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ANALYTICAL REVIEW OF WORKING CONDITIONS OF UNDERGROUND PERSONNEL IN THE OIL MINES OF THE YAREGSKOE FIELD

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АНАЛИТИЧЕСКИЙ ОБЗОР УСЛОВИЙ ТРУДА ПОДЗЕМНОГО ПЕРСОНАЛА НЕФТЯНЫХ ШАХТ ЯРЕГСКОГО МЕСТОРОЖДЕНИЯ

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oil mine, special assessment of working conditions, class of working conditions, Yaregskoe field, underground personnel, thermoshaft method, workplace, probability of factor impact.

At the present stage of production enhancement it is impossible to create absolutely safe working conditions in the oil production mines of the Yaregskoe field, but ensuring acceptable working conditions in the workplace remains one of the most important tasks in the field of labor protection. Yaregskoe is unique oil field in terms of the shaft method of heavy oil mining. An oil shaft is rather a deviation from the general ideas about the mining industry of Russia and the world. The main idea of the thermoshaft method is a decrease in viscosity and increase in oil mobility due to the heating of a formation by coolant injection. The technology used to extract heavy oil has created special working conditions.
The majority of workplaces in oil mines correspond to the 3rd class of working conditions (harmful), degrees 3.1-3.3, where the maximum permissible levels of exposure to harmful factors are exceeded in comparison with permissible values. Harmful working conditions entail a consistently high level of occupational disease. The variety of negative factors and possibility of their combined effects on the body with various combinations of the labor process determine the need for an integrated approach to assess the combined effects of negative factors.
Today, the assessment of working conditions is carried out in accordance with the Federal Law of the Russian Federation No. 426-FL "On a special assessment of working conditions" and Order No. 33n of the Ministry of Labor of Russia "On approving the methodology for conducting a special assessment of working condition classifier of harmful and (or) dangerous production factors, the form of a report on the special assessment of working conditions and instructions its filling". In a special assessment of working conditions the overall result is affected only by factors beginning with grades 3 and 4 of working conditions. The combined effect of production and labor process factors is represented only by a qualitative assessment.
The analysis performed allowed to rank the probability of the impact of factors of a certain class of working conditions on workers of the Yaregskoe oil mines by structural subdivisions.
To assess how labor conditions conform normative labor requirements and a degree of impact of deviations from normal values on human body a special point system (usually a six-point system) is used. There is a calculation of professional risks for the underground staff of the Yaregskoe oil mine made based on the "Point assessment of professional risk".
Assessment of occupational diseases shows a high risk of obtaining occupational diseases for a group of underground workers of the Yaregskoe oil mine. There is a special risk for workers at mining and oil production sites. The risk is represented in three parameters such as increased noise, vibration and physical overload. An underground miner and road worker are the safest jobs.

Ключевые слова:
нефтешахта, специальная оценка условий труда, класс условий труда, Ярегское месторождение, подземный персонал, термошахтный способ, рабочее место, вероятность воздействия фактора.

На современном этапе интенсификации производства создание абсолютно безопасных условий труда на нефтедобывающих шахтах Ярегского месторождения невозможно, но обеспечение допустимых условий труда на рабочих местах остается одной из важнейших задач в области охраны труда. Ярегское нефтяное месторождение уникально в шахтном методе добычи тяжелой нефти. Нефтешахта, скорее, отступление из общепринятых представлений о добывающей шахтной промышленности России и мира. Основой термошахтного метода является снижение вязкости и повышение подвижности нефти за счет разогрева пласта с помощью закачки теплоносителя. Используемая технология добычи тяжелой нефти сформировала особые условия труда.
В нефтешахтах большинство рабочих мест соответствуют 3-му классу условий труда (вредные), степени 3.1–3.3, при которых наблюдается превышение предельно допустимых уровней воздействия вредных факторов по сравнению с допустимыми значениями. Вредные условия труда влекут стабильно высокий уровень профессиональной заболеваемости. Многообразие воздействующих негативных факторов и возможность их комбинированного воздействия на организм при различных комбинациях трудового процесса определяют необходимость комплексного подхода к оценке комбинированного воздействия негативных факторов.
В настоящее время оценка условий труда выполняется в соответствии с ФЗ РФ № 426-ФЗ «О специальной оценке условий труда» и приказом Минтруда России № 33н «Об утверждении методики проведения специальной оценки условий труда, классификатора вредных и (или) опасных производственных факторов, формы отчета о проведении специальной оценки условий руда и инструкции по ее заполнению». При проведении специальной оценки условий труда на общий результат влияют только факторы, начиная с 3-го и 4-го класса условий труда. Комбинированное воздействие производственных и факторов трудового процесса представлено лишь качественной оценкой.
Выполненный анализ позволил провести ранжирование вероятности воздействия факторов определенного класса условий труда на работников ярегских нефтешахт по структурным подразделениям.
Для оценки степени соответствия состояния условий труда нормативным требованиям и степени влияния на организм человека отклонений от нормативных значений факторов условий труда используется система специальных баллов (обычно шестибалльная система). На основании «Балльной оценки профессионального риска» был произведен расчет профессиональных рисков для подземного персонала ярегских нефтешахт.
Оценка профзаболеваний показывает высокий риск получения профзаболевания для группы подземных работников ярегских нефтешахт, в особенности риску подвержены работники участков проходки горных выработок и добычи нефти. Для них наблюдается высокий уровень риска по трем параметрам: повышенный уровень шума, вибрации, физические перегрузки. Наиболее безопасными рабочими местами являются горнорабочий подземный и дорожно-путевой рабочий.

