Ensuring safety of labor on the basis of the method “Curve of Badles”

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Abstract. The analysis of the safety management method - the Bradley Curve method, as one of the effective tools in improving safety culture in the engineering industry, was carried out. The stages of the “Bradley's Curve” method are considered: natural instincts, supervision, one’s own consciousness and one team. A study was conducted to assess the effectiveness of the implementation of the “Curve Bradley” method. The level of safety culture at the enterprises of the engineering industry has been determined. It has been confirmed that microtraumas are used as indicators (predecessors) when identifying sources of occupational risks. Substantiated the consideration of microtraumas to improve efficiency in the fight against injuries.

1. Introduction
For the first time, the notion of a safety culture arose from the analysis of accidents in the nuclear power industry. At the same time, a serious reason for revising the approach to safety issues was the accident at the Chernobyl nuclear power plant. It became obvious that the standard mechanical execution of instructions to ensure safe operation is not enough. It is also necessary to take into account such parameters as the psychology of people, an understanding of their own actions and their consequences, as well as the degree of interest and involvement of employees.

The International Atomic Energy Agency proposed the first principles of safety culture in 1991 in the form of an INSAG-4 report. Later, it began to introduce and adapt the world’s largest companies to their production activities [1].

In scientific circles, the development of a safety culture began to be actively discussed at the end of the last century. Per Holmgren, author of the article “Developing a Security Culture - The Endless Process” [2] pointed out that to achieve a high level of security in the organization must be the continuous development of a safety culture. At the present stage of development of industry, the topic under study has become extremely relevant. Recently, issues of safety culture have become one of the main issues in the management of occupational safety in organizations, as well as improving the quality and production efficiency.

Recently, safety culture issues considered by many authors in their works. The work [3] states that the fundamental basis for ensuring security is the formation, maintenance and development of a safety culture. It is also noted that, according to world experience, an interrelation has been established between the commitment of workers to follow the requirements of occupational safety and accidents at work. Therefore, ensuring a high level of security depends on the behavior of all employees in the organization.
Along with this, in work [4] it is noted that a mature safety culture is considered as an important means of ensuring safety. Research results confirmed that there is a low incidence in organizations with a high level of safety culture maturity. At the same time, conducted the study [5] showed that the formation and improvement of safety culture, it is necessary to take into account the interaction of national values and the level of security commitment of both the managers and employees.

To date, among the popular methods for determining the maturity of a safety culture are the following: the method of «Curve Bradley», maturity model of safety culture M. Fleming and the model of P. Hudson [6]. As part of this work, the Bradley Curve method was chosen to manage occupational safety. Its feature is a visual representation of the relationship of the level of safety culture with the level of labor protection, employee involvement, their interdependence and mutual support [7]. Its advantages include simplicity, availability, and the use of both negative and favorable effects. This method has a simple diagram showing the main relationship between injury level and productivity, for which safety management measures can be developed.

The aim of the study is to analyze the “Bradley Curve” method and justify the effectiveness of the implementation of this method for the further development and improvement of the occupational safety program in the engineering industry.

2. Research materials
Ensuring safe labor is one of the basic conditions for the successful functioning and development of an enterprise. Team work organization allows to eliminate and identify hazards in a timely manner. This helps to prevent accidents at work. In this regard, we consider the system - the concept of "zero injuries". This is a new approach to reduce injuries and occupational diseases. It combines three areas - safety, occupational health and well-being of workers and their families at all levels of production [8].

Over the last decade, there have been significant changes in the provision of industrial safety and labor protection at the enterprises of Russia and CIS countries. Evolution has affected not only the safety management systems. First of all, the attitude of managers towards safety issues has changed.

Currently, there are two fundamental principles used to ensure occupational safety in organizations [7]. This is prophylaxis, prevention and minimization of consequences. The first principle is essential for real security. Consequently, the first step is the organization and implementation of preventive measures and the implementation of prevention of industrial injuries and occupational morbidity. For the practical implementation of the principle of "Prophylaxis, prevention" will effectively apply the method of labor safety management - the model of "Curve Bradley". With its help, it is possible to assess the existing level of safety culture and take measures for its further development.

As part of this work, the authors conducted an analysis method of safety management - the method of «Curve Bradley». The analysis shows that the more common efforts are spent on ensuring safe working conditions and personnel training, the less the likelihood of accidents. If the staff takes care of their safety under not only the influence of natural instincts, supervision of the leadership, but also shows personal activity, teamwork skills, the level of occupational safety is greatly increased [7].

