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«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ
«ХАЛЫҚ» ЖҚ

ХАБАРЛАРЫ

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК РЕСПУБЛИКИ
КАЗАХСТАН»
ЧФ «Халық»

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NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

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.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

ЧФ «ХАЛЫҚ»

В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект Ozgeris powered by Halyk Fund – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz.

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится

работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и Wos и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

С уважением,
Благотворительный Фонд «Халык»!

«ҚР ҰҒА» РҚБ Хабарлары. Геология және техникалық ғылымдар сериясы».
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STATISTICAL ANALYSIS AND QUANTIFICATION OF RISK DANGERS OF INJURIES

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Abstract. The article discusses the issues of injury analysis, an assessment of the risk of danger at the Aktobe ferroalloy plant of the Republic of Kazakhstan. The study took into account statistical materials on injuries for the period from 2012 to 2020. From the statistical analysis of accidents, it was revealed that the most traumatic experience is from 1 to 2 years, when a specialist is becoming a specialist and adapting to working conditions. The most traumatic profession is committed to workers of dangerous professions, such as ferroalloy smelters (26.5 %), repairmen (20.5 %), ferroalloy breakers (12 %), gas-electric welders (12 %). The study was conducted using the Kinney hazard risk quantification method, where the threshold indicator is a number of 70 points. Therefore, this method was used for research to determine the risk of danger at the Aktobe ferroalloy Plant. A quantitative assessment of the risk of danger identifies the causes, sources of risk and the magnitude of the likely consequences. It is established that the main danger for the manifestation of injuries at the Aktobe ferroalloy plant is the event number 23 (other). This accounts for 11 cases or almost 32.4

% of the total number of accidents during the study period, i.e. from 2012 to 2020. The same series includes event number 06 (exposure to extreme temperatures) – 17.6 %, 15 (falling (uneven and slippery surfaces)) – 11.8 % and number 04 (impact of moving, rotating, flying objects) – 11.8 %. Based on this, a quantitative assessment of the risk of injury hazard was carried out for hazardous event 23 (others, etc.). It was found that the risk of accidents and accidents at this hazardous production facility by factor 23 (others) is acceptable.

Keywords: injury, accident, occupational safety, risk, dangerous professions, production, statistical method, Kinney method

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ЖАРАҚАТ АЛУ ҚАУПІ ТӘУЕКЕЛДІЛІГІН СТАТИСТИКАЛЫҚ ТАЛДАУ ЖӘНЕ САНДЫҚ БАҒАЛАУ.

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Аннотация. Осы жұмыста Қазақстан Республикасының Ақтөбе ферроқорытпа зауытында қауіптілік қатеріне бағалау жүргізілді. Зерттеу киннейдің қауіп — қатерін сандық бағалау әдісі бойынша жүргізілді, онда шекті көрсеткіш 70 балл болып табылады. Сондықтан Ақтөбе ферроқорытпа зауытында қауіптілік қатерін анықтау бойынша зерттеу үшін осы әдіс қолданылды. Қауіп — қатерді сандық бағалау тәуекелдің себептерін, көздерін және ықтимал салдардың мөлшерін анықтайды. Ақтөбе ферроқорытпа зауытында жарақатты анықтау үшін негізгі қауіп болып 23 – ші (тағы басқа) номерлі оқиға орнатылды. Бұған 11 немесе барлық жазатайым жағдайдың барлық санынан 32,4 % жуығы, яғни 2012 – ші жылдан 2020 – шы жыл аралығына жатады. Бұл ретке 06 – шы нөмірлі оқиға (экстремал температурасының әсері) – 17,6 %, 15 (құлау (тегіс емес және сырғанақ беттер)) – 11,8 % және 04 – ші нөмерлі (жылжып бара жатқан, айналып тұрған, ұшып бара жатқан заттардың әсері) – 11,8 % жатады. Осыдан жарақаттың қауіптілік қатерінің сандық бағасы 23 – ші (және тағы басқалары) қауіпті оқиға бойынша жүргізілді. Апаттың қауіптілік пен жазатайым жағдайларының қатері қауіпті өндірістік объектте 23 – ші фактор бойынша жарамды.