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Introduction

The Yareganeft oil mine management department (OMMD) includes three oil-producing mines. There are 436 positions that were specially estimated for working conditions (SEWC) from 2014 to 2016. Based on results of SEWC a list of recommended measures to improve working conditions at 309 workplaces was developed. Working conditions of the personnel of various structural divisions can be understand through the analysis of protocols, maps and summary statements of the SEWC of the Yarega oil mines [1-6].

Levels of hazardous and harmful production factors are determined on the basis of instrumental measurements that were carried out in accordance with established methods with efficient and effective collective and individual protection facilities. The time of exposure to hazardous and harmful production factors was determined on the basis of the timekeeping carried out and work on duty magazine [7-9].

In order to ensure completeness and reliability of accounting for workplaces, the classification characteristics were used that are as follows:

– stationary or non-stationary – by the nature of the technical equipment and location of workplaces in the space;

– individual or collective – by the number of personnel employed in the workplace.

Analytical review of working conditions of underground personnel

There are 77 workplaces with acceptable working conditions and 359 workplaces with harmful and dangerous conditions.

In accordance with the classifier of harmful and (or) dangerous production factors controlled parameters are chemical, biological, physical (aerosols, noise, infrasound, ultrasound, general and local vibration, non-ionizing and ionizing radiation, microclimate, illumination), severity and tension work processes [10, 11].

Identified workplaces with harmful and dangerous factors based on the measurement and evaluation of SEWC are given in the Table 1.

Determination of the class of working conditions of workplaces is made in accordance with the "Classifier of harmful and (or) dangerous production factors", on the basis of which the working conditions are divided into 4 classes such as optimal, permissible, harmful and dangerous [12, 13].

Table 1

Harmful and dangerous factors defined on the basis of measurements and assessments of SEWC

Name of harmful and (or) dangerous production factor	Number of workplaces
Chemical	96
Aerosols of predominantly fibrogenic action (APFA)	77
Noise	341
Vibration total	4
Vibration local	59
Microclimate	78
Labor severity	179

The classifier of harmful and (or) dangerous production factors allows to assess the conditions and nature of work in the workplace in order to:

– establish professional risk levels for development of preventive measures and justification of social protection measures for employees;

– compare employee's state of health with his working conditions;

– set priorities for implementation of health measures and assessing their effectiveness.

The Fig. 1 presents mean results of SEWC performed on oil mines of the Yaregskoe field.

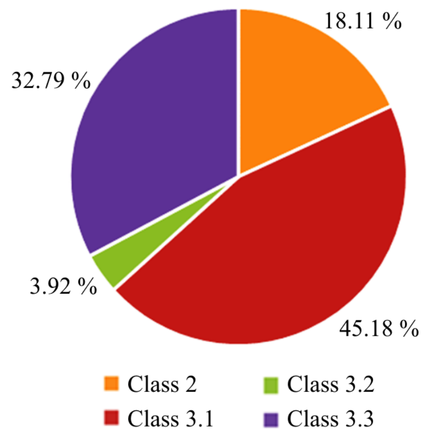

Fig. 1. Distribution of workplaces by classes of working conditions

The majority of workplaces at the Yaregskoe oil mines belong to the class with harmful working conditions (82 %), i.e. workers may experience occupational diseases. Subclasses 3.1 and 3.3 have 45 and 33 %, respectively, corresponding to a very high degree of occupational risk [14].

Harmful working conditions at workplaces of the personnel of oil mines are caused by both physical factors (noise, vibration, microclimate and APFA) and factors of the labor process (labor severity) and chemical factors which is a characteristic of oil production company.

Share distribution of harmful and hazardous production factors for the Yaregskoe oil mines is given in the Fig. 2.

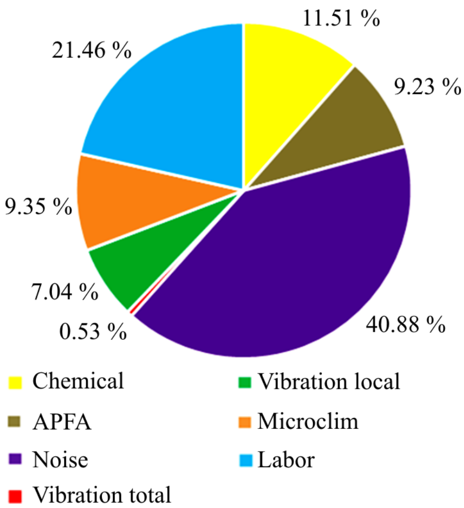

Fig. 2. Share distribution of harmful and hazardous production factors

There is in the oil industry a large part of the production personnel works under the influence of increased noise levels (40.88 %), labor severity (21.46 %), chemical factors (11.51 %), humidity and temperature (9.35 %), dustiness (9.23 %), local vibration (7.04 %) and total vibration (0.53 %). There are one or several harmful factors, levels of which exceed the established norms at workplaces of underground workers of the basic professions. Harmful working conditions attract a consistently high level of occupational diseases [15, 16].

