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ТЕХНОСФЕРНАЯ БЕЗОПАСНОСТЬ

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Original article

On the Issue of Assessing the Levels of Noise and Vibration Impacts on Workers of Industrial Enterprises of the Republic of Kazakhstan

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Abstract

Introduction. Ensuring safe and comfortable working conditions is one of the most important tasks in the organization of modern production processes that have a direct impact on employee productivity, injuries and occupational diseases. Despite all the efforts made both at the state and departmental levels, the current state of occupational safety and health of industrial workers in the Republic of Kazakhstan continues to remain at an insufficiently high level. The main cause of occupational injuries and occupational diseases is the impact on working personnel of dangerous and harmful production factors, one of which is an increased level of noise and vibration from production equipment. The authors analyze statistical data on the number of cases of injuries, their types and causes of occurrence in workers by sectors of the economy of the republic. The influence of noise and vibration on the health of workers is considered. It is found that an increased level of noise and vibration effects causes injuries to a lesser extent, and occupational diseases to a greater extent. The work objective is instrumental measurement of noise and vibration levels in the workplaces of production sites of a machine-building enterprise and assessment of working conditions there to develop effective measures to reduce the harmful effects on the health of workers.

Materials and Methods. Statistical data on occupational injuries and occupational diseases were used as basic information, as well as the results of instrumental measurements of the level of noise and vibration effects on workers using the methods set out in GOST ISO 9612-2016 and GOST 31319-2006, taking into account Order of the Minister of Health of the Republic of Kazakhstan of February 16, 2022 No. KR DSM-15 "On approval of hygienic standards to physical factors that have an impact on a person".

Results. The results of the conducted research allowed us to conclude that about 22.6% of workplaces at production sites are characterized by harmful and dangerous working conditions in terms of noise and vibration effects on workers.

Discussion and Conclusion. Based on the results of the study, a plan of priority measures was developed to reduce the harmful effects of increased noise and vibration in the workplace. The authors also recommend a special working regime, benefits and additional payments to employees for working conditions that do not meet safety requirements.

Keywords: occupational health and safety, occupational injuries, occupational diseases, workplace, dangerous and harmful production factors, noise, vibration.

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Научная статья

К вопросу оценки уровня шумовых и вибрационных воздействий на работников промышленных предприятий Республики Казахстан

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Аннотация

Введение. Обеспечение безопасных и комфортных условий труда является одной из наиболее важных задач в организации современных производственных процессов, оказывающих непосредственное влияние на производительность труда работников, травматизм и профессиональные заболевания. Несмотря на все усилия, предпринимаемые как на государственном, так и на ведомственном уровнях, современное состояние безопасности и охраны труда (БиОТ) работников промышленных предприятий в Республике Казахстан (РК) продолжает оставаться на недостаточно высоком уровне. Главной причиной производственного травматизма и профессиональных заболеваний является воздействие на работающий персонал опасных и вредных производственных факторов, одним из которых является повышенный уровень шума и вибрации от производственного оборудования. Авторы анализируют по отраслям экономики республики статистические данные о количестве случаев травматизма, их видах и причинах возникновения у работников. Рассмотрено влияние шума и вибрации на здоровье работающих, при этом установлено, что повышенный уровень шумовых и вибрационных воздействий в меньшей степени вызывает травматизм, а в большей — профессиональные заболевания. Целью данного исследования является инструментальное измерение уровня шума и вибрации на рабочих местах производственных участков машиностроительного предприятия и оценка условий труда там для выработки действенных мер по снижению вредного воздействия на здоровье работников.

Материалы и методы. В качестве базовой информации использованы статистические данные по производственному травматизму и профессиональным заболеваниям, а также результаты инструментальных измерений уровня шумовых и вибрационных воздействий на работников с использованием методик, изложенных в ГОСТ ISO 9612-2016 и ГОСТ 31319-2006 с учетом приказа министра здравоохранения Республики Казахстан от 16 февраля 2022 года № ҚР ДСМ-15 «Об утверждении гигиенических нормативов к физическим факторам, оказывающим воздействие на человека».

