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Satbayev University

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ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
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Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

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ANALYSIS OF THE LEVEL OF OCCUPATIONAL INJURIES ON THE EXAMPLE OF AN INDUSTRIAL ENTERPRISE OF A METALLURGICAL CLUSTER

Abstract. The article analyzes injuries in the smelting shops of the Aktobe ferroalloy Plant for the period from 2012 to 2020. The manifestation of injury cases at metallurgical cluster enterprises, in particular, metallurgical plants, is associated with a number of reasons, such as technical, organizational, technical, technological, maintenance and repair, maintenance and repair of electrical equipment, road transport, other types of accidents and psychophysiological factors. Using a statistical method, an analysis of the dynamics of changes in the number of incidents for reasons for the analyzed period was carried out. As a result of the study, the dynamics and nature of changes in the main indicators of occupational injuries have been established. The dynamics of the change in the effective indicator from the main factors is investigated, a mathematical model of the change in the frequency coefficient, the severity coefficient and the coefficient of the general injury index is obtained.

Based on the results of the study, it was concluded that in order to ensure safe working conditions, it is necessary to develop measures and conduct research on the actual materials of the enterprise. It is established that, along with taking into account the influence and significance of factors on the index of occupational injuries, it is necessary to pay attention to the study of psychological parameters of employees when they perform functional duties at the workplace.

Key words: injury; accident; occupational safety, research, frequency coefficient, severity coefficient, injury index coefficient.

Introduction. In industrial enterprises and mining and metallurgical industries, there is an established system of safe working conditions and protection of workers' vital activity. Metallurgical enterprises, in particular metal production plants, are among the most dangerous from the point of view of ensuring safe working conditions.

The system of organization of safe working conditions at industrial enterprises is regulated by existing regulatory documents and regulations: regulatory legal acts (Codes, Laws of the Republic of Kazakhstan, Government Resolutions); Conventions of the International Labor Organization ratified in Kazakhstan; regulatory and technical documents (Interstate standards (GOST), State Standards of the Republic of Kazakhstan (ST RK), Building Codes and Regulations (BCaR), Sanitary Rules and Regulations (SanRulaR, SR).

Let's consider the existing system of organization of safe conditions and labor protection and provision of workers on the example of the Aktobe ferroalloy plant of JSC TNK Kazchrome. [2,3]. At the industrial enterprises of the metallurgical cluster, the organizational structure of OOT and PB is generally accepted. The responsible chief Technical supervisor for labor protection is the head of the OOT and PB.

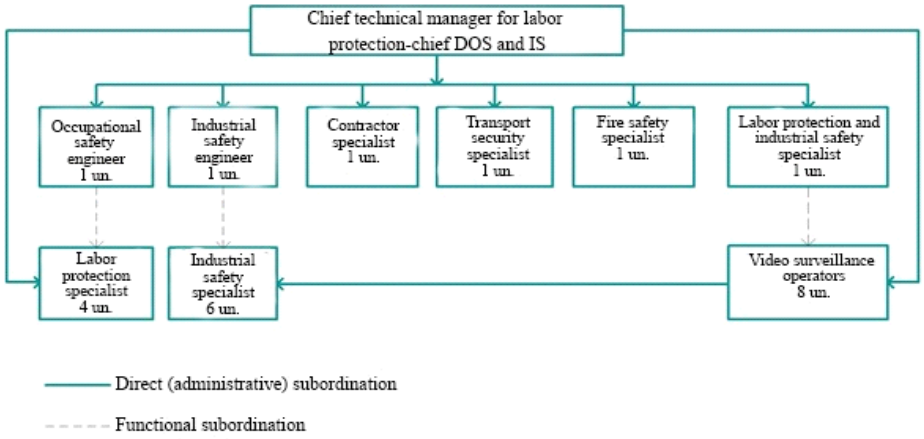

Figure 1. Organizational structure of OOT and PB

Industrial enterprises of similar types have a system that meets regulatory requirements. For the qualitative organization of safe working conditions, the administration of the enterprise uses in-house standards and instructions corresponding to the specifics of ensuring safe working conditions at specific production sites and workplaces. For example, in a number of industrial enterprises there are in-plant regulations and instructions on safety and labor protection (instructions for a ferroalloy smelter, smelter dispensers, crane operator, etc.). Taking into account these regulatory documents, the system and requirements for labor protection and ensuring safe production conditions are organized and regulated at enterprises. Along with organizational and technical measures at enterprises, there is a system for receiving training of personnel (introductory instruction, on-the-job instruction, etc.). According to the results of production activities, according to the hierarchy of production, the «Committee for Industrial Development and Industrial Safety» is compiled and provided to the republican state institution.