Experience suggests that in order to obtain a reliable estimate of working conditions, a SEWC has to be carried out, in maps where levels of harmful and dangerous factors are clearly established at each workplace and for certain technological processes and operations.

High levels of severity of the labor process (classes 3.1-3.2) are noted in persons of working specialties and middle-level specialists. High indicators in the first group are caused first of all by the fact that they lift and move over-standard masses of weight by hands, forced slopes of the hull at an angle of more than 30° and displacement in space. In the second group that is caused by the need to use in the process of work a large number of portable instrumentation, which are used directly by the employee, and movement in space, due to the technological process. High indicators of work severity of the process are a prerequisite for development of musculoskeletal system diseases [17].

Total and local vibrations, noise, APFA, microclimate and chemical factor at worksplaces of the underground group of oil mine workers belong mainly to classes 3.1, 3.2 and 3.3, i.e. can cause industry-related diseases. However, their combined effect with higher indicators of physical factors can lead to development of occupational diseases of various etiologies [11].

By the priority occupational diseases of the oil industry thay are as follows: vibro-disease, chronic loins-sacral radiculopathy, chronic neurosensory hearing loss and the only case of reflex myotonic syndrome [18].

According to results of the SEWC, intensity of the labor process is absent in all work places of the Yaregskoe oil refineries. Indicators of the intensity of the labor process are directly related to the specific conditions of underground labor activity, in particular the activities of oil production operators, mining machine drivers, whose work involves knowledge of instructions for both labor protection and industrial safety, and for production and mining operations, in addition, high emotional stress during the operation and maintenance of process equipment.

However, when examining workplaces, difficulties arise in assessing the intensity of the work of the underground personnel in oil mines related to the absence of an express methodology for assessing the intensity of the labor process in the SEWC, which allows shortening the time for assessing workplaces by working conditions [19].

It is proposed to develop a methodology for assessing the indicators of the labor process, which should take into account the world experience in assessing the indicators of the intensity of the labor process and base on checklists and questionnaires. Such an approach is a generally accepted means of data collection for persons involved in organizational planning, performance evaluation, safety management and health protection, designing interaction between a worker and machine as well as working conditions [20, 21].

The evaluation of the indicators of tension is obtained as a result of the study of a workplace, technological process, operations and interviewing of the employee, comparison of estimates obtained, detection of the percentage of discrepancies and comparison of the percentage of discrepancies with its permissible level.

The methodology proposed will reduce the time for assessing the severity and tension of the work of underground oil mines personnel, while ensuring comparability with results obtained during SEWC.

A summary list of results of SEWC is presented in Table 2. Workplaces of the management department (MD), preparation site, oil shipment and bottom water injection (SEWC and BWI), steam-water-heat workshops (SWHW), production support site (PSS), wood processing site (WPS), mechanization and production automation sites (MS and PAS) are located on the surface and intended for persons involved in the management and technical support of the work of the oil mine underground personnel.

Table 2

Summary list of SEWC results

Name	Number of workplaces and number of employees		Number of workplaces and number of employees work on them by classes (subclasses) of working conditions						
	total	where SEWC is carried	class 1	class 2	class 3				class 4
					3.1	3.2	3.3	3.4	
Employees	436	436	0	79	197	17	143	0	0
Employees in the workplace, people.	1443	1443	0	121	592	91	639	0	0
Manadgement department	40	40	0	40	0	0	0	0	0
Oil mine no. 1	113	113	0	3	61	0	49	0	0
Oil mine no. 2	107	107	0	3	58	0	46	0	0
Oil mine no. 3	111	111	0	5	57	0	49	0	0
Oil production site	3	3	0	2	1	0	0	0	0
SEWC and BWI	4	4	0	0	3	1	0	0	0
WPS	2	2	0	0	1	1	0	0	0
SWHW	47	47	0	20	13	14	0	0	0
PSS	4	4	0	4	0	0	0	0	0
MS and PAS	5	5	0	2	3	0	0	0	0

The most harmful working conditions are in oil mines at workplaces of the underground group of workers which is only considered. The group of management department is considered as a reference one, whose class of working conditions is permissible.

The analysis of protocols of the special evaluation, maps and summary statements of the working conditions of the oil mine will allow developing a rating ranking of the negative factors in priority to reduce their negative impact on the underground personnel of Yaregskoe oil mines.

Assessment of the probability of exposure factors of a certain class working conditions on employees

Based on an analytical review, the probabilities of the impact of factors of a certain class of working conditions on the employees of the management department and three oil mines, as well as various structural subdivisions of the oil mines of the Yaregskoe field were calculated (Fig. 3*a-d*) [22].