Результаты исследования. Результаты проведенных исследований позволили сделать вывод о том, что около 22,6 % рабочих мест на производственных участках характеризуются вредными и опасными условиями труда по уровню шумовых и вибрационных воздействий на работников.

Обсуждение и заключения. По итогам исследования был разработан план первоочередных мероприятий по снижению вредных воздействий повышенного уровня шума и вибрации на рабочих местах, а также рекомендованы особый режим труда, льготы и доплаты работникам за условия труда, не отвечающие требованиям безопасности.

Ключевые слова: безопасность и охрана труда, производственный травматизм, профессиональные заболевания, рабочее место, опасные и вредные производственные факторы, шум, вибрация.

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Introduction. Guarantees of ensuring safe working conditions at enterprises in the Republic of Kazakhstan are established at the state level: article 24 of the Constitution of the country declares the right of every citizen "... to working conditions that meet the requirements of safety and hygiene ...", and article 31 proclaims that the State aims to

"... protect the environment favorable for human life and health"[1]. Explaining these provisions, the Labor Code of the Republic of Kazakhstan defines that the safety of workers is understood as the level of their protection from the effects of hazardous and harmful production factors (workplace hazards, WH), and safety is ensured by the compliance of the labor process and the production environment with the requirements of safety and labor protection[2]. The above aspects are also fixed by other regulatory legal acts of the country in the field of safety and labor protection [1].

Nevertheless, according to the data of the Industrial Safety Committee of the Republic of Kazakhstan, out of 1.6 million workplaces checked in 2019, 373 thousand workers were exposed to hazardous and harmful production factors, that is, every fourth employee (22.3 %) was employed in production with the presence of workplace hazards[3]. Figure 1 shows the statistical data on the number of deaths and victims of accidents at work in the republic from 2017 to 2021 [2, 3].

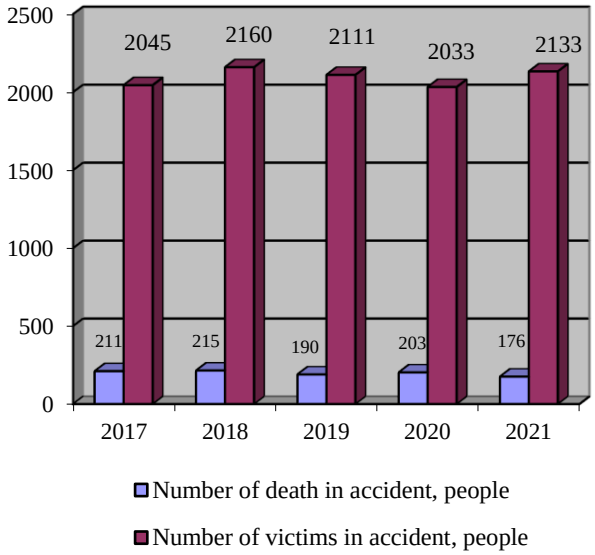

Fig. 1. Indicators of occupational injuries in the Republic of Kazakhstan from 2017 to 2021

In general, in the Republic of Kazakhstan and its regions in recent years, there have been no positive changes in the direction of occupational injuries reduction; its level remains quite high. According to the data presented in Fig. 1, it can be seen that in 2021, as a result of accidents, 176 people died at work (in 2017 — 211 people). Even if the mortality rate decreased by 16.5 %, this is explained not by an increase in the level of safety and labor protection of workers, but by the downtime of enterprises due to quarantine, as well as the subsequent shut down of some of them in the period from 2019 to 2021. The number of industrial injuries, on the contrary, has increased — from 2,045 people in 2017 to 2,133 people in 2021, or by 4.3 %.

Another negative side of industrial injuries is its high material consequences, or losses to the country's economy, data on which are presented in Fig. 2.

[1] *Constitution of the Republic of Kazakhstan*. Official website of the President of the Republic of Kazakhstan URL: https://www.akorda.kz/ru/official_documents/constitution (accessed 05.11.2022).
[2] *Labor Code of the Republic of Kazakhstan*. No. 414-V dated November 23, 2015. URL: https://kodeksy-kz.com/ka/trudovoj_kodeks.htm (accessed 06.04.2023).
[3] *Results of work for 2020, 2021*. Official website of the Industrial Safety Committee of the Ministry of Emergency Situations of the Republic of Kazakhstan. URL: https://www.gov.kz/memleket/entities/kpb/documents/details/198142?lang=ru (accessed 06.11.2022).

