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PECULIARITIES OF HYGIENIC ASSESSMENT OF WORKING CONDITIONS OF WORKERS ENGAGED IN OPENCAST AND UNDERGROUND MINING OF BROWN COAL AND IN UNDERGROUND MINING OF HARD COAL

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Abstract. Employees are working on opencast coal mining from May to September work in conditions of heating microclimate. A decrease in the influence of the high temperature of air and solar radiation is reached by the uniform distribution of the hottest time of day (from 12 to 16 o'clock) by drawing up the working schedule. The selection of means of individual protection of hearing organs, their regular use, and efficiency assessment performance will reduce the impact of noise on workers' bodies. Decrease of total working time in conditions of exposure to industrial vibration not exceeding 5-6 hours will allow reducing the class of working conditions on this factor. The effectiveness of individual respiratory protection means the size of dust particles, the degree of insulation of the underwear space in places where the mask is not tightly attached to the face. Considering dust dispersion, working conditions classes of workers engaged in brown coal mining in underground mine #9 "Angrenskaya" decreased by 1 stage, while in mine "Shargunkumir" the working conditions classes on dust factor, on the contrary, increased by 1 stage.

Keywords: coal dust, working conditions, noise, vibration, personal protective equipment.

Introduction. "Uzbekugol" OJSC carries out coal mining on the territory of Uzbekistan at Angren coal deposit by open pit (Angrensky surface mine, Apartak) and underground (Angrenskaya mine #9) methods. Shargun and Boysun deposits - mine "Shargunkumir" for the extraction of coal underground methods.

The most important professional risk factors of coal mines' production environment are noise, vibration, coal-bearing aerosols, carbon oxide and nitrogen dioxide [1].

All over the world, there are scientific researches on priority directions devoted to the improvement of methodological approaches to professional risk management, development of preventive measures in the sphere of health protection of the working population [2, 3].

Assessment of real risks using existing methods of risk assessment for individual risk factors and their consideration for large occupational groups, as well as using hygienic assessment of combined exposure to risk factors, can only serve as a preliminary stage. Due to incorrectly chosen assessment methods and methodological approaches, working conditions have

an unfavorable background that causes a high risk of developing professional and professionally conditioned morbidity among professions in industries [4, 5, 6].

In the Republic, the research on the working conditions of coal-mining enterprises for the last decades was carried out without considering the efficiency of individual protection means and "time protection" that confirms the actuality of professional risk assessment of coal industry workers [7].

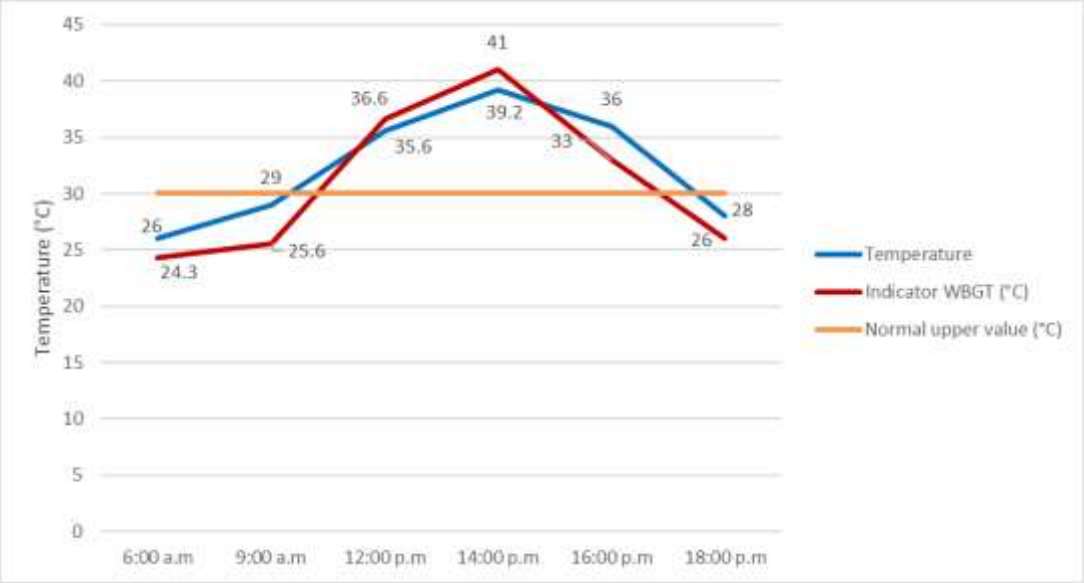
Purpose of work. Study and assessment of factors characterizing the working conditions of the coal mine workers for open-pit brown coal mining, underground mines for the production of coal and lignite.

