Prospects for the Introduction of Micro Training in the Occupational Safety Management System

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Abstract. The article presents the results of a study of the relationship between the competence of personnel of industrial enterprises and the level of industrial injuries. It is shown that micro training is an effective way to improve staff competence in the field of security requirements. The micro training is the submission of educational material in small blocks and the instantaneous consolidation of each block by micro-tasks (in the form of testing before the shift begins). Micro training allows you to continuously develop and control the competence of employees, to form skills of safe behavior. At Belgorod State Technological University named after V.G. Shukhov an Expert Information and Analytical Decision Support System in the field of occupational safety management has been developed, which includes a module for micro training, testing and evaluating the competence of workers. The proposed module is a component of an integrated occupational safety management system designed to determine the level of competence of the personnel of industrial enterprises and hazardous production facilities in matters of occupational health and safety of production activities. The use of the product will allow enterprises to monitor the dynamics of personnel competence indicators, the technical condition of production facilities, external factors, predict the risks of accidents, emergencies and industrial injuries at enterprises and hazardous production facilities, and apply ready-made solutions to eliminate accidents.

1. Introduction

In accordance with the Decree of the Ministry of Labor of Russia and the Ministry of Education of Russia №1/29 “On Approval of the Occupational Safety Training Procedure and Verification of Knowledge of Occupational Safety Requirements for Employees of Organizations” the following types of training on labor protection should be conducted for workers: instructions on labor protection; training in safe methods and techniques for performing work for all applicants as well as persons transferred to another job; training in labor protection of managers and specialists [1]. The frequency of all types of briefings on labor protection for employees of individual industries and organizations is regulated by the relevant industry and inter-sectoral regulations on safety and labor protection. The schedule of training and knowledge testing of occupational safety requirements for workers in occupations are established by the employer (or his authorized representative) in accordance with the regulatory legal acts governing the safety of specific types of work. The employer (or his authorized representative) organizes periodic, at least once a year, training of employees in conducting first aid to the injured. For managers and specialists of organizations, special training in labor protection in the amount of official duties should be carried out when applying for work during the first month, then –
as needed, but not less than once every three years. This means that, in accordance with regulatory requirements, there is no need to train and test the knowledge of workers every day. However, studies have confirmed that the student is able to actively perceive information for no more than 20 minutes [2]. The average concentration activity on a single site or stream of information is about 10 seconds [3]; in the first hour after memorization, 60% of information is lost, 65% is forgotten within 10 hours, 80% – after 6 days [4]. This means that for quality memorization, a person needs to repeat as often as possible the necessary information, which means that there is a need to increase the frequency of training in labor protection, especially at hazardous production facilities and facilities with a high level of industrial injuries. For this purpose, this type of modern learning is well suited as micro training.

Micro training is the delivery of educational material in small blocks and the instantaneous consolidation of each block by micro-tasks [2, 3].

2. Relevance and scientific significance of issue
In the modern world, large companies are actively introducing e-learning. Which allows the use of micro training in a complex, taking into account such components as: time (a small amount of time, short-term efforts); content (simple questions, small blocks of information, focus on "problematic" issues causing difficulties for the employee); type of training (repetitive; acting; training using examples; corporate training), etc. [5–10, 13–15].

An example of such training is the introduction of pre-shift control in the coal industry of Russia. After the introduction of the Pre-shift Examiner, there was a real reduction in occupational injuries (Figure 1) [7].

![Figure 1](image1.png)

**Figure 1.** Occupational injuries in JSC SUEK-Kuzbass before and after the introduction of the Pre-shift Examiner.

Micro training allows to increase the competence of workers. The competence of workers directly affects the level of industrial injuries at the enterprise. At the coal industry enterprises, an assessment of the level of competence of workers was carried out, a ranking scale was developed: 1 – incompetent; 2 – low competent; 3 – competent workers and the dependence of the number of injured on their competence has been established (Figure 2) [5, 7].
Table 1 shows the assessment of the severity of harm to employees health (occupational risk) in accordance with the levels of their competence, which are used in JSC SUEK-Kuzbass [7].

Table 1. The severity of harm to employees health (occupational risk) in accordance with the levels of their competence.

| Indicators                                              | Years       |
|---------------------------------------------------------|-------------|
| The actual number of injured                           | 22          |
| Average level of competence, %                         | 82.14       |
| Predicted number of injured as a result of personal in-competent actions | 19          |
| The proportion of human factors in the total number of injured, % | 80          |

The data of Table 1 demonstrate that improving the competence of workers reduces the number of injured [5, 7]. The result of the introduction of the Pre-shift Examiner was that every day thousands of workers after conducting daily training and monitoring their knowledge of safety requirements changed their behavior in the workplace. They became more attentive and responsible in carrying out their work [5, 7, 21–24].

3. Results and discussion

At Belgorod State Technological University named after V.G. Shukhov an Expert Information and Analytical Decision Support System in the field of occupational safety management has been developed, which includes a module for micro training, testing and evaluating the competence of workers [8, 9, 10]. An integral part of this system is the Module of micro-training, express testing and assessment of the competence of personnel of industrial enterprises and hazardous production facilities (a system of admission to work of increased danger). The module allows to solve the issues of occupational safety management, includes a system of test tasks developed for specific types of work (for example, work at height, welding work) and professions.