Түйін сөздер: жарақат, жазатайым жағдай, еңбекті қорғау, қатер, қауіпті мамандық, өндіріс, статистикалық әдіс, Кинней әдісі

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СТАТИСТИЧЕСКИЙ АНАЛИЗ И КОЛИЧЕСТВЕННАЯ ОЦЕНКА РИСКА ТРАВМАТИЗМА

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Аннотация. В настоящей работе проведена оценка риска травматизма на Актюбинском заводе ферросплавов Республики Казахстан. Исследование учитывало статистические материалы по травматизму за период с 2012 по 2020 год. Исследование проведено по методу количественной оценки риска опасности Киннея, где пороговым показателем является число в 70 баллов, что предопределило выбор этого метода для исследований на Актюбинском заводе ферросплавов. Количественная оценка риска опасности выявляет причины, источники риска и величину вероятных последствий. Установлено, что основной опасностью для проявления травматизма на Актюбинском заводе ферросплавов является событие под номером 23 (прочие). Сюда приходится 11 случаев или почти 32,4 % от общего количества несчастных случаев за изучаемый период, т. е. с 2012 по 2020 год. К этому же ряду относится событие под номером 06 (воздействие экстремальных температур) – 17,6 %, 15 (падение (неровные и скользкие поверхности)) – 11,8 % и под номером 04 (воздействие движущихся, вращающихся, разлетающихся предметов) – 11,8 %. Исходя из этого количественная оценка риска травматизма была проведена по опасному событию 23 (прочие и т.д.). Получено, что риск аварий и несчастных случаев на этом опасном производственном объекте по фактору 23 (прочие) является приемлемым.

Ключевые слова: травматизм, несчастный случай, охрана труда, риск, опасные профессии, производство, статистический метод, метод Киннея.

Introduction

Occupational injuries (hereinafter referred to as P) as a result of accidents and accidents has long been an urgent problem in all countries of the world. Every year, according to the International Labor Organization (ILO), more than 2 million people die from injuries, which is almost 5 % of the total mortality rate on the planet and 270 million people are injured, 160 million people suffer from various diseases related to production [1]. To date, the level of PT in Kazakhstan, as one of the CIS countries, is an order of magnitude higher than similar indicators in countries such as the UK, Germany, Canada, Japan, and the level of fatal injuries at work in our country is 2.5 times higher than in the USA, 7 times higher than in Japan, 8.7 times - than in England. The events of major tragedies at the mines of the Karaganda coal basin, the enterprises of the Kazakhmys Corporation in recent years with the death of dozens of workers are proof of this. (Imangazin, 2014).

The main objectives of injury analysis are to establish the patterns that cause accidents and develop effective preventive measures on this basis. Four main methods are used for the analysis of occupational injuries: statistical, topographic, monographic and economic.

The statistical method is based on the study of the causes of injuries according to the documents in which accidents are registered (acts in the form of H-1, disability sheets) for a certain period of time. This method allows you to get a general picture of the state of injuries, determine its dynamics, identify relationships, patterns between circumstances and causes of accidents.

Materials and basic methods

To determine injuries in the workshops of the AZF for the period from 2012 to 2020, it was decided to use two methods: the statistical method and the Kinney method. When using the Kinney method, a quantitative assessment of hazard levels for various analyzed situations is given by assigning numerical values to the assessed hazard levels — points calculated as the product of three variables: the probability that this dangerous event will actually occur; the frequency of exposure to a potentially dangerous situation; the severity of the consequences or damage caused.