Materials and methods of research. As a result of the production activities of enterprises at the AZF of TNK Kazchrome JSC in recent years, the state of occupational safety and health is characterized by the following data:

Table 1 - Grouping of NS by types and places, accident zones

№	Causes of accidents	Number of incidents	Number of victims	Number of dead	Values of indicators by year								
					2012	2013	2014	2015	2016	2017	2018	2019	2020
1	technical	4 (12,5%)	4	-	2	-	-	-	-	-	-	1	1
2	organizational and technical	5 (15,5%)	5	-	1	-	-	-	1	-	-	2	1
3	technological operations	5 (15,5%)	7	-	-	-	-	-	-	1	-	3	3
4	maintenance and repair	3 (9,5%)	3	-	-	1	-	-	-	-	-	2	-
7	maintenance and repair of electrical equipment	1 (3%)	-	1	-	-	-/1	-	-	-	-	-	-
8	road transport	2 (6,5%)	-	2	-	2/2	-	-	-	-	-	-	-
9	other types of incidents	12 (37,5%)	11	1	4	1	1	1	-	1	1/1	-	2
	Total	32	30	4	7	2/2	1/1	1	1	2	1/1	8	7

Note: 3/1 the numerator is the number of victims, the denominator is the number of n/a. with a fatal outcome.

The data given in Table 1 show that during the analyzed period, the number of accidents and accidents is 32, 34 injured, including the number of deaths is 4.

The dynamics of changes in accidents over the years shows that over the past nine years, the number of accidents in the enterprise as a whole ranges from one to seven and is very uneven. This indicates the accidental nature of the occurrence of the causes of accidents. Accidents and accidents are distributed by production sites and zones and depend on the specifics and types of work performed. The results of the analysis of Table

1 show that accidents and accidents occur for the reasons grouped in the table (technical, organizational, technical, technological operations, maintenance and repair, LLP and electricity, road transport, other types of accidents).

It can be seen that the distribution of the number of accidents for various reasons for the analyzed period is represented by data: when performing technological operations – 15.5%, organizational and technical - 15.5%, technical - 12.5%, road transport - 6.5%, maintenance and repair - 9.5%, other types of accidents - 37.5%.

Over the past five years, the same indicators of causes have changed as follows: when performing technological operations – 12.5%, organizational and technical - 25%, technical - 50%, maintenance and repair - 50%, other types of accidents - 33%. The results of the analysis show that the specified types of causes of accidents, the largest increase in dynamics is observed for the studied factor in 2019-2020. It can be seen that in the period 2013-2018, there were practically isolated accidents that occurred due to organizational, technical, technological, maintenance and repair, etc. At the enterprise, the number of accidents that occurred by type of work (road accidents, maintenance and repair of electrical equipment) was not observed. Thus, there is a tendency to weaken attention to the system organization and control over compliance with the requirements for labor protection and labor safety regulated by rules and regulations at the level of performers of technological operations. In our opinion, such phenomena are explained by the manifestation of the human factor, namely, the psycho-physiological characteristics of not only the performers of utility operations, but also the direct owners of the process, the requirements for which are prescribed in the relevant regulatory documents and procedures of the occupational safety system at the enterprise. The analysis of the above data shows the need to improve the system of organization of safety and OT when performing other types of accidents, maintenance and repair, technological operations, organizational and technical causes of accidents. In our opinion, one of the important causes of accidents is the psychophysiological characteristics of workers employed at dangerous and especially dangerous production sites. The need to take into account such factors has been repeatedly noted in the scientific literature. [8, 9]

