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Possibility of using the results of non-destructive testing for assessing occupational risks in the labor protection management system

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Introduction. The paper discusses the methods for occupational risks assessment of workers within the framework of the labor protection management system. To date, there is no legally approved methodology for occupational risks assessment. Numerous well-known methods of ORS are advisory in nature. Their main weak point is the influence of the human factor and, consequently, the relative subjectivity of the final conclusions.
Problem Statement. The main objective of this work is to study the possibility of occupational risks assessment of workers by the "Bow tie" method in the occupational safety management system.
Theoretical Part. The method of risk assessment "Bow tie" was adopted as a basis. The main components of this method are considered. Approbation has been carried out. It is proposed to introduce an additional barrier into the "Bow tie" risk assessment method, which is called "Non-destructive control".
Conclusions. As a result, a technique for occupational risks assessment was proposed, taking into account the results of non-destructive testing. The positive aspects of the proposed approach are also identified.

***Keywords*:** occupational risk, labor protection management system, bow tie method, risk factor, initiating event, non-destructive testing, barrier.

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Introduction. Occupational risk assessment plays an important role in the occupational health management system. To date, there is no generally accepted and approved by the federal executive authority approach to the assessment of occupational risk in the Russian Federation. The key objective of risk assessment is to collect objective information necessary for risk analysis and improvement of working conditions.

In the wording of the Labor Code of the Russian Federation, occupational risk is the probability of harm to the health of an employee when exposed to harmful and (or) hazardous production factors [1]. Among many approaches to occupational risks assessment (ORA), we note the use of special matrix, Fine— Kinney methods, expert assessments and SWOT[1].

Matrix method is based on the direct dependence of the probability of an event, severity and risk. The Fine-Kinney method also takes into account the frequency of the event. The method of expert analysis involves the opinion of specialists — the employees of the enterprise. SWOT analysis is a more detailed assessment of the external and internal situation in the company (four factors are taken into account: strengths, weaknesses, opportunities and threats). All these methods are quite simple in terms of application and understanding of the results. However, such a risk assessment is subjective, as it depends on a person's opinion.

The choice of the ORA method is influenced by:

— time resources,

[1] Eng. SWOT: S — strengths, W — weaknesses, O — opportunities, T — treats.

— method complexity,

— quantitative and qualitative data,

— conditions for collecting information,

— risk reduction goals,

— required availability of the results.

Problem Statement. The main objective of this work is to study the possibility of applying the results of non-destructive testing to assess the occupational risk of employees of oil and gas industry enterprises within the framework of the occupational health management system. The methodology should be simple and convenient for conducting and evaluating the results.

The "bow tie" method of risk assessment is considered. This approach is used in many areas.

Theoretical Part. "Bow tie" is a schematic way of describing and analyzing a dangerous event from causes to consequences [2, 3]. The causes (risk factors) are investigated using the fault tree (malfunctions), the consequences (dangerous events) — using the event tree. The use of the "bow tie" method involves focusing on conditional barriers between dangerous events, their causes and consequences.

In occupational safety, the risk factor is the reason for the realization of the danger and the onset of the initiating event [4]. Identification of risk factors allows you to identify barriers and prevent triggering events. By influencing the risk factor through the development and implementation of management measures, it is possible to reduce the probability of an initiating event [5].

Events that are fraught with undesirable consequences for a person, assets, the environment or reputation are called initiating. Dangerous events occur due to initiators.

In the "bow tie" diagram, the initiating event is in the center, separating the fault tree (left part) and the event tree (right). Each initiating event has a limited list of corresponding dangerous events [6]. In the "bow tie" diagram, a dangerous event is located at the end of each branch of the event tree.

The result of the ORA analysis is an understandable scheme, which presents the main ways of implementing risk and barriers. The latter serve as a barrier to adverse consequences, or reduce their likelihood, or help to realize the desired consequences.

Let us consider a situation in which an incident is the initiating event. In this case, risk factors may be:

— human factor,

— working conditions,

— production environment.

Dangerous events will be an injury or death of an employee.

One more factor should be taken into account — the barrier. This is a technical and (or) organizational measure aimed at ensuring occupational safety [7]. It reduces the likelihood of an initiating event (a warning barrier) or reduces the harm of a dangerous event (a reacting barrier).

When planning and implementing management measures, it is important to take into account that the barrier system is built for operations in the existing conditions [8]. It is necessary to identify and evaluate the technical, organizational and financial possibilities of eliminating or reducing the danger.

So, for each risk factor, there is a barrier that reduces the likelihood of an initiating event. To prevent it from leading to dangerous events, additional barriers are provided[2].

But this approach does not provide the holistic picture necessary for a full assessment of occupational risk. In this regard, it is proposed to supplement the "bow tie" method with another component (barrier). We are talking about the results of non-destructive testing, which shows the condition of equipment, devices, tools, identifies defects and irregularities in the design of devices and structures. This approach makes it possible to control the reliability of the main components or parameters of the object without its dismantling or decommissioning [9]. The result of non-destructive testing is the assessment of the conformity of the object with the established and required technical

[2] Federal Law No. 116-FZ of 21.07.1997 On Industrial safety of hazardous production facilities. State Duma. ConsultantPlus. Available from: http://www.consultant.ru/document/cons_doc_LAW_15234 (accessed: 04.10.2021) (In Russ.).

standards (i.e., the comparison of real operational data about the object of control with the requirements of regulatory and technical documentation).