Distribution of probability of the impact of factors of a certain class of working conditions on employees of the Yaregskoe oil mines indicates that the structure of harmful and dangerous factors is similar and almost the same for all three oil mines.

An analysis of the distribution allowed to determine the structural subdivisions for which the most likely impacts are the factors of a certain hazard class and hazard of working conditions (oil production site, site of mine excavation and expansion and site of repair and remedial works and intermine transportation [23].

A generalized calculation of the probability of effects of factors of a certain class of working conditions on employees of structural subdivisions of oil mines of the Yaregskoe field is shown in Fig. 3*e*.

As a result of assessment of significance of harmful and dangerous production factors of a physical group, it is established that their identification in workplaces is possible for all hazards except APFA, whose contribution to the total number of occupational diseases for oil mine employees is 2 %. At the same type of workplace the variation of harmful factors is within the limits of classes 2-3.1. Such a factor, as a dust effect, slightly affects the occurrence of occupational disease [24, 25].

At the same type of workplace the amount of dust in the air can be within the limits of classes 2-3.3.

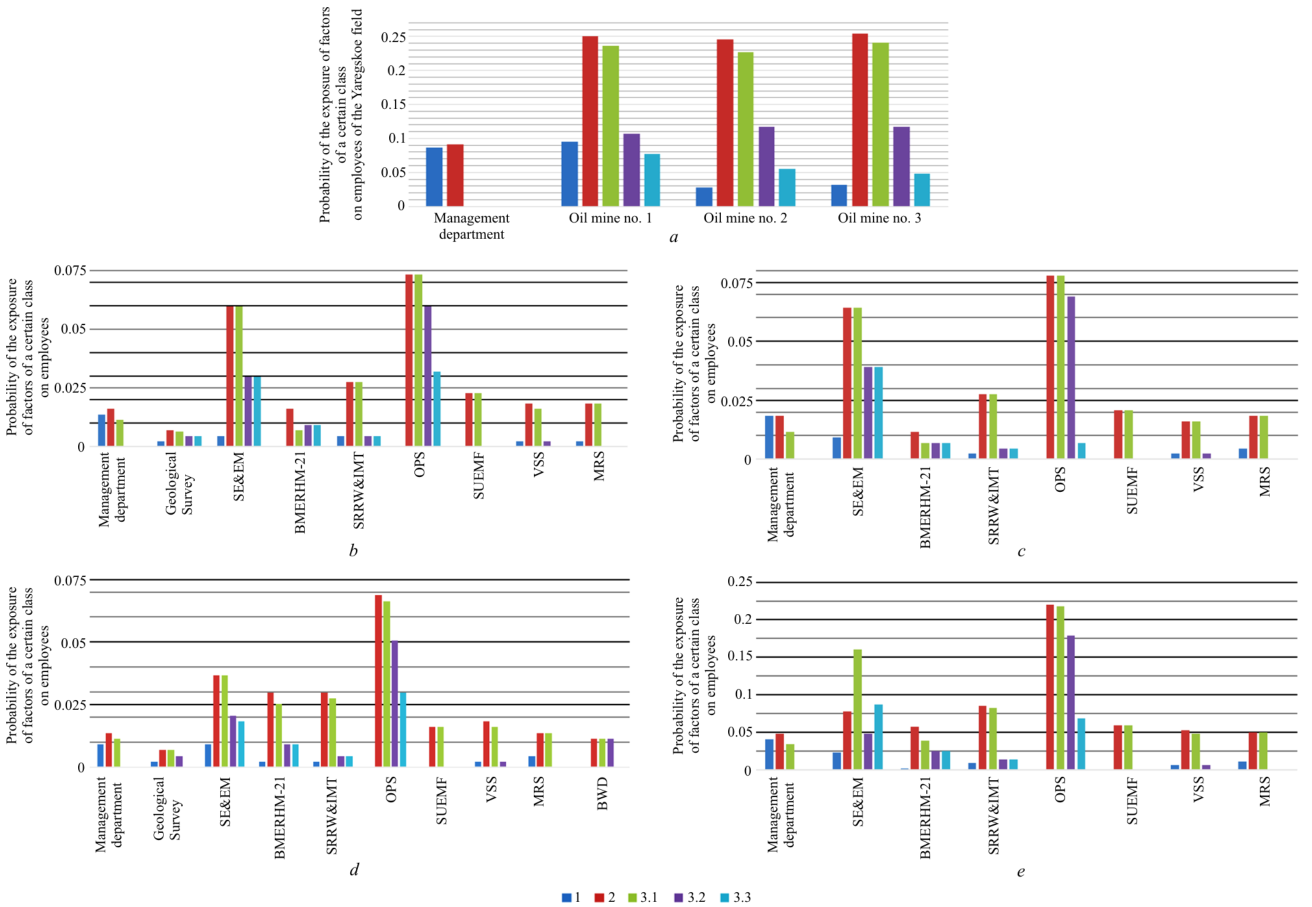

Fig. 3. Distribution of the probability of the exposure of factors of a certain class on working conditions on employees: *a* – OMMD Yareganeft; *b* – structural subdivisions of the oil mine No. 1; *c* – structural subdivisions of the oil mine No. 2; *d* – structural subdivisions of the oil min No. 3; *e* – structural subdivisions of oil mines; SME&E – site of mine excavation and expansion; OPS – oil production site; SRRW&IMT – site of repair and remedial works and intermine transportation; BMERHM-21 – brigade on mining of excavations by road header machine KP-21; SUEMF – site of underground electromechanical facilities; VSS – ventilation and safety site; MRS – mine raise site; BWD – brigade on well drilling

Assessment of occupational risks of underground personnel

The object of the study is assessment of professional risks of underground personnel of the Yaregskoe oil mines. Activities of the personnel of oil mines are characterized by a combination of factors in the production environment and labor process that directly affect workers.