Table 2 - Quantitative indicators of industrial injuries at the gas station

№ п/п	Indicators	Values of indicators by year								
		2012	2013	2014	2015	2016	2017	2018	2019	2020
1	Number of employees in organizations, B, peop.	3161	3311	3784	3872	3991	4236	4278	4402	4286
2	The number of accidents, A	7	4	2	1	1	2	2	6	7
3	Number of victims	7	2	1	1	1	2	1	8	7
	Number of dead, L	0	2	1	0	0	0	1	0	0
	The number of victims with a severe outcome	5	2	-	-	-	2	-	5	5
	The number of victims with a mild outcome	2	-	1	1	1	-	1	3	2
4	Number of victims of group accidents	-	-	-	-	-	-	-	3	-
5	The number of calendar days of disability, C	604	197	31	132	60	282	254	471	563
6	Frequency factor, C_f	2,21	1,21	0,52	0,25	0,25	0,47	0,46	1,36	1,63
7	Gravity coefficient, C_s	86,3	49,25	15,5	132	60	141	127	78,5	80,4
8	General injury rate, C_g	191	59,6	8.1	33	15	66,3	59	1068	131
9	Mortality rate	0	0,6	0,26	0	0	0	0,23	0	0

The level of injuries at the Aktobe Ferroalloy Plant (hereinafter referred to as AZF) was analyzed for the period from 2012 to 2020 by statistical method, the results are given in Table.2. The study of the dynamics of occupational injury indicators shows that during the nine years from 2012 to 2020, the number of accidents and their frequency decreased, but in 2019, 2020, these indicators increased sharply.

The dynamics of employee growth is characterized by an increase in the number of employees during the study period, which is 11% in percentage terms. The analysis of the increase in the number of accidents shows that the number of accidents during this period, which is a percentage of 250%. Here, the total share of the number of accidents for the year as a whole for the enterprise is 0.16%. Obviously, it is necessary to improve the system of ensuring safe working conditions in the whole enterprise in order to reduce the intensity of the growth of accidents.

We have analyzed the structural grouping of the number of accidents of the type, location, and zones of accidents at the enterprise for the period from 2012-2020. The changes in the number of victims according to the analyzed types of accidents are considered. At the same time, the indicators of the first three characteristics, taken as a productive feature, which vary greatly depending on the year of the incident.

Results and discussions. It is necessary to change the approach to the consideration of the causes of accidents from the point of view of identifying additional factors affecting the value of the effective indicator.

To determine the level of injuries, a statistical method was used, which consists in processing and studying statistical material based on the results of the accident investigation for the specified period. According to this method, a number of coefficients are determined, which are relative indicators of the level of injuries at the enterprise. This allows you to get a correct and complete picture of the level of injuries, moreover, only according to the absolute number of accidents that occurred at the enterprise during the time period under study. These include: injury frequency coefficient C_f; injury severity coefficient C_s; hazard coefficient C_h.

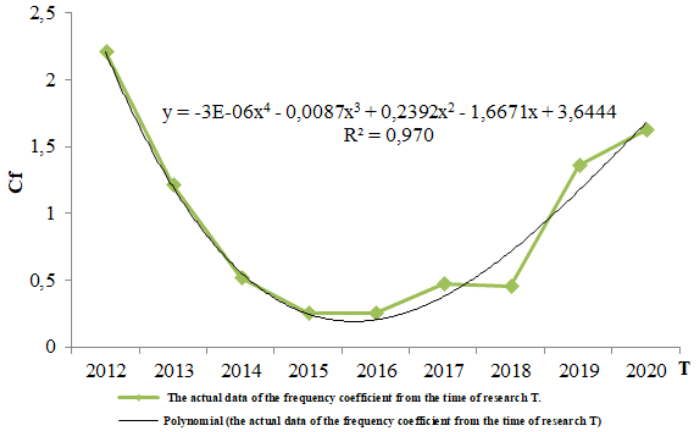

Figure 1. Graph of the dependence of the frequency coefficient C_f (y) on the study time T (x).