Materials and methods. To achieve the goal, sanitary and hygienic, instrumental, calculation, analytical, and statistical research methods were used. Factors of working conditions at 250 workplaces of coal industry workers, including open and underground coal mining methods, were studied. The work was carried out according to the Institute's research plan on the theme "Hygienic characteristics of working conditions, assessment and management of the professional risk of health impairment of workers of Uzbekistan for 2015-2019". The determination of satisfactory work experience was carried out based on the accepted work experience of 25 years. Admissible work experience in the section and underground mines was calculated based on average dust concentration, category of work and number of shifts per year (average - 248 shifts). Calculations of the allowed work experience were made based on "Methodical guidelines for developing a professional risk forecasting model and preventive measures for employees' health" [8].

Results and discussions. Working conditions at Angren coal surface mine depend on the year's season and are characterized by both climatic and microclimatic conditions of workplaces. Microclimatic conditions of workers of the studied professions, such as mining machine operators and their assistants (in the cabins), depending on the open air temperature, ranging from +10 to +47 º C - in warm from -19 to +9 º C - in cold weather.

Working conditions of the workers of the studied professional groups engaged in the open coal mining, according to the degree of hazard and danger in the warm period of the year, belong to the 3rd class of 3-4 degrees and depend on the workers' exposure to solar radiation.

The workers engaged in opencast coal mining during the period from May to September work in conditions of heating microclimate IV of the Republic's climatic zone at air temperature over 370C. Consequently, solar radiation plays the leading role in forming a heating microclimate at the workplaces located at open territories (Pic. 1).



Picture 1. - A heating climate in the coal mine "Angrensky."

It is known that the assessment of the class of working conditions changes when the time of exposure to a harmful factor is reduced (protection by time). Consequently, the reduction of the impact of high air temperature and solar radiation on workers engaged in opencast coal mining can be achieved by evenly distributing the hottest time of the day (from 12 to 16 hours), by scheduling the work mode with a shift in the morning (from 6 to 14 hours) and daytime (from 14 to 22 hours) work shifts, as well as by organizing places that provide shade at work.

The analysis of noise level indicators at the workplaces of workers of the main professions engaged in opencast coal mining shows that the average equivalent noise levels at the workplaces exceeded the sanitary norms of excavator operators by 2 dBA, bulldozers and diesel locomotives by 3 dBA, technological transport drivers by 4 dBA, machinists of drilling rigs by 6 dBA and auxiliary transport operators by 10 dBA.

When working on coal mining transport equipment used on open-pit mines, workers are exposed to medium and high frequency ranges, and when working on drilling rigs - low and medium frequency ranges. Consequently, the working conditions of the listed occupations by noise correspond to class 3 of 1-2 degrees of harmfulness and danger.

The impact of noise on workers' bodies can be reduced through personal protective equipment hearing. In this regard, we have made calculations and established classes of working conditions for the professions studied, taking into account the means of individual protection from noise factors (Table 1).

Table 1. : Working conditions classes (WCC) for employees of the Angren coal mine in terms of noise indicators, considering the use of hearing protection equipment

№	Profession	Noise level, dBA	WCC	PPE efficiency, dBA	Noise level, dBA	WCC
1	Excavator driver	82	3.1	10*	72	2
2	Bulldozer driver	83	3.1	10*	73	2
3	Diesel locomotive driver	83	3.1	10*	73	2

4	Process vehicle driver	84	3.1	10*	74	2
5	Auxiliary vehicle driver	90	3.2	25**	65	2
6	Drilling rig operator	86	3.2	10*	76	2