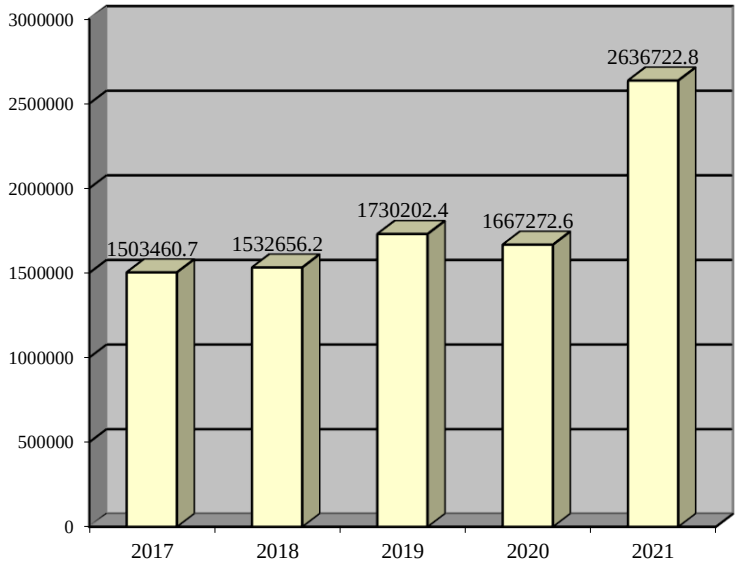

Fig. 2. Material consequences from accdents in the Republic of Kazakhstan from 2017 to 2021, thousand tenge

In 2021, these losses amounted to 2 billion 636 million 722.8 thousand tenge in the Republic (or at the exchange rate of the Central Bank of the Republic of Kazakhstan 383 million 802.4 thousand rubles of the Russian Federation).

Let us consider in more detail the causes of the occurrence of accidents at industrial enterprises of the Republic of Kazakhstan in 2021 (Table 1)[4,5].

Table 1

Number of workers killed and injured due to accidents in the Republic of Kazakhstan in 2021[4]

Cause of the accident	Number, people.	
	injured	killed
Impact on the victims of an increased level of dust and air pollution of the air of the production environment	10	1
Violation of safety requirements in the operation of vehicles	54	10
Violation of traffic rules requirements	165	20
Accidents and other emergencies	63	13
Unsatisfactory organization of work	266	26
Poor technical condition of buildings, structures and shortcomings in the organization of workplaces	34	3
Shortcomings in the organization of employee training in the rules and requirements of safety and labor protection	41	5
Absence or non-use of personal protective equipment by victims	19	1
Increased noise exposure	1	–
Presence of workplace hazards and their impact on victims	88	14
Exposure to elevated levels of ionizing radiation	1	–
Absence or non-use of collective protective equipment	11	–
Violation of the norms and rules of industrial and labor discipline by the victims	39	9
Violation of safety and labor protection rules	276	19
Violation of the established work and rest regime by the victims	6	–
Gross negligence by the victims	688	61
Impact of increased physical activity	3	–
Design flaws or the use of faulty equipment	25	1
Gross violation of technological regulations and processes	17	3
Others	63	4

[4] *Health statistics*. Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan. URL: https://stat.gov.kz/ru/industries/social-statistics/stat-medicine/publications/ (accessed 08.11.2022).

[5] *Occupational safety and health for 11 months of 2022*. Official website of the Committee of Labor and Social Protection of the Population of the Republic of Kazakhstan. URL: https://www.gov.kz/memleket/entities/lspm/activities/292?lang=ru (accessed 08.11.2022).

Thus, according to the data provided, it can be concluded that the main causes of deaths and injuries at work were violations of the requirements and rules of safety and labor protection by the personnel of enterprises, shortcomings in the organization of work, the presence of workplace hazards in the workplace and their impact on workers, and so on. Thus, in 2021, the unsatisfactory organization of work was the cause of the death of 26 and injury to 266 workers, and violations of basic rules of safety and labor protection by workers — 19 and 276 people, respectively. One of the main causes of industrial injuries at the enterprises of the republic was the gross negligence by the victims themselves in the performance of their duties (for this reason, 61 people died and 688 people were injured).