The statistical method consists in processing and studying the statistical material accumulated as a result of the investigation of accidents during the specified period. Using this method, a number of coefficients are determined, which are relative indicators of the level of injuries at the enterprise and allow us to give a more correct and complete picture of the level of injuries than only according to the absolute number of accidents that occurred at the enterprise during the time period under study. (Uakhitova et al., 2022: 2).

The level of injuries in the Aktobe ferroalloy Plant was analyzed for 2012–2020. A period of 9 years is quite sufficient to obtain reliable results on the state of general injuries of the Aktobe ferroalloy Plant. The study of the dynamics of the indicators of occupational injuries shows that during the nine years from 2012 to 2020, the number of accidents, namely their frequency, decreased, but in recent years, has a tendency to increase. At the same time, out of 32 accidents, one belongs to a group type, and out of 30 injured workers - 19 severe cases, 11 cases with a mild outcome, 4 cases with a fatal outcome. (Uakhitova et al., 2022: 1).

Table 1 - Distribution of employees of the Aktobe ferroalloy plant affected by an accident by profession and by length of service in the period from 2012 to 2020.

№	Profession	Up to 1 year	1–2	3–4	5–6	7–9	10–14	More than 20 years	Total quantity	in % to total number
1	Ferroalloy Smelter	2	3	1	3				9	0,26
2	Locksmith repairman		3	1	1		1	1	7	0,2
3	Ferro - alloy Breaker	1	1		1			1	4	0,12
4	Gas - electric welder				1	2	1		4	0,12
5	Assistant locomotive driver			1		1			2	0,06
6	The crawler driver					1			1	0,03
7	Acting Shift Supervisor		1						1	0,03
8	Electrician			1					1	0,03
9	Bunkering			1					1	0,03
10	Senior Repairman						1		1	0,03
11	Installer	1							1	0,03
12	Driver						1		1	0,03
13	Ferroalloy Dispenser					1			1	0,03
	in % to total number	0,12	0,26	0,15	0,18	0,14	0,12	0,05	34	1,0

Based on Table 1, the distribution of employees of the Aktobe Ferroalloy Plant affected by an accident by profession and by length of service in the period from 2012 to 2020 shows that workers of dangerous professions, such as ferroalloy smelters (26.5 %), repairmen (20.5 %), ferroalloy breakers (12 %), gas-electric welders (12 %), and in other professions there are isolated cases. The most traumatic is the experience from 1 to 2 years, when there is a formation of a specialist and adaptation to working conditions.

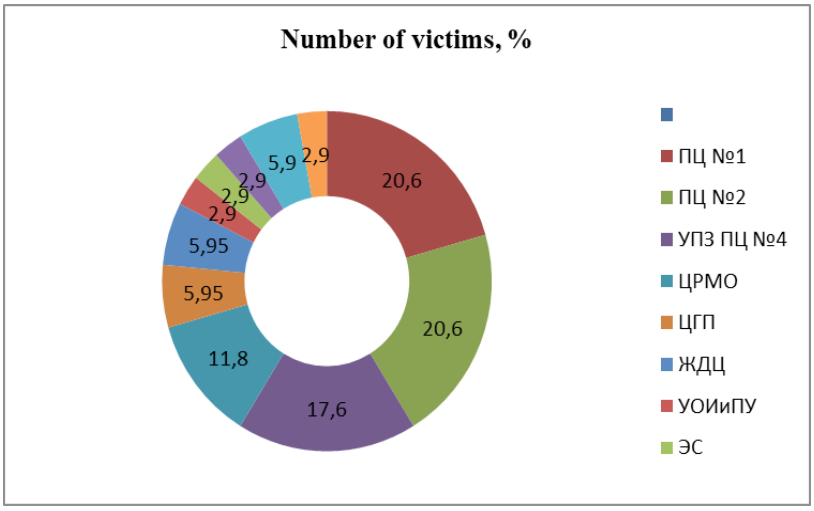

Figure 1 - Histogram of the distribution of injuries in the workshops of the Aktobe ferroalloy plant in the period from 2012 to 2020.