An analytical review of occupational pathology in companies extracting oil by mining method over the past 16 years with the given statistical indicators and structure of occupational deseades is shown in the Fig. 4 [26].

The level of occupational diseases in the production oil mine industry remains stably high. The average number of underground personnel for 16 years is 170 people, the total number of cases is 122.

Analysis of statistical data for oil mine production showed that the production personnel works using vibrating tool (75.6 %), heavy physical labor was detected in 61.2 %, noise effect in 84.7 %. Comparison of harmful and dangerous production factors causing occupational diseases of personnel in the coal and oil mine production industry of the Komi Republic for 2000-2016 shows a different etiology of occupational pathologies.

The structure of occupational deseases by categories of personnel is shown in the Fig. 5.

The main causes of occupational diseases in oil mines are vibration, heavy physical labor, noise, unfavorable microclimate.

All cases of occupational diseases are recorded at the site of mine excavation and expansion. The greatest number of cases was recorded in miners and timbermans, which is associated with simultaneous exposure in the main labor operations of harmful factors that cause occupational diseases [27, 28].

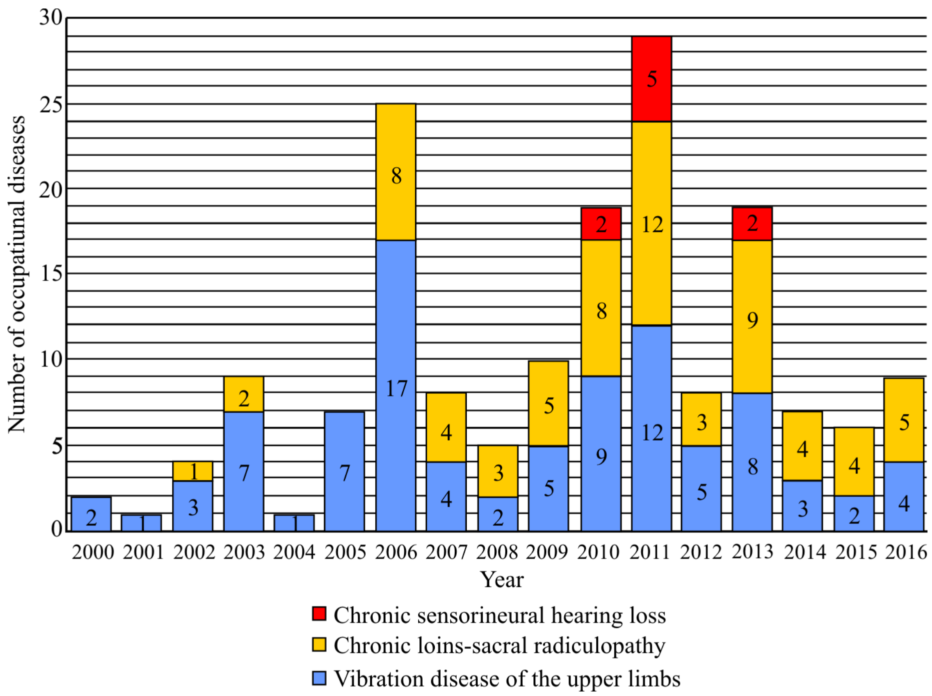

Fig. 4. Dynamics of the number of occupational diseases of underground personnel of the Yaregskoe oil mines for the period of 2000-2016

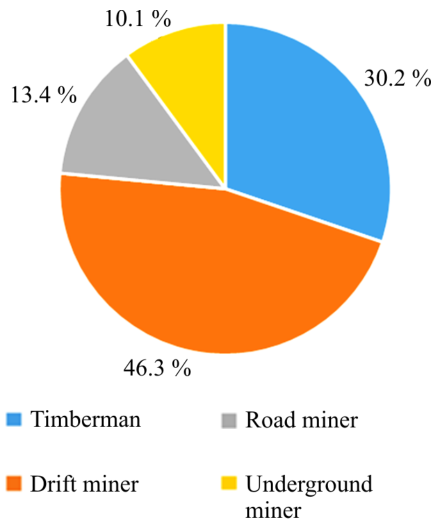

Fig. 5. Distribution of occupational diseases among persons by occupation in oil fields of the Yaregskoe field

The procedure for determination of prognostic occupational risks is based on use of materials from a special assessment of working conditions conducted in accordance with the methodology of a special assessment of working conditions according to Federal Law No. 426 of December 23, 2013, and attestation of workplaces held at the company before January 1, 2014 in accordance with the requirements of the "Procedure for the certification of workplaces for working conditions" approved by the order of the Ministry of Health and Social Development No. 342n of April 26, 2011 [29].