One of the examples of non-destructive testing is the determination of harmful and hazardous production factors of an enterprise that contribute to the emergence of risks for employees. This is the beginning of the occupational risk assessment procedure. Then it is necessary to use the information obtained during non-destructive testing, to assess the probability of a dangerous situation and damage from the consequences, to calculate the reliability of the controlled object [10]. Obviously, this process will also reveal unreliable information about the condition of the equipment. Using the obtained set of data on the probability of an emergency situation, it is possible to:

— assess the consequences of an accident,

— identify its scale,

— find out the dangerous factors affecting workers,

— determine the level of this impact

Based on this information, it is possible to compare the risks with the technical condition of the equipment. Thus, technological processes that are dangerous for employees are identified.

In other words, decision makers will be provided with the systematized information obtained as a result of a special assessment of working conditions and non-destructive testing. This is how a holistic view of the existing and probable threats is formed [11, 12], without taking into account the data of long-term statistics (Fig. 1) .

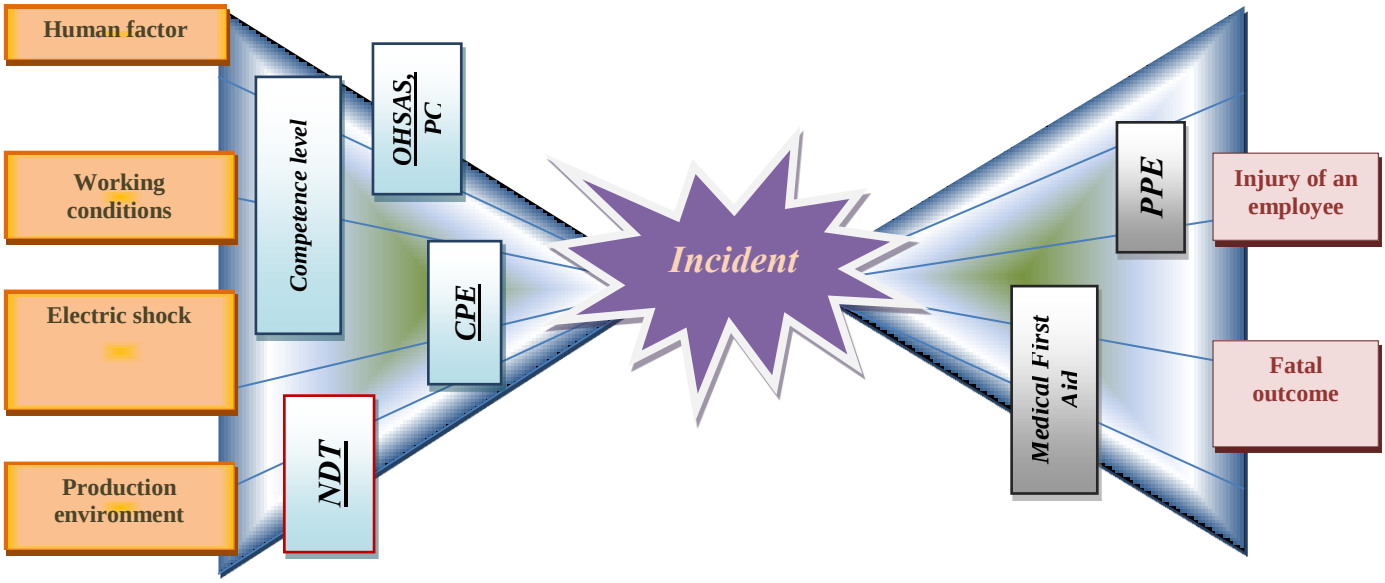

Fig. 1. Scheme of the "bow tie" method for the initiating event "incident" with the "non-destructive testing" barrier: OHSAS — occupational health management system; PC — production control; NDT — non-destructive testing; CPE, PPE — means of collective and individual protection; MFA — medical first aid

Non-destructive testing is only indirectly affected by human influence; therefore it occupies a leading place in the risk assessment system. Flaw detection in this case is not a separate additional procedure. It complements the system with technical diagnostics data.

Conclusions. The article presents a new approach to occupational risk assessment taking into account the methods of non-destructive testing.

Some positive aspects of this method are worth noting:

— increased safety for the facility and employees,

— possibility of timely risks prevention.

— economic feasibility.

This method of ORA can be used at any enterprise, regardless of the field of activity. However, when choosing a non-destructive testing method, it is necessary to take into account the peculiarities of the production process.

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N. Kh. Abdrakhmanov — formulation of the structure of the article, critical analysis, editing; A. V. Fedosov — scientific supervision, formulation of the main goal of the study, development of research methods, processing of the initial observations, text editing; A.S. Guseva — development of the basic research concept, statement of the problem, participation in the study; R. R. Ahmetyanov — collection and analysis of literature data.