*Note: * - use of earplugs; ** - use of headphones*

From the presented in table 1 data, it is visible that at the application of means of personal protection of organs of hearing, in the form of earphones or headphones, the class of working conditions on noise decreases to an acceptable level and corresponds to the 2nd safe class.
Therefore, to reduce the impact of noise on the body of workers engaged in coal mining, it is necessary to conduct an individual selection of means of individual protection of hearing organs (noise headphones, antiphons, earmolds - earplugs, bushings, swabs), their mandatory regular use and evaluation of the effectiveness of applied protective equipment.
It is established that the levels of general vibration exceed the hygienic norms of vibration velocity established in sanitary norms: drivers of technological transport - by 8 dB, excavator drivers, bulldozers and auxiliary transport operators - by 7 dB, locomotive drivers - by 6 dB. Excess of local vibration norms is registered at machinists and drivers (5 dB on average). Thus, workers' working conditions at the Angren open-pit coal mining equipment belong to class 3 of 1-2 degrees of harmfulness and danger due to high levels of both transport and transport-technological (general vibration) and local vibration.

To reduce the working conditions class by industrial vibration, we attempted to calculate parameters of the safe time of this factor influence on the organism of workers (Table 2).

Table 2.: Working conditions classes (WCC) of Angren coal mine workers considering the Allowable time of vibration impact

№	Profession	Excess RCP ratio	Exposure time, min	WSS	Allowable exposure time, min	WSS
1	Excavator driver	1,1	480	3.1	381	2
2	Bulldozer driver	1,1	480	3.1	381	2
3	Diesel locomotive driver	1,1	480	3.1	381	2
4	Process vehicle driver	1,1	480	3.1	381	2
5	Auxiliary vehicle driver	1,3	480	3.2	302	2
6	Drilling rig operator	1,1	480	3.2	381	2

It is determined that if the vibration exceeds the remote control by 1.1 times, the Allowable time of exposure is 381 minutes (6 hours 21 minutes), while if the vibration exceeds the remote control by 1.3 times, the Allowable time of exposure is 302 minutes (5 hours 2 minutes). Therefore, the total time of operation in conditions of exposure to industrial vibration not exceeding 5-6 hours, depending on the profession, will reduce the class of working conditions on this factor to a safe level.

At the open method of coal mining, the total dust content of the coal mine's atmospheric air is, on average 1.2±0.4 mg/m^3. Fibrinogenic Aerosol Dust (hereinafter referred to as FAD) rates at the work places of machinists (cabins of coal mining equipment) depended on the type of

equipment. Thus, FAD values at the working places exceeded MPC (4 mg/m^3) and were 11.1 mg/m^3 for excavator operators, 12.4 mg/m^3 for bulldozers, 16.2 mg/m3 for diesel locomotives, 25.7 mg/m^3 for auxiliary transport equipment and 13.3 for drilling rig operators. mg/m3. In the cabins of technological transport drivers, FAD concentrations depended on the type of work and were 16.3 mg/m^3 on average.

By its properties, coal dust refers to aerosols that have a fibrous effect on the body. According to the "Sanitary Rules and Hygienic Requirements for Coal Industry Enterprises" (SanPiN RU №0210-06), with the content of free silicon dioxide in coal up to 5% of the MAC is 10 mg/m3, from 5 to 10% of the MPC - 4 mg/m^3, and for coal and coal-rock dust with the content of free silicon dioxide from 10 to 70% of the MPC - 2 mg/m^3.

Set values of FAD concentration at the work places of opencast coal mining workers allowed to estimate working conditions of machinists, drivers and operator of the drilling rig. Working conditions of auxiliary transport machinist by dust factor correspond to class 3 of 3rd degree, and other professions - to class 3 of 2nd degree of harmfulness.

Study of technological process of underground coal mining has shown that the main works (drilling and blasting, coal-excavation and heading works, coal stripping, etc.) and auxiliary works (loading and transportation of coal, bottomhole cleaning, etc.) are accompanied by dust emission and, as a consequence, almost all workers of underground coal mines are exposed to dust factor (Table 3).

Table 3.: Working conditions classes (WCC) of underground mine workers in terms of air pollution by dust factor

Profession	**«Angrenskaya»**		**«Shargunkumir»**	
	FAD, mg/m^3			
	C_{av}	**WCC**	**C_{av}**	**WCC**
String Machine, Scraper	25,5	3.3	32,3	3.2
Cleaning face miner with demolition hammer, electric drills	78,6	3.4	90,5	3.3
Thunderstorm for cleaning lava, conveyor, chips	24,8	3.3	32,1	3.2
Fixer	29,2	3.3	38,0	3.2
Excavation machine operator (in the cleaning face)	64,5	3.4	84,3	3.3
Underground Machine Operator	9,7	3.2	16,0	3.1
Roadheader and loading and unloading machine operator	17,2	3.2	22,5	3.2
Electric locomotive driver	17,4	3.2	22,3	3.2
Puncher when working with a perforator	55,0	3.4	83,7	3.3
Bottleneck when working with a demolition hammer	30,2	3.3	37,2	3.2
Drilling Rig Engineer	21,1	3.2	27,2	3.2
Explosionist	50,2	3.4	62,5	3.3