At industrial enterprises, along with other workplace hazards, the most common negative production factors are noise and vibration [2, 4, 5]. Thus, every third employee of enterprises works in conditions of noise and vibration that specifically affect the human body. A large number of various technological equipment has been installed at production sites and workplaces, which, being a source of increased noise and vibration, has a negative impact on the health and general well-being of workers [3, 6-8]. For these reasons, which can be partially attributed to the indicators presented in Table 1, such as increased noise levels, exposure to workplace hazards, lack of individual and collective protective equipment, design flaws and operation of faulty machines and mechanisms, 16 people died and 144 people were injured in 2021.

However, the increased level of noise and vibration cause injuries to workers to a lesser extent, and to a greater extent — the occurrence of occupational diseases, as evidenced by the data in Table 2.

Of the 351 identified cases of occupational diseases of workers in the republic as a whole, 167 (47.5 %) were occupational diseases, the cause of which was an increased level of noise and vibration, which caused the victims to develop vibration disease, conductive and sensorineural hearing loss, bilateral sensorineural hearing loss, bilateral mixed conductive and sensorineural hearing loss.

Materials and Methods. The basis for conducting research to assess the level of noise and vibration from the equipment were the workplaces of the production sites of the Ural Plant for the production of transformers. The research was carried out according to the methods set out in GOST ISO 9612-2016 "Interstate standard. Acoustics. Noise measurement for the purpose of evaluating human exposure to noise"[6], GOST 31319-2006 "Vibration. Measurement and evaluation of human exposure to whole-body vibration. Practical guidance for measurement at the workplace"[7], taking into account the provisions of Order of the Minister of Health of the Republic of Kazakhstan No. KR DSM-15 dated February, 16, 2022[8]. In the course of instrumental measurements of noise and vibration, the following instruments and equipment were used: a sound level meter (sound level measuring device) of the ATT-9001 brand and a vibration parameter meter (vibrometer) of the Vibrotest-MG4.01 brand.

Table 2

Number of employees who received occupational diseases in 2021[4]

Name of occupational disease	Number of victims, people
Total for the Republic of Kazakhstan, including:	351
impact of vibration	73
sensorineural and conductive hearing loss	46
bilateral conductive hearing loss	1

[6] GOST ISO 9612-2016. *Interstate standard. Acoustics. Noise measurement for the purpose of evaluating human exposure to noise. Method of measurements at workplaces*. URL: https://online.zakon.kz/Document/?doc_id=39455237 (accessed 10.11.2022). (In Russ.).
[7] GOST 31319-2006. *Vibration. Measurement and evaluation of human exposure to whole-body vibration. Practical guidance for measurement at the workplace*. URL: https://online.zakon.kz/Document/?doc_id=30979214 (accessed 10.11.2022). (In Russ.).
[8] *Ob utverzhdenii gigienicheskikh normativov k fizicheskim faktoram, okazyvayushchim vozdeistvie na cheloveka*. Order of the Minister of Health of the Republic of Kazakhstan No. KR DSM-15 dated February 16, 2022. Information and legal system of regulatory legal acts of the Republic of Kazakhstan. URL: https://adilet.zan.kz/rus/docs/V2200026831 (accessed 10.11.2022).

unilateral sensorineural hearing loss with normal hearing in one ear	2
bilateral sensorineural hearing loss	22
mixed conductive and sensorineural hearing loss	20
bilateral unspecified mixed conductive and sensorineural hearing loss	1

By comparing the measured parameters of the actual values of noise and vibration with the maximum permissible levels (MPL), a working conditions class (WCC) was assigned to workplaces according to the "Rules of mandatory periodic certification of production facilities according to working conditions"[9]. According to the above Rules, depending on the degree of deviation of the actual levels of workplace hazards from hygienic standards, working conditions were divided into four classes according to the degree of harmfulness and danger: 1 — optimal, 2 — acceptable, 3 — harmful and dangerous (with subclasses 3.1, 3.2, 3.3 and 3.4 depending on the degree of excess over the standards), 4 — unacceptable.