In order to assess the degree of compliance of the state of working conditions with normative requirements and degree to which the deviations from the normative values of labor conditions factors affect the human body, a system of special scores (usually six points) is used:

1 – optimal working conditions (class 1);

2 – allowable working conditions (class 2);

3 – not quite favorable working conditions (class 3.1);

4 – unfavorable working conditions (class 3.2);

5 – very unfavorable working conditions (class 3.3);

6 – ultra-extreme, critical working conditions (class 3.4).

The higher the score the greater the discrepancy between the working conditions for this factor and the more dangerous and harmful effects on the human body.

Such the methodology certainly gives positive results in determination of the influence of certain factors of the production environment on the state of human health. There are quite reliable mathematical models are constructed based on such the methodology for calculation of occupational risk, taking into account three main components such as level of the factor, duration of its impact and effective indicator, i.e. indicators of the health status of underground personnel.

The higher the score the greater the discrepancy between working conditions for that factor and the more dangerous and harmful its effect on the organism is.

The results of a quantitative assessment of the state of the production environment for individual factors with their isolated effects are shown in the Table 3.

Table 3

Calculated levels of safety of production factors at workplaces of underground personnel of the Yaregskoe oil mines for 2014-2016

Name of the workplace	Levels of safety S_{nc} by the i-th production factor										Total safety level
	Chemical	APFA	Noise	Vibration total	Vibration local	Non-ionizing radiation	Microclimate	Light environment	Work severity	Labor tension	
Drift miner	0.83	0.67	0.33	0.83	0.5	–	0.83	–	0.5	–	0.0316
Machinist of mining excavation machines	0.83	0.33	0.5	0.67	0.67	–	0.83	–	0.83	–	0.0423
Timberman	0.83	0.67	0.33	0.83	0.5	–	0.83	–	0.5	–	0.0316
Underground miner	0.83	0.83	0.67	0.83	–	–	0.83	–	0.83	–	0.264
Operator of oil and gas production	0.67	0.83	0.67	0.83	–	–	0.33	–	0.5	–	0.0510
Underground electrician	0.83	0.83	0.67	0.83	–	0.83	0.83	0.83	0.83	–	0.182
Mechanic	0.83	0.83	0.67	0.83	–	–	0.83	0.83	0.83	–	0.219
Mining electric locomotive driver	0.83	0.83	0.67	0.83	0.83	–	0.83	–	0.83	–	0.219
Road miner	0.83	0.83	0.83	–	0.83	–	0.83	–	0.67	–	0.264
Supervisor	0.83	0.83	0.67	0.83	–	–	0.83	0.83	0.83	–	0.219

As a scoring for the i-th unfavorable factor of the production environment the results of a special assessment of working conditions or attestation of workplaces on working conditions are used. Points are given in the following dependency on the class of working conditions [30]:

1.0 – 1 point;
2.0 – 2 points;
3.1 – 3 points;
3.2 – 4 points;
3.3 – 5 points;
3.4 – 6 points.

Assuming that all factors of the production environment operate independently of each other (additivity principle), estimation of the total risk level of R_{PE} is [31]

$$R_{\text{PE}} = 1 - \prod_{i-1}^{n} S_{nc_i}, \qquad (1)$$

where n – number of environmental factors to be considered; S_{nc_i} – the level of safety in the i-th factor of the production environment, which can be determined by the formula

$$S_{nc_i} = \frac{(x_{\max} + 1) - x_i}{x_{\max}}, \qquad (2)$$

where $x_{\max}$ is for a maximum score, in accordance with the methodology of the Institute of Labor $x_{\max} = 6$; x_i is for score by i-th environment factor, calculated by the formulas in Table 1 or by the class of working conditions in accordance with P 2.2.2006-05.

It is important to note that the value determines the total level of safety of the production environment compared with work experience.

$$S_{nc} = \prod_{i-1}^{n} S_{nc_i}. \qquad (3)$$

Experience shows that the probability of disease in the time interval t_i does not depend on whether the disease was in the previous period $t_{t\text{-}1}$, which indicates the independence of events. Then the probability of working without diseases (the level of safety of the working environment) for a period of m years can be determined by the formula

$$S_{nc} = (1 - r_a)^m, \quad (4)$$

where r_a is for annual professional risk. From (4), taking into account expression (3), we obtain

$$r_a = 1 - \sqrt[m]{\prod_{i-1}^{n} S_{nc}}, \quad (5)$$

where m is for work experience (25 years).

The results of calculations according to the formula (5) should be close to the data obtained from the actual desease rates.

The results of the calculation of the level of safety for each workplace of underground personnel are presented in the Table 3 and Fig. 6.

The results of calculations of the total level of safety (3), total level of risk (1) and annual professional risk (5) are grouped in the Table 4 and Fig. 7 for work places of underground personnel [32].