Worker	7,4	3.1	11,6	3.1
Equipment repair locksmith	7,3	3.1	11,6	3.1

According to the certification of workplaces on working conditions, conducted in 2006, 2011 and 2015, dustiness in the places of coal preparation of mine № 9 "Angrenskaya" differed and averaged: in the lava - 118.0 ± 8.0 mg/m^3, in the tunnel face - 57.5 ± 7.5 mg/m^3, at the points of transhipment of the main conveyor lines - 25.1 ± 5.0 mg/m^3, in other mines - 10.2 ± 1.1 mg/m^3. The average dust concentration (C_{av}) during the work on bottomhole cleaning was 64.5±7.1 mg/m^3 (MPC - 4 mg/m^3), during the work of roadheaders CFC was at the level of 55.0±6.3 mg/m^3, during drilling and blasting operations - at the level of 50.2±8.1 mg/m^3.

According to the data of certification of workplaces on working conditions, conducted in 1993, 2008 and 2013, the average APFD indicators in the mine "Shargunkumir" were significantly higher than MAC (10 mg/m3) and were equal to: in lava - 147,5±10,2 mg/m^3, tunnel face - 71,9±12,7 mg/m^3, points of overload of the main conveyor lines - 31,2±7,1 mg/m^3 and other mountain spinners - 12,3±3,1 mg/m^3. Average APFD concentration at miners' work places in "Shargunkumir" mine was 6-10 times higher than MPCav (10 mg/m^3) and during bottomhole cleaning, it was 95,3±8,7 mg/m^3, work of heading machines - 83,7±8,4 mg/m^3, drilling and blasting operations - 62,5±6,6 mg/m^3.

A comparative analysis of the established classes of working conditions of the workers of the studied professions showed that the parameters of the Class at Angrenskaya mine No.9 (lignite) are lower, and the classes of working conditions are higher than those of the workers of Shargunkumir mine (hard coal). This situation can be explained by the fact that in lignite, the content of free silicon dioxide varies from 9.8 to 10.1% (MPC - 4 mg/m^3), and in hard coal of free silica - up to 5% (MPC - 10 mg/m^3). In this connection, working conditions of workers engaged in brown coal mining in underground mine #9 "Angrenskaya" compared with such workers of "Shargunkumir" mine are more harmful by dust factor and correspond to class 3 of 1-4 degree of harmfulness.

Further, in work, we have made calculations and established classes of working conditions for the studied professions, taking into account personal respiratory protection equipment and reducing exposure to dust factor (Fig. 2).

From the data presented in Table 4, it can be seen that with the use of personal respiratory protection equipment in the form of half masks, classes of working conditions for dust factor decreased by 1-2 stages, depending on the actual level of dust concentration at the workplaces of workers of the studied professions.

Consequently, to reduce dust impact on an organism of workers engaged in underground coal mining, it is necessary to carry out an individual selection of means of individual respiratory protection, obligatory regular use in the process of work and evaluation of their efficiency.