Results. The results of the studies conducted to assess the level of noise and vibration effects on humans from the operation of production equipment are presented in Tables 3 and 4.

Table 3

Results of the study of the level of noise and vibration effects on workers

No.	Name of the production site	Workplace characteristics	Total number of WP	Noise, dBA			Vibration, dB			WCC
				MPL	Measured level	Excess over the MPL	MPL	Measured level	Excess over the MPL	
1	Areas No. 1 and No. 2 of the assembly shop	Foreman of insulation materials	15	No more than 80	71.3	None	No more than 97	83.1	None	2
		Machine operator (plasma cutting of metal)	3	No more than 80	69.7 70.1 70.5	None	No more than 97	81.3 80.6 82.1	None	2
		Machine operator (transverse metal cutting)	9	No more than 80	90.7 90.4 89.8 90.3 91.8 90.5 91.2 92.1 91.1	+10.7 +10.4 +9.8 +10.3 +11.8 +10.5 +11.2 +12.1 +11.1	No more than 97	102.3 101.9 102.4 101.5 102.4 101.5 101.5 102.4 101.6	+5.3 +4.9 +5.4 +4.5 +5.4 +4.5 +4.5 +5.4 +4.6	3.2 3.2 3.2 3.2 3.2 3.2 3.2 3.2 3.2
		Machine operator (metal slitting)	3	No more than 80	90.3 89.2 90.4	+10.3 +9.2 +10.4	No more than 97	101.7 100.9 100.2	+4.7 +3.9 +3.2	3.2 3.2 3.2
		Sheet bending machine operator	3	No more than 80	70.3 69.2 70.4	None	No more than 97	83.2 82.1 82.4	None	2
		Machine operator (guillotine scissors)	3	No more than 80	88.7 89.5 87.8	+8.7 +9.5 +7.8	No more than 97	100.7 99.6 100.8	+3.7 +2.6 +3.8	3.2 3.2 3.2
		Carpenter (woodworking machine)	2	No more than 80	78.1 77.1	None	No more than 97	92.3 90.9	None	2
		Argon arc welding welder	7	No more than 80	71.9	None	No more than 97	81.1	None	2
		Charge maker	9	No more than 80	70.7 70.4 69.8 70.3 71.8 70.5 71.2	None	No more than 97	82.3 81.9 82.4 81.5 82.4 81.5 81.5	None	2

[9] *Pravila obyazatel'noi periodicheskoi attestatsii proizvodstvennykh ob"ektov po usloviyam truda*. Order of the Minister of Health and Social Development of the Republic of Kazakhstan No. 1057 dated December 28, 2015. Information and legal system of regulatory legal acts of the Republic of Kazakhstan. URL: https://adilet.zan.kz/rus/docs/V1500012743 (accessed 10.11.2022).

No.	Name of the production site	Workplace characteristics	Total number of WP	Noise, dBA			Vibration, dB			WCC
				MPL	Measured level	Excess over the MPL	MPL	Measured level	Excess over the MPL	
					72.1 71.1			82.4 81.6		
2	Area No. 3 of the assembly shop	Transformer assembler	23	No more than 80	70.3	None	No more than 97	81.7	None	2
3	Welding and painting area	Electric welder (welding machine)	13	No more than 80	69.1	None	No more than 97	81.4	None	2
		Painter	13	No more than 80	60.4	None	No more than 97	64.8	None	2
		Driller (drilling machines)	4	No more than 80	84.2	+4.2	No more than 97	98.9	+1.9	3.1
4	Mechanical area	Turner (turning workstation)	8	No more than 80	91.7 92.5 91.8 92.5 93.4 92.8 91.9 91.4	+11.7 +12.5 +11.8 +12.5 +13.4 +12.8 +11.9 +11.4	No more than 97	100.4 101.2 100.1 101.4 100.7 99.8 100.2 101.4	+3.4 +4.2 +3.1 +4.4 +3.7 +2.8 +3.2 +4.4	3.2 3.2 3.2 3.2 3.2 3.2 3.2 3.2
		Miller (milling machines)	2	No more than 80	84.8 84.1	+4.8 +4.1	No more than 97	98.4 99.3	1.4 1.3	3.1 3.1
5	Winding and wire section	Winder NN	11	No more than 80	68.9	None	No more than 97	80.4	None	2