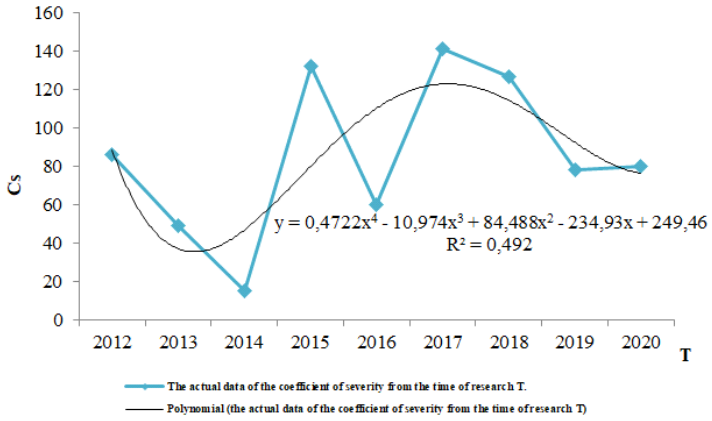

Figure 2. Graph of the dependence of the severity coefficient of C_s (y) on the time of studies T (x).

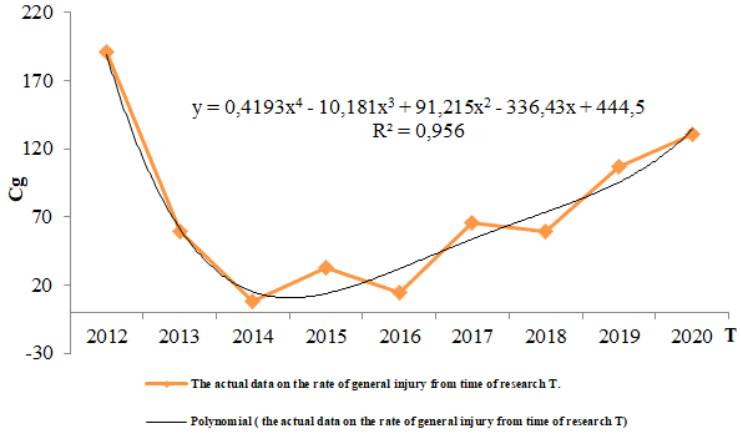

Figure 3 Graph of the dependence of the indicator of general injury C_g (y) on the time of studies T (x).

These dependence graphs are described by polynomial dependences, respectively:
The frequency coefficient of the C_f: y = -3E-06x4 - 0,0087x3 + 0,2392x2 – 1,6671x + 3.6444
gravity coefficient C_s: y = 0,4722x4 - 10,974x3 + 84,488x2 – 234,93x + 249,46

the index of total injury C_g: y = 0,4193x4 - 10,181x3 + 91,215x2 – 336,43x + 444.5

The analysis of the above dependencies shows that the indicators of the coefficients of frequency, severity, indicators of general injury during the study period vary as follows. The injury frequency coefficient varies from 0,25 to 2,21 (in 2016 and 2012, respectively, C_f = 0,25 and C_f = 2,21). The injury severity coefficient for the study period varies from 15,5 to 141 and has two extremes for the study period (2014 and 2017, respectively, C_s = 15,5 and C_s = 141). The values of the coefficient of the indicator of total injuries of the C_g for the same period ranges from 15 to 191 (2012 and 2016 respectively, C_g =191 and C_g=15). The analysis of the dynamics of C_f, C_s and C_g shows that the value of these factors varies greatly over the years and is characterized by the data given in Figures 1,2,3. From the graphs it follows that the studied factors indicate that there is a tendency to increase the absolute values of the coefficients of C_f, C_s and C_g in recent years with a significant level of variation in their values. It is obvious that there is a need to improve comprehensive measures to minimize the values of coefficients characterizing the quality of the organization of the system to ensure safe working conditions.