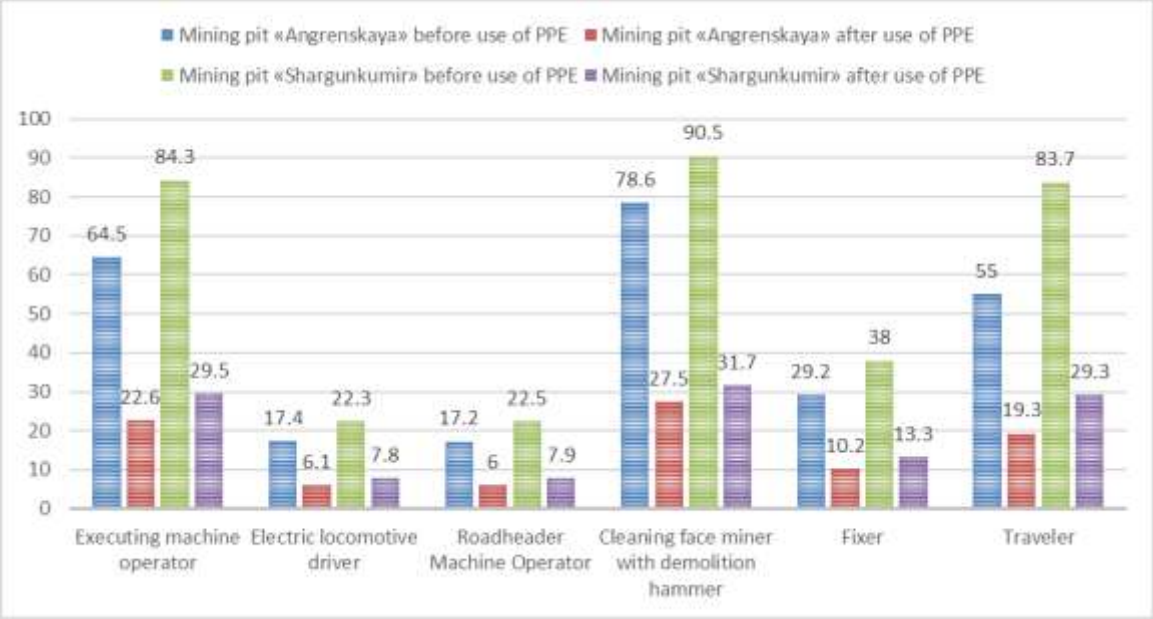


Figure 2: Inhaled air dust levels before and after the use of personal respiratory protection equipment (PPE)

The efficiency of respiratory protection depends on several factors: the size of dust particles, the degree of insulation of the underwear space from the surrounding dusty air, but primarily on the size and number of gaps in places where the mask does not fit tightly to the face. As shown above, the working conditions of workers engaged in the extraction of brown coal in the underground mine number 9 "Angren", compared to such workers in the mine "Shargunkumir" on the dust factor were more harmful and corresponded to the mine number 9 "Angren" 3 class 1-4 degree of harmfulness, and in the mine "Shargunkumir" - 3 class 1-3 degree.

To establish actual classes of working conditions for the dust factor, we made calculations taking into account dust dispersion parameters. Obtained data changed the picture established by the traditional method, the class of working conditions. Considering dust dispersion, classes of working conditions of workers engaged in brown coal mining in underground mine #9 "Angrenskaya" decreased by 1 stage, while in mine "Shargunkumir" the classes of working conditions on dust factor, on the contrary, increased by 1 stage. Thus, working conditions, taking into account the dispersibility of dust, in the mine "Shargunkumir" are presented as more harmful and, in almost all professions, corresponded to 3 class 2-4 degrees, and in mine ¹ 9 "Angren" mainly - 3 class 1-3 degrees (Table 4).

Table 4.: Working conditions classes (WCC) of underground mine workers by air dustiness indicators of workplaces taking into account dust dispersibility (MPC of lignite dust - 4 mg/m^3, of black coal - 10 mg/m^3)

Profession	C_{av} mg/m^3	WCC	Dispersity, %	C_{av} alveolar dust	MPC, mg/m^3	WCC

mine #9 " Angrenskaya" for lignite mining						
Executing machine operator	64,5	3.4	25,8	16,6	2	3.3
Electric locomotive driver	17,4	3.2	17,0	3.0	2	3.1
Roadheader Machine Operator	17,2	3.2	16,9	2.9	2	3.1
Cleaning face miner with demolition hammer	78,6	3.4	24,4	19.2	2	3.3
Fixer	29,2	3.3	11,7	3.4	2	3.1
Traveler	55,0	3.4	22,0	9.1	2	3.2
the " Shargunkumir " mine for coal mining						
Executing machine operator	84,3	3.3	42,1	35.5	2	3.4
Electric locomotive driver	22,3	3.1	37,2	8,4	2	3.2
Roadheader Machine Operator	22,5	3.1	37,7	8,5	2	3.2
Cleaning face miner with demolition hammer	90,5	3.3	37,5	34,0	2	3.4
Fixer	38,0	3.2	37,6	14,3	2	3.3
Traveler	83,7	3.3	26,3	31,4	2	3.4

Therefore, in establishing the class of working conditions for the dust factor and the calculation of the dust load on the body of workers, it is necessary to take into account not only the average values of the actual concentration of dust in the air of the working area, MPC, the average volume of pulmonary ventilation, exposure time per shift, the number of work shifts in a calendar year (worked in a dusty environment), the duration of the work shift, the coefficient of efficiency of the used means of individual respiratory protection, but also the dispersion of dust.