Table 4

Generalized results of WCC assessment in the workplace by the level of noise and vibration effects on workers

Name of the production site	Number of WP	Number ofworkers on WP	Distribution of the number of WP by WCC						
			class 1	class 2	class 3				class 4
					3.1	3.2	3.3	3.4	
Areas No. 1 and No. 2 of the assembly shop	45	28	–	30	–	15	–	–	–
Area No. 3 of the assembly shop	23	23	–	23	–	–	–	–	–
Welding and painting area	30	18	–	26	4	–	–	–	–
Mechanical area	10	6	–	2	8	–	–	–	–
Winding and wire section	11	11	–	11	–	–	–	–	–
Totsl:	119	86	–	92	12	15	–	–	–

More clearly, the results of the assessment of working conditions at the workplaces of the production sites of the plant by the level of noise and vibration effects on workers and their certification according to WCC are presented in Fig. 3.

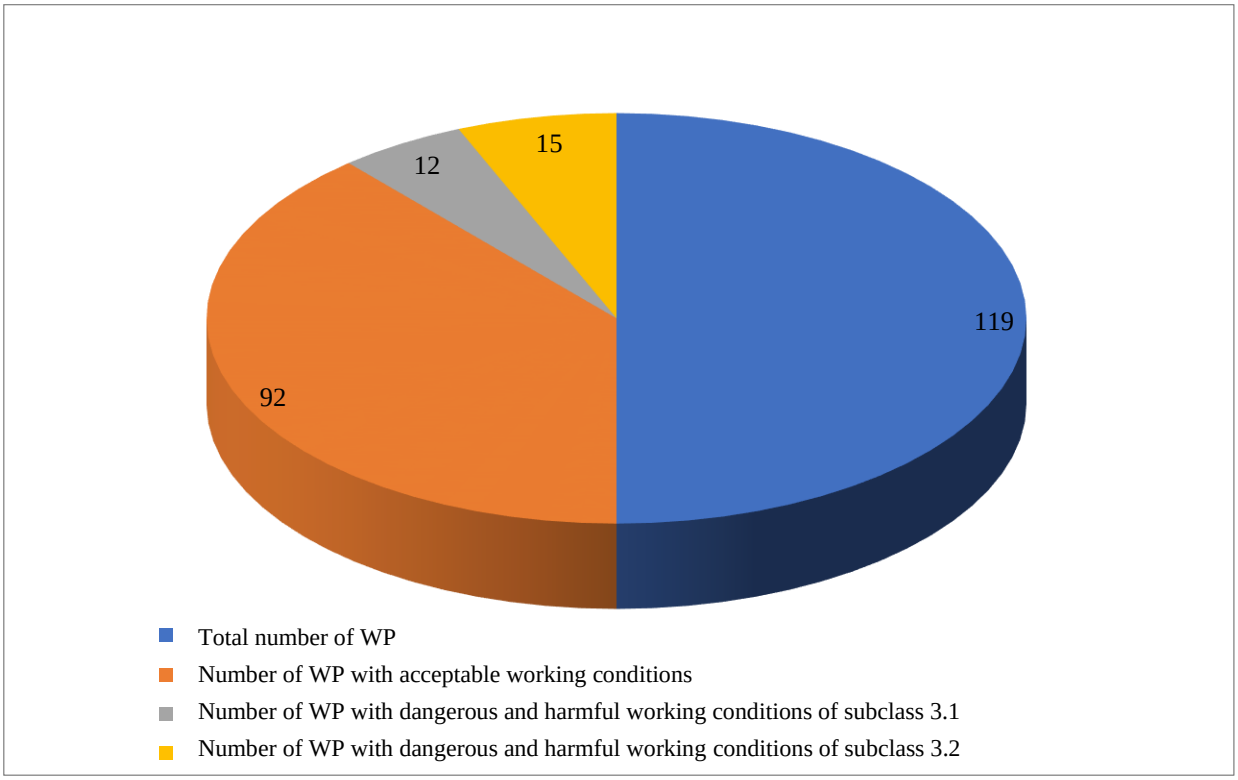

Fig. 3. Results of working conditions assessment at workplaces and their certification according to WCC