Calculated values of the level of occupational risk for each workplace of underground personnel should be compared with the maximum permissible risk for this workplace. This comparison is necessary for ranking risks that require prompt operational intervention, development of measures and adjustment of labor operations [33-35].

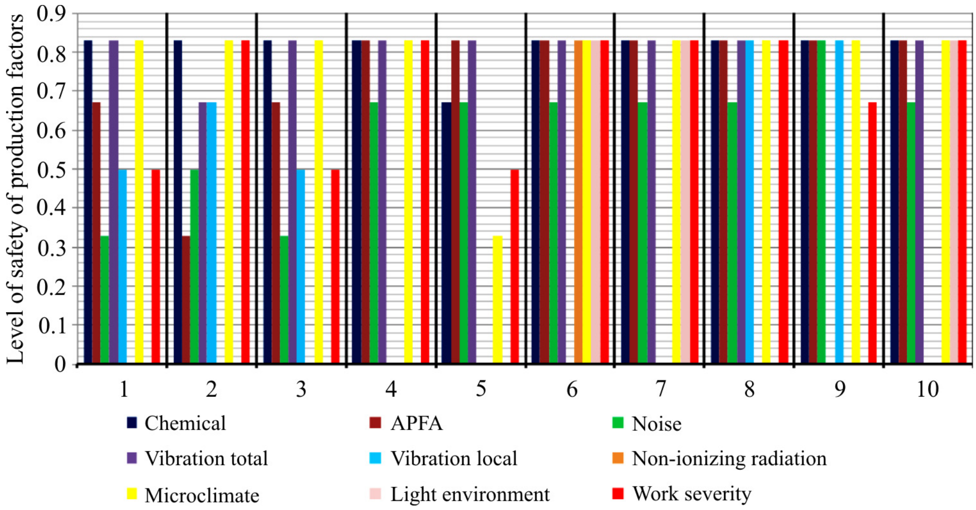

Fig. 6. Diagram of average values of safety levels of production factors of workplaces of the underground personnel of oil mines: *1* – drift miner; *2* – machinist of mining excavation machines; *3* – timberman; *4* – underground miner; *5* – operator of oil and gas production; *6* – underground electrician; *7* – mechanic; *8* – mining electric locomotive driver; *9* – road miner; *10* – supervisor

Table 4

Summary table of safety and risk of obtaining occupational disease by the underground personnel of the Yaregskoe oil mines for 2014-2016

Name of the workplace	Total safety level	Total risk level	Maximum permissible level of total risk	Deviation of the actual level of occupational risk from the maximum allowable, %
Drift miner	0.0316	0.968	0.82	18.04
Machinist of mining excavation machines	0.0423	0.958	0.82	16.83
Timberman	0.0316	0.968	0.82	18.05
Underground miner	0.264	0.736	0.67	9.85
Operator of oil and gas production	0.0510	0.949	0.82	15.73
Underground electrician	0.182	0.818	0.78	4.87
Mechanic	0.219	0.781	0.73	6.99
Mining electric locomotive driver	0.219	0.781	0.73	6.99
Road miner	0.264	0.736	0.67	9.85
Supervisor	0.176	0.781	0.73	6.99