The calculation of the Allowable work experiencefor the leading production factors, forming the professional risk of coal industry workers, was performed at work. Allowable (safe) work experience, depending on the working conditions and total exposure time of heating microclimate, is given in Table 5.

Calculation of the allowable work experience on heating microclimate was carried out only for the workers employed in the Angren coal mine at surface mining because, due to their labor activity, they are exposed to solar radiation in the warm period of the year. Allowable work experience for workers of such professions as mining master, diesel locomotive driver and blaster, whose working conditions were estimated as class 3 of 3 degrees is 15.5 years, and for other professions with working conditions class 3.4, the Allowable work experience on heating microclimate - 8 years.

Table 5.: Allowable work experience on heating microclimate, depending on the class of working conditions and total exposure time

Professions	Working conditions class	Allowable work experience, years
"Angrensky" section		
Mining Master	3.3	15,5
Excavator driver	3.4	8
Bulldozer Machine	3.4	8
Diesel locomotive driver	3.3	15,5
Auxiliary vehicle driver	3.4	8
Process vehicle driver	3.4	8
Mining worker	3.4	8
Equipment repair locksmith	3.4	8
Drilling rig operator	3.4	8
Explosionist	3.3	15,5

To calculate the allowable work experience were selected professions of workers, for which one of the leading adverse factors of working conditions was the dust load. The Angrensky surface mine workers' allowable work experience, calculated considering these indicators, is 8.7 years on average (from 3.9 to 12.2 years).

Allowable work experience, depending on the class of dust load conditions, was calculated using the work category, average shift concentration and its MPC, actual and control dust loads (Table 6).

It was found that the minimum allowable work experience for the dust factor is consistently characteristic for auxiliary transport operators (3.9 years), locomotive operators and process transport drivers (6.1-6.2 years), drilling rig operators (7.5 years) and bulldozer, excavator and miners (8.1-10.1 years).

From the presented data, we can see that 12 years of allowed work experience on the dust factor was typical for 3 out of 10 studied professions of the Angrensky surface mine workers. Allowable work experience on dust factor in mine #9 "Angrenskaya" of workers engaged in underground mining of brown coal was only 3,3 years on average (from 1,3 to 5,8 years). Conducted calculations on dust load testify that workers' allowable experience in underground mining of coal of "Shargunkumir" mine is 6 years (from 2,8 to 11,2 years) on the average.

Table 6.: Allowable work experience depending on the class of working conditions for dust load

Profession	Work category	C_{av}, mg/m^3	MPC_{av}, mg/m^3	Dust load, mg	Control dust load, mg	Allowable work experience, years
"Angrensky" section						

Mining Master	I б	8,2	4,0	8134,4	3968,0	12,2
Excavator driver	II б	11,1	4,0	19269,6	6944,0	9,0
Bulldozer Machine	II б	12,4	4,0	21526,4	6944,0	8,1
Diesel locomotive driver	I б	16,2	4,0	16070,4	3968,0	6,2
Auxiliary vehicle driver	II б	25,7	4,0	44615,2	6944,0	3,9
Technology vehicle driver	II б	16,3	4,0	28296,8	6944,0	6,1
Mining worker	II б	9,1	4,0	15798,0	6944,0	10,1
Equipment repair locksmith	II a	8,2	4,0	14235,2	6944,0	12,2
Drilling rig operator	II б	13,3	4,0	23088,8	6944,0	7,5
Explosionist	I б	8,3	4,0	8233,6	3968,0	12,0
mine #9 " Angrenskaya" for lignite mining						
Excavation machine operator (in the cleaning face)	II б	64,5	4,0	111972,0	6944,0	1,6
Electric locomotive driver	I a	17,4	4,0	17260,8	3968,0	5,7
Roadheader and loading and unloading machine operator	II б	17,2	4,0	29859,2	6944,0	5,8
Cleaning face miner with demolition hammer and electric drills	III	78,6	4,0	194928,0	9920,0	1,3
Fixer	II б	29,2	4,0	50691,2	6944,0	3,4
Puncher when working with a perforator	III	55,0	4,0	136400,0	9920,0	1,8
the "Shargunkumir" mine for coal mining						
Excavation machine operator (in the cleaning face)	II б	84,3	10,0	146344,8	17360,0	3,0
Electric locomotive driver	I a	22,3	10,0	22121,6	9920,0	11,2
Roadheader and loading and unloading machine operator	II б	22,5	10,0	39060,0	17360,0	11,1
Cleaning face miner with	III	90,5	10,0	224440,0	24800,0	2,8