Discussion and Conclusion. According to the data presented in Table 4 and in Fig. 3, it can be seen that 27 out of 119 workplaces, or 22.6 % of their total number, are characterized by the presence of workplace hazards in terms of noise or vibration factors, as well as their combined influence. However, it is often difficult, and sometimes impossible, to completely localize or eliminate increased noise and vibration levels of equipment, machines and mechanisms, as well as other workplace hazards, in real production conditions, since they are an accompanying part of technological processes. Moreover, this problem is characteristic not only for Kazakhstan, which many domestic scientists and specialists explain with outdated equipment and backward technologies, but also for industrially developed Western countries [9–14]. Nevertheless, the parameters of noise and vibration, as well as the degree of their impact on employees, should be constantly monitored, and if a negative impact is detected, technical and organizational measures to reduce them to safe levels should be developed and implemented in a timely manner.

The results of the research revealed another problem, which is that the certification of workplaces of the production sites of the plant, previously carried out by an accredited organization, did not reveal any deviations in working conditions from the acceptable ones, and according to its results, all workplaces were assigned the 2nd class. The fact is that accredited organizations are engaged in certification of workplaces, with which the employer enters into a contract for its conduct and pays for all work, therefore, in the results obtained, such organizations do not reflect the actual state of affairs, but the wishes of the employer [15].

Since, according to the results of the research, part of the workplaces of the plant's production sites was assessed according to WCC as corresponding to subclasses 3.1 or 3.2, i.e. characterized by harmful and dangerous conditions in terms of noise and vibration effects, the personnel engaged in the labor process at these places, in accordance with the current labor legislation of the Republic of Kazakhstan, have the right to a number of benefits and compensations.

When calculating wages, determining work and rest regimes in accordance with these benefits and compensations, it is necessary to provide:

a) additional payments to the basic rate up to 10 % (according to Paragraph 1 of Article 105 of the Labor Code of the Republic of Kazakhstan) for work in conditions of exposure to workplace hazards (increased noise and vibration);

b) additional annual leave for at least six days (Paragraph 1 of Article 88 of the Labor Code of the Republic of Kazakhstan);

c) reduction of working time — no more than 36 hours per week (Paragraph 2 of Article 69 of the Labor Code of the Republic of Kazakhstan), and the working shift — no more than eight hours;

d) two intra-shift breaks during the shift (Paragraph 1 of Article 82 of the Labor Code of the Republic of Kazakhstan), included in working hours, lasting no more than 20 minutes. 1.5–2 hours after the start of the shift and after a break for rest and meal (lunch);

e) a break for rest and meal approximately in the middle of the shift lasting no less than 30 min. (as a rule, the duration is set as one hour.) (Paragraph 1 of Article 81 of the Labor Code of the Republic of Kazakhstan).

Recruitment proposals:

– age of employees — at least 18 years old;

– prohibition on the employment of women and adolescents (Subparagraph 2, Paragraph 1 and Subparagraph 4, Paragraph 2, Article 26 of the Labor Code of the Republic of Kazakhstan).

It provides for the following mandatory medical examinations: preliminary (indicating contraindications for hiring if there are workplace hazards at the workplace) — before concluding an individual employment contract and periodic — once every two years.

A plan of technical measures was developed for the implementation at production sites and workplaces of the plant to reduce the increased noise and vibration effects on workers from production equipment.

The results of the conducted research allowed us to conclude that about a quarter of the workplaces at the production sites of the plant are characterized by dangerous and harmful working conditions in terms of noise and vibration effects on workers from production equipment, therefore, the working regime, benefits and additional payments to workers for working conditions that do not meet safety requirements were recommended. Providing employees with safe and comfortable working conditions, including such factors as increased noise and vibration, helps to reduce the potential risks of injuries and occupational diseases and, as a result, to increase the overall efficiency of labor activity and labor productivity.

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