The experience of implementing the “Bradley Curve” method has shown that the system efforts of managers to build a progressive safety culture will lead to tangible sustainable results:

1. Formation of a safe working environment conducive to unlocking the potential of staff;
2. Reducing the number of errors in the workplace;
3. Safety and extension of equipment operation time [7].

Consider the Bradley Curve diagram (Figure 1). The evolution of safety culture is divided into four stages [7]. According to the level of maturity of the organization, these stages are characterized as follows:

1. Reactive - There is no safety management. Highest injury rate and lowest performance. People themselves decide how to act based on their personal experience;
2. Dependent - Management in the form of supervision. There is a decrease the level of injury;
3. Independent - The safe behavior of people is determined by their own consciousness, learning.
4. Interdependent - Teamwork organization. Based on common goals and values, caring for other team members.

It is with this approach that the level of injury is the lowest and tends to zero with a simultaneous increase in productivity.

These stages make it possible to understand which methods for managing occupational safety will work in the organization and see the next stage, in the direction of which work should be done and the necessary measures should be developed.

Modern studies show that in order to remedy the current situation, it is necessary to carefully identify microtraumas. They may be due to the psychophysiological state of the worker, his qualifications, the state of the main elements of technological lines in general and specific types of equipment in particular, and others.

Consequently, the mastery of staff skills in team work organization will prevent not only injuries, but also microtraumas at the work execution stage.

3. Results and its discussion

To assess the effectiveness of the implementation of the “Curve Bradley” method, the authors conducted a study to study the existing safety culture at the enterprises of the engineering industry. Along with this, to assess the level of micro-injuries among workers, the authors conducted a survey.

Hazardous situations at work can lead to microtraumas, accidents, and death. This pattern is reflected in the pyramid of G. Heinrich [9]. Consequently, if the organization remains without attention to violations of labor protection requirements, then this will necessarily lead to emergency situations.

The study conducted by the authors yielded the following results: in the studied workshops of machine-building production, according to the results of processing the questionnaires, about 750 microtraumas were recorded. At the moment there is no mechanism for registering microtraumas at the legislative level and their registration is not obligatory. The study shows that in the engineering industry this is an important element for reducing injuries.

Cases of receiving various kinds of microtraumas workplace re shown in Figure 2, their causes and type of damage are presented in Figure 3.
Consequently, microtraumas are a harbinger of disability injuries. The results of the study confirmed that the level of labor safety in organizations is at the second stage - “Dependent”. This is due to the fact that in organizations safety management is carried out in the form of control and supervision over the implementation of labor protection requirements. The main type for the motivation of the requirements is the promotion and punishment. Employees are periodically trained in labor protection. Therefore, in order to achieve “zero injuries”, it is necessary to pay special attention to the prevention of microtraumas both at the individual and personal and organizational (team) stages. This is necessary in order to reduce injuries and further increase the level of safety culture.

In order to develop a safety culture, the safety management system was transformed during the research. It contains a number of main components:
- a safety labor policy was formed;
- increased value of safety in organizations;
- proposed methods for the formation of personnel commitment to safe work;
- developed programs and outlined plans for their implementation in training and motivating staff in order to increase the level of safety culture;
- suggested further activities to develop a safety culture in the organization.

4. Conclusions
The Curve Bradley method of occupational safety management made it possible to visualize the interrelation of the level of safety culture with the level of labor protection, employee involvement, the level of their interdependence and mutual support in the machine-building organizations under study. Thus, confirmed the effectiveness of the "Bradley curve" method in the engineering industry.
The study showed that in the organizations under study the level of safety culture is at the second stage - Dependent. For the further development of safety culture in the organization, the existing safety management system was transformed.

The results of the study highlighted the importance of registering microtraumas for further analysis and prevention of injuries, as well as forecasting and eliminating causes that contribute to the occurrence of accidents and accidents. Thus, accounting for microtraumas allows you to more effectively deal with injuries. They are used as indicators (predecessors) in identifying the sources of occupational risks.

These preliminary data provide new opportunities for the development of an effective safety program in the engineering industry. The main problems at this stage lie in the complexities of improving the safety culture in domestic organizations. When planning changes, managers should be aware of: no standards will work unless you change the attitudes and behavior of people. The main reason is their low commitment to safety. There is a need for a qualitative transition from the dependent to the conscious behavior of workers, from concealment - to openness, from the fear of being punished - to proactive actions to prevent incidents. Such a transition is possible only with purposeful work at all levels of the enterprise - from the first person of the company to the working staff.

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