demolition hammer and electric drills						
Fixer	II б	38,0	10,0	65968,0	17360,0	6,6
Puncher when working with a perforator	III	83,7	10,0	207576,0	24800,0	3,0

Thus, presented data on allowed work experience testifies that the most harmful and dangerous working conditions on dust factor are marked in mine #9 "Angrenskaya", i.e. the workers engaged in underground mining of brown coal have the highest risk of development of professional pathology connected with the influence of dust.

Allowable work experience, depending on the class of working conditions at 8 hours of noise exposure, was calculated for the occupations of workers most exposed to this factor. It was determined that in underground mines #9 "Angrenskaya" and "Shargunkumir," safe work experience for electric locomotive operators, roadheader and loading-and-delivery machines is 4.5 years on average (Table 7).

Table 7.: Admissible work experience depending on the class of working conditions by noise at 8 hours exposure

Profession	Work category	Noise level, DBA	Allowable work experience, years
“Angrensky” section			
Drilling rig operator	3.2	86	12,6
Explosionist	3.2	87	11
mine #9 " Angrenskaya" and the "Shargunkumir"			
Electric locomotive driver	3.2	91	5,0
Roadheader and loading and unloading machine operator	3.2	92	4,0

It is known that the production factor - vibration - affects the development of professional pathology and depends on its level and type (local, general). Considering that one of the leading professional pathologies is vibration disease, we have made calculations of the acceptable work experience, depending on the impact of general and local vibration (Table 8).

From the data presented in the table, we can see that the class of working conditions determined by the impact of vibration on workers depended on the brand, type, service life and condition of used mechanized equipment and hand tools, as well as hardness of coal rock (brown, stone), but did not depend on the method of coal mining (open, underground). In class 3.2 of working conditions, established from the local vibration level, the Allowable work experiencewas 7 years, and at class 3.4 - reduced to 5 years. At 5 years of work experience in conditions of influence of general vibration (3 class 2 degree), initial signs of vibration disease were observed, and in 10 years of exposition experience, the development of vibration disease

was noted. Calculations showed that under working conditions assessed by general vibration as 3 class 3 degree, the development of vibratory disease is revealed at the same exposition experience (10 years), but an increase in the number of cases of registration of vibratory pathology was observed. Whereas, at a class of working conditions 3.4, established on the indicator of general vibration, the increase in number of cases of vibratory illness is revealed at the same exposition experience (5 years of work experience).

Table 8.: Allowable work experience depending on the class of working conditions on vibration at 8-hour exposure.

Professions	Working conditions class	Allowable work experience, years initial signs/vibration disease
"Angrensky" section		
Excavator driver	3.2*	7
Bulldozer Machine	3.2*	7
Diesel locomotive driver	3.2**	5/10
Process vehicle driver	3.2**	5/10
mine #9 " Angrenskaya" and the "Shargunkumir"		
Stringer and scraper machine operator	3.3**	5/10
Electric locomotive driver	3.2**	5/10
Underground machine operator (wagon tipper)	3.3**	5/10
Drilling Rig Engineer	3.3**	5/10
Cleaning face miner with demolition hammer and electric drills	3.4*	5
Fixer	3.2**	5/10
Puncher when working with hammers	3.4**	5
Bottleneck when working with demolition hammers	3.3*	5/10
Drilling Rig Engineer	3.3*	5,5

*Note: * - local vibration; ** - general vibration*

Thus, their all calculated values of the admissible work experience for the studied production factors, the lowest values were characteristic of the dust factor. It was determined that depending on the profession, the allowable work experience on dust in the section "Angrensky" ranged from 3.9 to 12.2 years, in mine № 9 "Angrenskaya" - from 1.3 to 5.8 years and in mine "Shargunkumir" - from 2.8 to 4.2 years.