The most traumatic during this period of time is PC №1 - 7 accidents, PC №2 - 7, UPS PC №4 - 6 accidents, CRMO - 4 cases. These four workshops account for 24 accidents at the plant in 2012–2020, one group case also falls on these workshops (PC №2). Fatal accidents occurred in auxiliary workshops – 4 cases, 11.7 % of all deaths in the plant as a whole. According to the research results, it is clear that indicators are of the greatest importance in responsible and complex workplaces (professions).

Occupational hazard risk assessment is one of the main forms of preventive measures to prevent and thereby reduce injuries. Methods of hazard risk assessment are quantitative and qualitative. For large enterprises, such as the Aktobe Ferroalloy Plant, quantitative methods of hazard risk assessment are used to determine the most dangerous workshops on injury issues. These methods make it possible to apply decades of accumulated statistical material on injuries at a given enterprise and thereby obtain more accurate results on the actual state of injury and its possible prevention.

A quantitative assessment of the risks of injury hazard at the Aktobe ferroalloy Plant was carried out according to the developed MIOT methodology-01-02-2006 according to the Kinney method, according to injury statistics for the period from 2012 to 2020

When using the Kinney method, a quantitative assessment of hazard levels for various analyzed situations is given by assigning numerical values to the assessed hazard levels - points calculated as the product of three variables: the probability that a given dangerous event will actually occur; the frequency of exposure to a potentially dangerous situation; the severity of the consequences or damage caused as a result of a dangerous event.

The risk assessment is carried out according to the average statistical data of accounting accidents that occurred during the study period for each or the main identified hazard. (Imangazin, 2014).

Identification of dangerous and harmful factors

The process of identifying dangerous and harmful factors is carried out in accordance with the specific internal procedures of each division of the plant on the basis of a general classifier (list) adopted at the plant.

To quantify the risks at the gas station, we apply the Kinney method, according to which it is necessary to calculate a potentially dangerous situation, indicated by the risk index R according to the i–th classifier, according to the following formula:

$$R_i = P_i \cdot E_i \cdot G_i, \qquad (2)$$

P_i - indicator of the probability of a dangerous event;

E_i - indicator of the frequency of exposure to risk; G_i – an indicator of the severity of damage caused by the consequences of a dangerous event.

The assessment of risk indicators Ri for various analyzed hazardous situations is carried out by assigning a score to each of the above parameters, based on the classification scale, corresponding numerical values determined in Tables 7, 8, 9 below.

According to the methodology, according to Table 5, we will determine the KNSi by the main of the identified hazards, for this we will analyze statistical data on 34

accidents among the personnel of the PC №1, PC №2, UPZ PC №4, CGP, UOIiPU, ES, ERC, railway station of the Aktobe ferroalloy Plant. (Uakhitova et al., 2022: 2).

Table 5 provides these data, from which the most common dangerous events can be identified.

Table 5 - List of hazards and harmful factors

Danger code	Name of the hazard
01	Traffic accident
02	The victim's fall from a height
03	Falling, collapse, collapses of objects, rock mass, etc.
04	Moving, flying, rotating objects and parts
05	Electric current
06	Extreme temperatures
07	Harmful substances (dust, gas, chemicals)
08	Ionizing radiation
09	Physical overload
10	Neuropsychic stress
11	Contact with animals and insects
12	Drowning
13	Premeditated murder
14	Natural disasters
15	Falling (uneven and slippery surfaces)
16	Unauthorized explosions in the course of blasting operations
17	Formation of explosive mixtures
18	Vibration and noise
19	Fires
20	Accidents of a natural nature
21	Man-made accidents
22	Hazards other than those listed are characteristic of the mining and metallurgical industries
23	Other

Results. We have analyzed the causes of accidents that occurred at the enterprise for the period from 2012–2020 (Uakhitova et al., 2022: 2). Based on the study of accident investigation reports, it was found that the total number of causes of accidents is 23.