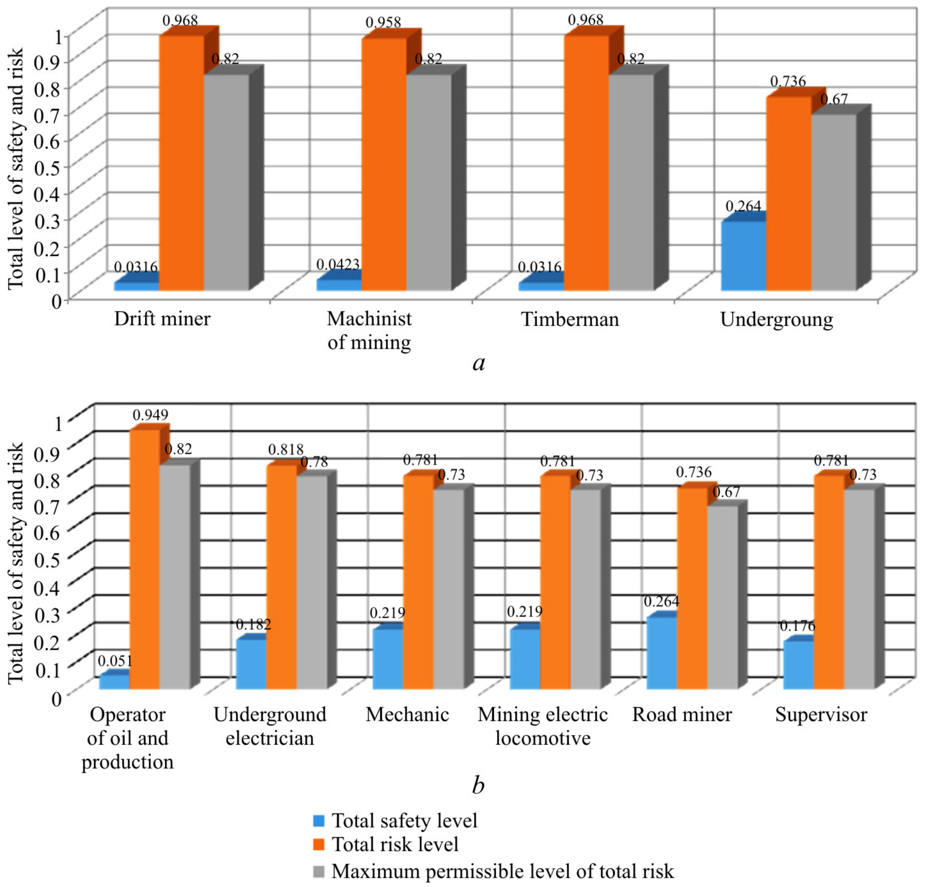

Fig. 7. Diagram of safety and risk of occupational disease:
a – personnel in the site of mine excavation and expansion of the Yaregskoe oil mines;
b – underground personnel of the Yaregskoe oil mines

The maximum permissible level of risk is calculated from the condition that all the factors of the working environment that act on the employee during labor activity are brought to the best level. Ideally, those factors are classes of working conditions for each factor 1.0 and 2.0, except for those that can not be reduced (improved) due to the peculiarities of the technological process (for example, noise from the equipment) [36].

If the level of exposure of the factor corresponds to the classes of working conditions 3.2, 3.3 and 3.4, but employees are equipped with certified personal protective equipment and regularly use them, and also organizational measures are taken to reduce the negative impact of the harmful factor, the class of working conditions can be estimated as less harmful (one step, but not lower than class 3.1) [37, 38].

In order to control the effectiveness of implemented measures to reduce the identified risk levels, the collective dose rate J of the adverse effects of labor conditions factors is calculated:

$$J = \sum_{j=1}^{m} \sum_{i=1}^{n} x_{ij} \cdot N_{ij}, \qquad (6)$$

where m – number of workshops (sites) at the company; n – the number of factors taken into account in working conditions in the workshop (site); x_{ij} – score of the i-th factor of working conditions; N_{ij} – number of employees under the influence of i-th factor.

The Table 5 shows an example of calculation of the collective dose capacity of the adverse impact of labor conditions factors on the underground staff of the Yaregskoe oil mines.

Collective dose rate of unfavorable expoisure of factors of working conditions in the company is J = 13 805 person-points.

Table 5

An example of calculation of the collective dose capacity of adverse effects of labor conditions factors in a company

Workshop (group of workplaces)	Identified dangerous and harmful production factors	Initial scores X_{ij}	Number of employees under the influence of the *ij*-th dangerous and harmful production factor
Site of mine excavation and expansion	Increased noise	5	377
	Increased local vibration	4	332
	Physical overload	4	317
	Increased dustiness	3	221
Brigade on mining of excavations by road header machine KP-21	Increased dustiness	5	75
	Increased noise	4	75
	Increased local vibration	3	75
	Increased total vibration	3	75
	Physical overload	3	75
Site of repair and remedial works and intermine transportation	Increased noise	3	111
	Physical overload	3	111
Oil production site	Increased chemical factor	3	372
	Increased noise	4	372
	Increased temperature	5	372
	Physical overload	4	372
Site of underground electromechanical facilities	Increased noise	3	102
Ventilation and safety site	Increased noise	3	69
Mine raise site	Increased noise	3	60

Conclusions

Analytical review of working conditions of underground personnel allowed determining the main groups of negative factors such as noise, local and total vibration, microclimate and APFA, labor severity and chemical factor. The majority of workplaces in the Yaregskoe oil mines are mainly related to the class with harmful working conditions (82 %), i.e. activity carried on them can cause occupational diseases of personnel. Subclasses 3.1 and 3.3 correspond to a very high professional risk (45 and 33 %, respectively) and prevail. The main harmful and dangerous production factors allowed substantiating the causes of conditionality of certain forms of diseases in the work places of underground personnel of oil mines [18].

The analysis performed allowed to rank the probability of the impact of factors of a certain class of working conditions on personnel of the Yaregskoe oil mines by structural subdivisions.

However, during the survey of workplaces, there are difficulties in assessing the intensity of the work of the underground personnel of oil mines araise due to the absence of a rapid method for assessing the intensity of the labor process in the SEWC. That could shorten the time for assessing workplaces by working conditions. Therefore, that is necessary to develop and test new method.

There is a group of personnel in the risk for occupational pathology that consists of workers who are involved in the site of mine excavation and expansion. By the priority occupational diseases of the oil industry they are as follows: vibro-disease, chronic loins-sacral radiculopathy, chronic neurosensory hearing loss and the only case of reflex myotonic syndrome.

The analysis showed a high risk of getting occupational diseases by a group of underground personnel of the Yaregskoe oil mines. The persons at especially risk are as follows: drift miner, timberman, machinist of mining excavation machines, operator of oil and gas production. Workplaces of underground miner and road miner are the safest.

There is a high risk level observed in three parameters such as increased noise level, vibration and physical overload for the employees at the site of mine excavation and expansion.

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