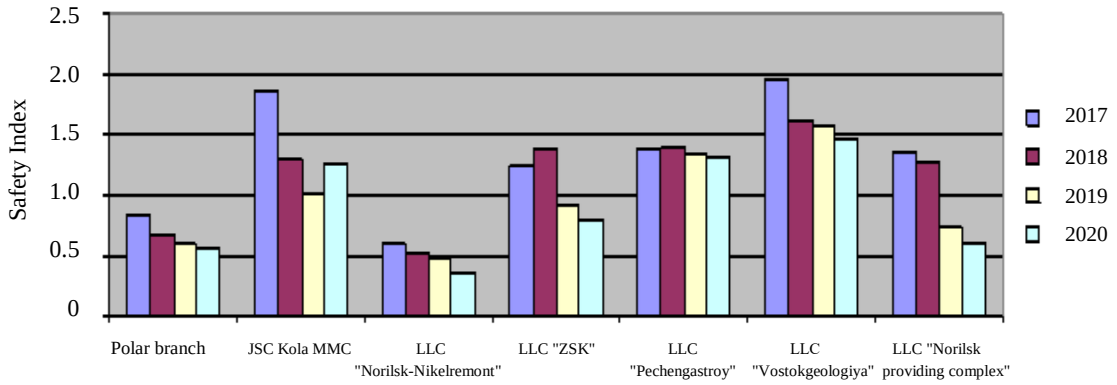

Fig. 1. Annual dynamics of the production safety index on the example of industrial enterprises of PJSC "MMC "Norilsk Nickel"

The presented data allow us to conclude that the majority of branches (the Polar branch, JSC Kola MMC, LLC "Norilsk providing complex", LLC "Vostokgeologiya", LLC "ZSK", LLC "Norilsk-Nikelremont") clearly demonstrate a clear decrease in the level of the production safety index over a four-year period of the analysis from 2017 to 2020, which allows us to talk about the effectiveness of the declared SC concept.

Due to the adoption of targeted programs to reduce production risks and the introduction of corporate standards, it became possible to revise the risk management system of an industrial enterprise itself, increase the SC level and reduce occupational injury rates in 2020. One of the goals of risk management is the compliance with modern international standards in the field of industrial safety, labor protection and the environmental protection.

At the same time, many mining enterprises of the North-Western region of the Russian Federation in the Murmansk region (JSC "Olkon", JSC "Kovdorsky GOK", etc.) still practice a compensation policy within the framework of the occupational safety management system, focused mostly on compensation for damage from accidents. Obviously, such an approach cannot eliminate the systemic causes of accidents of varying severity in the workplace and does not reduce the level of occupational injuries.

The result of the comparative analysis allows us to conclude that the goals, principles and methods of organizing a system for monitoring working conditions and the compliance with regulatory documents in the field of occupational safety in Russia do not correspond to the goals, objectives and functions of the occupational risk management system of employees. The dynamics of changes in injury rates at the micro level is not consistent with changes in the dynamics of labor safety indicators at the macro level. Consequently, it can be concluded that there is

insufficient formation of a safety culture at the enterprises of the mining complex of the region. The data provided annually by the specialists of the statistical service of the EU "Eurostat" also indicate the demand for the formation of SC, which allows you to really reduce the level of occupational injuries. For example, in 2012-2017, a decrease in occupational injuries to 25–30% was found in the EU countries [26]. The purpose of the SC formation is to change the general style of behavior and the formation of a certain environment that will reduce production risks and occupational injuries. The formation of a safety culture at the HPF provides for the improvement of the organization's activities in the field of occupational safety, the development of a comprehensive system of training, analysis and control over the state of industrial safety.

When forming a SC, measures to determine the procedure for accessing information about the levels of potential production risks in the organization (company) should be the first priority. The information must be reliable, up-to-date, scientifically based, taking into account the impact of industrial risks on human health and possible damage to it, as well as collateral damage to the environment.

Conclusions. As part of the modern industrial safety strategy, the administration of PJSC "MMC "Norilsk Nickel" has created an effective occupational safety and health management system in accordance with GOST R 55271-2012 [27], focused on safety culture and occupational risk management [28]. However, it should be noted that despite the growth of the safety culture [25], the concept of "zero" fatal injuries by the end of 2020 has not been implemented. Therefore, the management of the enterprise in the field of labor protection needs to learn how to analyze the available statistical information about the causes of accidents not only at the enterprises that are part of PJSC "MMC "Norilsk Nickel", but also at other enterprises of the mining and metallurgical complex.

Despite a well-organized system of internal audit of the state of the occupational safety and industrial safety system, attention should be paid to the quality and timeliness of the reports being prepared, as well as to conduct a risk assessment at the most traumatic workplaces, while it is worth considering all causes of injuries in the context of the general level of safety culture.

When making managerial decisions, it is necessary not only to make timely adjustments to the labor protection policy, but also to determine the means and methods for preventing and eliminating the causes of occupational injuries, as well as to carry out work on the prevention of accidents and occupational diseases [29].

Thus, when making management decisions, the administration of the enterprise must demonstrate its interest in both occupational safety and industrial safety.

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