As a result of the comparative ranking of these sources of accidents, a list of significant hazards and harmful factors that occurred at the gas station has been established, which are shown in Table 6:

Table 6 - List of significant hazards and harmful factors

Danger code	Name of the hazard	Number of accidents
01	Traffic accident	3
02	The victim's fall from a height	2
03	Falling, collapse, collapses of objects, rock mass, etc.	3
04	Moving, flying, rotating objects and parts	4
05	Electric current	1
06	Extreme temperatures	6
15	Falling (uneven and slippery surfaces)	4
23	Other	11

It was found that some of the listed dangerous events are represented by an insignificant number of incidents from 1 to 3, so they can not be considered due to the low probability of their manifestation and insignificant impact on the overall injury rates.

Based on the analysis of the above data, it can be argued that the main danger for the manifestation of injuries at the Aktobe ferroalloy plant is the event number 23 (other). This accounts for 11 cases or almost 32.4 % of the total number of accidents during the study period, i.e. from 2012 to 2020. The same series includes event number 06 (exposure to extreme temperatures) – 17.6 %, 15 (falling (uneven and slippery surfaces)) – 11.8 % and number 04 (impact of moving, rotating, flying objects) – 11.8 %. Based on this, we will conduct a quantitative assessment of the risk of injury risk for dangerous event 23 (others, etc.).

It is accepted here that the total number of accidents for this hazard will be **23** = 11 cases, 23 is the number from the nomenclature listed from the list of hazards and harmful factors.

The average number of accidents per year is:

$$СКНС_{23} = КНС_{23} : Т$$

$СКНС_{23}$ = 1.22 cases per year, where T is the reporting study period of 9 years.

Similarly, the expected frequency of occurrence of the event is determined from the expression:

$$ОЧС_{23} = СКНС_{23} : n = 1{,}22 : 3924 = 0{,}00031,$$

where n = 3924 is the average number of AZF workers for the study period.

Based on the obtained value of the OCHS23 and data from Tables 7, 8, 9, we determine the necessary values for the probability of occurrence of a dangerous event (P23), frequency of exposure (E23) and severity of consequences (G23), the values of which are given below,

Table 7 - Probability of occurrence of a dangerous event P_i

Name		scores
High degree of probability	$> 1 \text{ год}^{-1}$	10
Average degree of probability	$1 - 1 \cdot 10^{-2} \text{ год}^{-1}$	6
Not always, but maybe	$1 \cdot 10^{-2} - 1 \cdot 10^{-4} \text{ год}^{-1}$	3
Low probability	$1 \cdot 10^{-4} - 1 \cdot 10^{-5} \text{ год}^{-1}$	1
Incredibly, but it is impossible to completely exclude the possibility	$1 \cdot 10^{-4} - 1 \cdot 10^{-5} \text{ год}^{-1}$	0,5
Almost impossible	$1 \cdot 10^{-5} - 1 \cdot 10^{-6} \text{ год}^{-1}$	0,2
Virtually impossible	$1 \cdot 10^{-6} - 1 \cdot 10^{-7} \text{ год}^{-1}$	0,1
	$1 \cdot 10^{-7} - 1 \cdot 10^{-8} \text{ год}^{-1}$	

According to Table 7, the value of P23 at PTS23 = 0.00031 or corresponding to the value of the row $1 \cdot 10^{-2} - 1 \cdot 10^{-4}$ год$^{-1}$ – the specified criterion characterizes the degree of manifestation of danger as Not always, but possible, i.e. P23 = 3 points.

According to the above materials, ОЧС23 can be seen that with the number of accidents equal to 11, the probability of accidents is 0.01–0.0001 per year, which is consistent with the recommendation (Imangazin, 2014). In case of occurrence or manifestation of factors with 10 and 6 points, the probability of occurrence of ОЧС23 will be higher. In accordance with the above data, when developing planned measures for the organization and provision of a set of measures for TB, it is necessary to pay special attention to points or factors with a score of 3 or higher.