Based on the results of this study, it is possible to conclude about the significance of changes in the above factors on the resulting indicator. It is obvious that in this case it is necessary to improve the system of ensuring safe working conditions for enterprises as a whole in the areas of improving organizational and technical measures, strengthening the requirements for occupational safety in the workplace of technological operations, maintenance and repair [6, 7]. It is necessary to pay special attention when performing other types of work that are not directly related to production. Consideration of accidents on the basis of a more in-depth analysis of factors affecting the number of accidents, such as the use of elements of labor organization, advanced methods of labor organization techniques in the workplace, on the basis of labor organization, the use of safer labor tools, etc. In our opinion, it is advisable to improve and expand the existing practice of workplace timekeeping in order to determine the most significant factors affecting the safety of working conditions, ergonomic indicators of specific operations at workplaces that cause not only a decrease in productivity, but also the overall psychophysiological state of the worker.

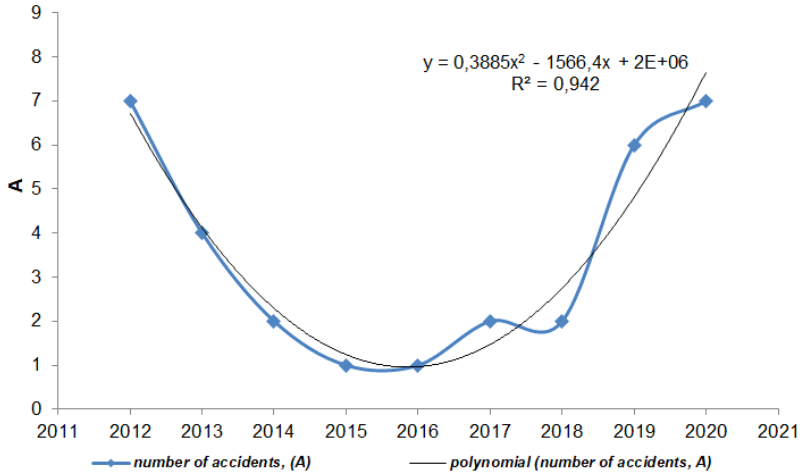

Figure 4. Graph of the dependence of the indicator of the number of accidents in the study period

Figure 4 shows a graph of the dependence of the number of accidents in the study period. This dependence is presented in the form of a polynomial model. Analysis of this model shows that the number of accidents in recent years tends to increase. One of the objective reasons for this process is also the indicator of the growth in the number of employees at enterprises in recent years, which are shown in Table 2.

Conclusions. As shown above, the manifestation of injury cases at metallurgical cluster enterprises, in particular, metallurgical plants, is associated with a number of reasons, such as technical, organizational, technical, technological, maintenance and repair, maintenance and repair of electrical equipment, road transport, other types of accidents and psychophysiological factors. The distribution of the number of accidents for reasons for the analyzed period is shown, which is characterized by data: when performing technological operations – 15,5%, organizational and technical – 15,5%, technical – 12,5%, road transport – 6,5%, maintenance and repair – 9,5%, other types of accidents – 37,5%. The obtained data should be taken into account when planning a set of measures to ensure safe working conditions at work.

As a result of the study, the dynamics and nature of changes in the main indicators of occupational injuries

have been established. It is established that the prevailing factors of changes in injury rates are the severity coefficient and the coefficient of the indicator of general injury, which in recent years has tended to increase. The dynamics of the change in the effective indicator from the main factors was studied, a mathematical model of the change in the frequency coefficient y = -3E-06x4 - 0,0087x3 + 0,2392x2 – 1,6671x + 3,6444 was obtained: the severity coefficient y = 0,4722x4 - 10,974x3 + 84,488x2 – 234,93x + 249,46: the indicator of general injury y = 0,4193x4 - 10,181x3 + 91,215x2 – 336,43x + 444,5. The analysis of the obtained models showed a close correlation between the effective feature and the studied factors.

At present, the metallurgical production is undergoing reconstruction and the introduction of new innovative technologies that impose higher requirements not only on the professional level, but also on the psychophysiological parameters of employees. Moreover, the influence of the latter factor according to the literature data can be 65-70%. In order to assess the importance of this factor in ensuring safe working conditions, it is necessary to develop measures and conduct research on the actual materials of enterprises. It is established that, along with taking into account the influence and significance of factors on the index of occupational injuries, it is necessary to pay attention to the study of psychological parameters of employees when they perform functional duties at the workplace.