The analysis of acceptable work experience testifies that workers engaged in underground mining of brown coal in mine #9 "Angrenskaya" had the highest risk of developing professional pathology connected with the influence of dust. Therefore, to increase working capacity and work experience, it is necessary to take preventive measures to protect coal industry workers' health utilizing collective and individual protection.

Conclusions:

1. Working conditions of workers engaged in surface coal mining during the warm period depend on the duration of exposure to solar radiation on the body of workers and optimization of working conditions is achieved by the uniform distribution of the hottest time of the day (from 12 to 16 hours), by scheduling the work mode with a shift in the morning (from 6 to 14 hours) and daytime (from 14 to 22 hours) work shifts.
2. When working on the applied coal mining transport equipment, the working conditions of the studied professions according to the noise level at open-pit mines correspond to the 3rd class of 1-2 degrees, and on underground works - to the 3rd class of 1, 2 and 3 degrees of harmfulness and danger. To reduce the impact of noise on workers' organisms, it is necessary to carry out an individual selection of individual protection of hearing organs.
3. Working conditions at surface coal mining by vibration are as follows:
to the 3rd class of 1-2 degrees of hazard and danger, and underground mine workers by the local and general vibration level belong to the 3rd class of 1, 2, 3 and 4 degrees of hazard and danger. The reduction of total time of work in conditions of influence of industrial vibration not exceeding 5-6 hours, depending on a profession, will reduce a class of working conditions on this factor to a safe level.
4. Application of personal protective equipment and reduction of exposure to such harmful production factors as heating microclimate, noise, vibration and dust allowed reducing the class of working conditions by 1-2 levels.
5. Considering dust dispersion, working conditions classes of workers engaged in lignite mining were reduced, and those engaged in coal mining were increased by 1 stage.
6. The lowest values of the allowable work experience for the studied production factors were characteristic of the dust factor and, depending on the profession, the allowable work experience for dust in the Angrensky mine varied from 3.9 to 12.2 years, in the Angrenskaya mine #9 - from 1.3 to 5.8 years and in the Shargunkumir mine - from 2.8 to 4.2 years; it testifies to the fact that workers engaged in underground mining of brown coal in mine #9 "Angrenskaya" had the highest risk of development of professional pathology connected with influence of dust.

Reference.

[1] Adilov, U.H. Influence of factors of industrial environment on the state of health of coal industry workers // Health and environment : a collection of scientific articles / M-in Health Republic of Belarus, RUE "Scientific and practical center of hygiene" ; Ch. I. Sychik. - Minsk : RNMB, 2016. - Episode. 26. - pp. 163–166.
[2] Kuzmina, L.P. Modern medical technologies in diagnostics and risk estimation of professional diseases development (in Russian) // Meditsina labor and industrial ecology. - – M., 2013. - №7. - pp. 9-13.
[3] Rushkevich, O.P. Actual problems of prevention of occupational pathology in coal industry workers // Zdravookhraneniye Rossiyskoy Federatsii. - – M., 2001. - №2. - pp. 25-27.

[4] Skrypal, B.A. The role of professional-production risk factors in the formation of morbidity levels at mining underground mines of the Kola Peninsula // B.A. Skrypal, A.N. Nikanov // Human Ecology - Arkhangelsk, 2005. - №5. - pp. 10-13.
[5] Hou C.L. Prevalence and risk for posttraumatic stress disorder from a coal mining accident after 2 and 10 months / C.L. Hou, L.J. Li, Y.Zhang // Zhong Nan Da Xue Xue Bao Yi Xue Ban. - – 2008. - №33 (4) - P. 279-283.
[6] C.A. Soutar, J.F. et al. Dust concentration and respiratory risks in coal miners: key risk from the British Pneumoconiosis Field Research / C.A. Soutar, J.F. Soutar. Hurley //Occup. Environ Med. - – 2004. - №61 (6). - P. 477-481.
[7] Adilov U.H., Khashirbaeva D.M. Characteristics of general classes of working conditions and professional risks established by different methods// International Journal of Applied and Fundamentals Research, 2019. -№10-2. - pp.250-257.
[8] Ibragimova G.Z. et al. Methodical manual on development of professional risk forecasting model and preventive measures for employees' health // Methodical recommendations. - Tashkent, 2005. - p.76.