Table 8 shows data on the determination of scores by frequency of exposure E_i.

Table 8 - Frequency of exposure E_i

Name	scores
Constantly (at least once an hour)	10
Often (at least once a day)	6
Sometimes (at least once a week)	3
Not constantly (at least once a month)	2
Rarely (several times a year)	1
Very rarely (less than once a year)	0,5

Based on the actual statistical data of the number of accidents for this dangerous event, we will determine E23 and set the corresponding points according to Table 8. For 9 years, 11 cases were identified for this event, i.e. an average of 1.22 cases per year. This value corresponds to the column in Table 4 – Rarely (several times a year) , i.e. the value of E23 = 1 point.

Table 9 shows the scores for determining the significance of the severity of the consequences

Table 9 - Severity of consequences G_i

Name	Scores
Tragic consequences (death of several people)	100
Very serious consequences (death of one person)	40
Severe consequences (permanent disability)	15
Significant consequences (temporary disability)	7
Mild consequences (ambulance call)	3
Microtrauma (without disability)	1

According to Table 9, we will determine the severity of the consequences of this dangerous event. For 9 years, there have been no fatal cases for this event. Therefore, the most appropriate graph for this list is Severe consequences (permanent disability), which corresponds to the value of G23 = 15 points. (Imangazin, 2014).

Based on the results of the above studies, we will determine the risk index for the

considered case according to the formula (2). Here the values of the coefficients P23, E23 and G23 are defined above. Then the calculated values of the risk indicator are:

$$R_{23} = 3 \cdot 1 \cdot 15 = 45 \text{ points.}$$

Results and diccussion

The risk assessment of the occurrence and development of an accident, with possible emergencies, was carried out using mathematical calculation models based on actual or probable data, as well as situational indicators that determine the scale of the probable incident.

Based on the acts of investigation of official materials, an analysis of the main factors that are the causes of accidents was carried out.

From the statistical analysis of accidents, it was revealed that the most traumatic experience is from 1 to 2 years, when there is a formation of a specialist and adaptation to working conditions.

The most traumatic profession is committed to workers of dangerous professions, such as ferroalloy smelters (26.5 %), repairmen (20.5 %), ferroalloy breakers (12 %), gas-electric welders (12 %).

As a result of the point evaluation, significant factors of the manifestation of accidents at work were identified: extreme temperatures; moving, flying, rotating objects and parts; falling (uneven and slippery surfaces); others, etc. The most significant factor is paragraph 23 (other).

The values of indicators characterizing the manifestations of accidents at work are determined: the average number of accidents per year is 1.22; the expected frequency of occurrence of the event is 0.00031;

Based on the data presented, a point estimate of the probability of occurrence of a dangerous event Pi = 3 points; frequency of exposure Ei = 1 point; severity of consequences Gi = 15 points is presented. The degree of risk of accidents for the case in question is R23 = 45 points.

In accordance with the recommendations in, the permissible limit of this indicator is R = 70 points. Thus, the risk indicators for a dangerous event R23 = 45 points corresponds to the recommendations and is acceptable for the case under consideration.

Conclusion

An accident is quite a complex phenomenon. Prevention or prevention of such cases in the workplace is carried out using various means and methods presented above. The study of the circumstances of accidents and the identification of their causes makes it possible to develop preventive measures that prevent the recurrence of emergencies. Such an analysis of the conducted studies allows for the subsequent period of time to carry out preventive measures to prevent injuries. Timely analysis of injuries with the identification of the most dangerous workshops and workplaces provides significant assistance in preventing and reducing the level of injuries in the workplace.

The given methodology for determining the indicators of the degree of risk of dangerous accidents can be recommended for the analysis and evaluation of indicators characterizing the probability of accidents in metallurgical production.

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