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МЕТАЛЛУРГИЯЛЫҚ КЛАСТЕРДІҢ ӨНЕРКӘСІПТІК ҚӘСІПОРНЫ МЫСАЛЫНДА ӨНДІРІСТІК ЖАРАҚАТТАНУ ДЕҢГЕЙІН ТАЛДАУ

Аннотация. Мақалада Ақтөбе ферроқорытпа зауытының балқыту цехтарындағы 2012-2020 жылдар аралығындағы жарақатқа талдау жасалды. Металлургия кластерінің кәсіпорындарында, атап айтқанда металлургия зауыттарында жарақаттану жағдайларының көрінісі техникалық, ұйымдастырушылық-техникалық, технологиялық, техникалық қызмет көрсету және жөндеу, Электр жабдықтарын жөндеу, жол-көлік, оқиғаның басқа түрлері және психофизиологиялық факторлар сияқты бірқатар себептерге байланысты. Статистикалық әдісті қолдана отырып, талданатын кезеңдегі себептер бойынша оқиғалар санының өзгеру динамикасына талдау жасалды. Зерттеу нәтижесінде өндірістік жарақаттанудың негізгі көрсеткіштерінің өзгеру динамикасы мен сипаты анықталды. Негізгі факторлардан тиімді көрсеткіштің өзгеру динамикасы зерттелді, жиілік коэффициентінің өзгеруінің математикалық моделі, ауырлық коэффициенті және жалпы жарақаттану коэффициентінің коэффициенті алынды.

Зерттеу нәтижелерінің негізінде қауіпсіз еңбек жағдайларын қамтамасыз етуде іс-шараларды әзірлеу және кәсіпорынның нақты материалдарында зерттеулер жүргізу қажет деген қорытынды жасалды. Өндірістік жарақаттану көрсеткішіне факторлардың әсері мен маңыздылығын ескере отырып, жұмысшылардың жұмыс орындарында функционалдық міндеттерін орындау кезінде олардың психологиялық параметрлерін зерттеуге назар аудару қажет екендігі анықталды.

Түйінді сөздер: жарақаттану, жазатайым оқиға, еңбекті қорғау, зерттеулер, жиілік коэффициенті, ауырлық коэффициенті, жарақаттану көрсеткішінің коэффициенті.

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АНАЛИЗ УРОВНЯ ПРОИЗВОДСТВЕННОГО ТРАВМАТИЗМА НА ПРИМЕРЕ ПРОМЫШЛЕННОГО ПРЕДПРИЯТИЯ МЕТАЛЛУРГИЧЕСКОГО КЛАСТЕРА

Аннотация. В статье проведен анализ травматизма в плавильных цехах Актюбинского завода ферросплавов за период с 2012 по 2020 годы. Проявление случаев травматизма на предприятиях металлургического кластера, в частности металлургических заводах, связана с рядом причин, как

технические, организационно-технические, технологические, техническое обслуживание и ремонт, ТО и ремонт электрооборудования, дорожно-транспортные, прочими видами происшествия и психофизиологическими факторами. Используя статистический метод проведен анализ динамики изменения количества происшествий по причинам за анализируемый период. В результате исследования установлена динамика и характер изменения основных показателей производственного травматизма. Исследована динамика изменения результативного показателя от основных факторов, получена математическая модель изменения коэффициента частоты, коэффициент тяжести и коэффициент показателя общего травматизма.

На основании результатов исследования сделан вывод, что в обеспечении безопасных условий труда необходимо разработать мероприятия и провести исследования на фактических материалах предприятия. Установлено, что наряду с учетом влияния и значимости факторов на показатель производственного травматизма необходимо обратить внимание на изучение психологических параметров работников при выполнении ими функциональных обязанностей на рабочих местах.

Ключевые слова: травматизм; несчастный случай; охрана труда, исследования, коэффициент частоты, коэффициент тяжести, коэффициент показателя травматизма.

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