The module includes a multimedia content database:

– base of test and measurement materials (test tasks developed on the basis of job descriptions, instructions for occupational safety, results of the investigation of the accidents, the most typical production situations);
– 3D models and schemes of real incidents for conducting training of workers and assessing the correctness of their decisions on the proposed situations;
– an algorithm for assessing the competence of an employee in matters of labor protection.

The staff competency assessment algorithm implemented in the Module is a set of actions aimed at identifying the probability of an employee making an error, taking into account such criteria as – the level of existing education (EL), the results of testing the knowledge of occupational safety and industrial safety requirements (KL) a particular employee.

The level of competence of production personnel (LCPP) is calculated as the mathematical expectation of the following indicators:

$$LCPP = M[EL+KL]$$  \hspace{1cm} (1)

The weight coefficients of the level of education and level of knowledge are in the range from 0 to 1. The scale of assessment of the competence of staff depending on the level of education is presented in Table 2.

| Education Level       | Weight coefficient |
|-----------------------|--------------------|
| Higher education      | 1                  |
| Secondary special education | 0.5               |
| Secondary education   | 0                  |

Table 2. Scale of assessment of staff competence in terms of the “Education Level”.

As a result of express testing, the following results can be obtained (the rating scale is presented in Table 3):
– “excellent” – 81–100% correct answers, which implies excellent knowledge of instructions;
– “good” – 61 – 80% correct answers, there are minor errors;
– “satisfactory” – 41 – 60% of correct answers, there are gaps in knowledge that should be eliminated or corrected, say, by repeating instructions on labor protection;
– “unsatisfactory” – 0 – 40% correct answers, significant knowledge gaps that imply a low level of knowledge of labor protection and industrial safety requirements.

| Knowledge Level      | Weight coefficient |
|----------------------|--------------------|
| Excellent            | 1                  |
| Good                 | 0.66               |
| Satisfactory         | 0.33               |
| Unsatisfactory       | 0                  |

Table 3. Scale of assessment of staff competence in terms of the “Knowledge Level”.

The qualification level can be determined for:
– line managers on the subject of not only the performance of direct duties, but also the ability to make the right decisions and manage in emergency situations;
– an individual employee in order to identify his abilities and appropriateness of his position, determine the probability of the frequency of mistakes, actions in conditions of non-standard production situations;
– groups of workers with the same qualifications.

Table 4 presents the matrix of compliance with the level of mathematical expectation of the level of personnel competence from the indicators of the level of education and the level of knowledge of the requirements of safety (test results).
Table 4. Matrix of conformity of the mathematical expectation of the Level of Competency (LCPP) of the education level (EL) and the knowledge level (KL) of the employee.

| Knowledge Level (Result of testing) | Education Level |
|-------------------------------------|-----------------|
|                                     | Secondary | Secondary special | Higher |
| Excellent                           | 0        | 0.25               | 0.5    |
| Good                                | 0.3      | 0.415              | 0.665  |
| Satisfactory                        | 0.6      | 0.58               | 0.83   |
| Unsatisfactory                      | 1        | 0.75               | 1      |

From Table 4 it follows that all personnel should be divided into 4 groups according to the level of competence:

Competent (LCPP = 1) – employee is able to independently identify, assess and manage risks in compliance with labor protection requirements. The actions of the employee may lead to the realization of low risk with low harm to health.

Low competent (0.33 < LCPP <0.665) – employee has individual competences, is not able to independently identify, evaluate and manage risks in compliance with labor protection requirements only in the simplest standard cases. The actions of the employee may lead to the realization of a significant risk and the causing of light and low damage to health.

Incompetent (0.165 < LCPP <0.25) – employee is unable to independently identify, assess and manage risks in compliance with labor protection requirements, even in the simplest standard cases. The actions of the employee may lead to the realization of high risk and harm to the health of all levels.

Dangerously incompetent (LCPP = 0):
– employee is not able to independently identify, assess and manage risks in the performance of work associated with mortal risk, in order to preserve both his life and the lives of others;
– deliberately violates labor protection requirements governing the work associated with the possibility of realizing deadly and high risks. The actions of an employee may lead to the realization of a deadly risk and causing harm to the health of all levels, including mortal.

The value of LCPP indicator determined in accordance with Table 3 is taken into account in the further calculation of the value of occupational risk based on the analysis of statistical indicators of industrial injuries, the psycho-emotional state of an employee, employee, working conditions and other factors.

An additional advantage of using the Module is to increase the level of competence of workers with the daily repetition of educational material and conducting pre-shift express testing and micro training.

4. Conclusion
The article presents the prospects for the introduction of micro-training systems for workers to increase the level of competence in ensuring occupational safety. The system of micro training and personnel competency assessment is implemented in the form of a micro training module, rapid testing and competence assessment of personnel of industrial enterprises and hazardous production facilities. The proposed Module is designed to calculate the levels of competence of personnel of enterprises and hazardous production facilities taking into account various factors to reduce the likelihood of accidents and emergency situations.

5. References
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