

OVERVIEW OF MECHANISMS FOR ENSURING SAFE WORK IN CHEMICAL PRODUCTION

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This article presents the results of the review of scientific and technical information on the use of a risk-based approach (RBA) in providing personal protective equipment (PPE) at an enterprise. Regulatory documents, scientific works and developments of domestic and foreign scientists on the use of PPE against industrial health and safety hazards and their selection based on RBA were used as the theoretical and methodological basis for the study.

Scientific works are considered in the Science Direct, Dergi Park, Web of Science (Publon), Elsevier, Google Scholar databases, on professional industry platforms on labor protection ILO, EU-OSHA, NEBOSH, IOSH.

The study contains information retrieval, descriptive, experimental and effective research stages. The information retrieval stage includes the study of scientific and methodological literature, national and interstate standards. This article covers the entire range of theoretical and methodological substantiation of the use of PPE in the provision of RBA, including regulatory standards for the use of PPE, in force in the Republic of Kazakhstan in comparison with international practice

Keywords: personal protective equipment (PPE), labor protection, Labor Code, collective agreement, industrial safety, harmful production factors, professional risks, regulatory and technical framework.

ХИМИЯЛЫҚ ӨНДІРІСТЕГІ ҚАУІПСІЗ ЖҰМЫСТЫ ҚАМТАМАСЫЗ ЕТУ
МЕХАНИЗМДЕРІНЕ ШОЛУ

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¹Қазақстан Республикасы Еңбек және халықты әлеуметтік қорғау министрлігінің еңбек қауіпсіздігі және еңбекті қорғау жөніндегі республикалық ғылыми-зерттеу институты, Астана қ., Қазақстан,

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Бұл мақалада кәсіпорында жеке қорғаныс құралдары (ЖҚҚ) қамтамасыз етуде тәуекелге бағытталған тәсілді (ТБТ) қолдану туралы ғылыми-техникалық ақпаратты қарау нәтижелері келтірілген. Зерттеудің теориялық және әдістемелік негізі ретінде нормативтік құжаттар, ғылыми еңбектер мен отандық және шетелдік ғалымдардың ЖҚҚ-ны өнеркәсіптік денсаулық пен қауіпсіздік қатерлеріне қарсы қолдану және оларды ТБТ негізінде таңдау бойынша әзірлемелері пайдаланылды.

Ғылыми жұмыстар Science Direct, Dergi Park, Web Of Science (Publon), Elsevier, Google Scholar дерекқорларында, ХЕҰ, ЕО-OSHA, NEBOSH, IOSH еңбекті қорғау бойынша кәсіби салалық платформаларда қарастырылады.

Зерттеу ақпаратты іздеу, сипаттамалық, эксперименттік және тиімді зерттеу кезеңдерін қамтиды. Ақпаратты іздеу кезеңі ғылыми-әдістемелік әдебиеттерді, ұлттық және мемлекетаралық стандарттарды зерттеуді қамтиды. Бұл мақала Қазақстан Республикасында халықаралық практикамен салыстырғанда қолданыстағы ЖҚҚ пайдалану жөніндегі нормативтік стандарттарды қоса алғанда, ЖҚҚ көрсету кезінде ЖҚҚ пайдаланудың теориялық және әдіснамалық негіздемелерінің барлық спектрін қамтиды.

Түйін сөздер: жеке қорғаныс құралдары (ЖҚК), еңбекті қорғау, Еңбек Кодексі, ұжымдық шарт, өнеркәсіптік қауіпсіздік, зиянды өндірістік факторлар, кәсіби тәуекелдер, нормативтік-техникалық база.

ОБЗОР МЕХАНИЗМОВ ОБЕСПЕЧЕНИЯ БЕЗОПАСНОГО ТРУДА НА ХИМИЧЕСКОМ ПРОИЗВОДСТВЕ

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В данной статье представлены результаты обзора научно-технической информации об использовании риск-ориентированного подхода (РОП) при обеспечении средствами индивидуальной защиты (СИЗ) на предприятии. В качестве теоретико-методологической основы исследования были использованы нормативные документы, научные труды и разработки отечественных и зарубежных ученых по применению средств индивидуальной защиты от производственных рисков для здоровья и техники безопасности и их подбору на основе РОП.

Научные работы рассматриваются в базах данных Science Direct, Dergi Park, Web of Science (Publon), Elsevier, Google Scholar, на профессиональных отраслевых платформах по охране труда ILO, EU-OSHA, NEBOSH, IOSH.

Исследование содержит информационно-поисковый, описательный, экспериментальный и результативный этапы исследования. Информационно-поисковый этап включает в себя изучение научно-методической литературы, национальных и межгосударственных стандартов. Данная статья охватывает весь спектр теоретических и методологических обоснований использования СИЗ при оказании РСА, включая нормативные стандарты по использованию СИЗ, действующие в Республике Казахстан в сравнении с международной практикой.

Ключевые слова: средства индивидуальной защиты (СИЗ), охрана труда, Трудовой кодекс, коллективный договор, промышленная безопасность, вредные производственные факторы, профессиональные риски, нормативно-техническая база.

Introduction. As is known, occupational safety and health requirements are established by regulatory legal acts of the Republic of Kazakhstan and must contain rules, procedures and standards aimed at preserving the life and health of workers in the course of their work.

Occupational safety and health requirements are mandatory for employers and employees when they carry out their activities in the territory of the Republic of Kazakhstan [1].

In the system of measures aimed at ensuring safe working conditions, PPE of workers plays an important role. Ensuring safe working conditions is one of the main tasks of the International Labour Organization (ILO). According to Article 16 of the ILO Occupational Safety and Health Convention,

1981 (No. 155), employers are obliged to ensure the safety of workplaces, machinery, equipment and processes under their control, as well as the use of PPE to prevent accidents or harmful effects on the health of their workers. In all the sources studied, four distinctive approaches to the selection of PPE were found:

- approaches related to the provision of PPE and their proper use (information, training in the correct use of PPE);

- collective, personal disciplinary responsibility for failure to use PPE;

- unification and modernization of protective equipment;

- factor approach [2].

New threats are emerging, principles and approaches to providing PPE during a pandemic are changing, including poorly studied biological threats [3-7].

However, at present there are no works that

would cover the entire broad range of theoretical and methodological justification for the use of PPE in the provision of RBA with an analysis of regulatory standards for the use of PPE in force in the Republic of Kazakhstan in accordance with international practice.

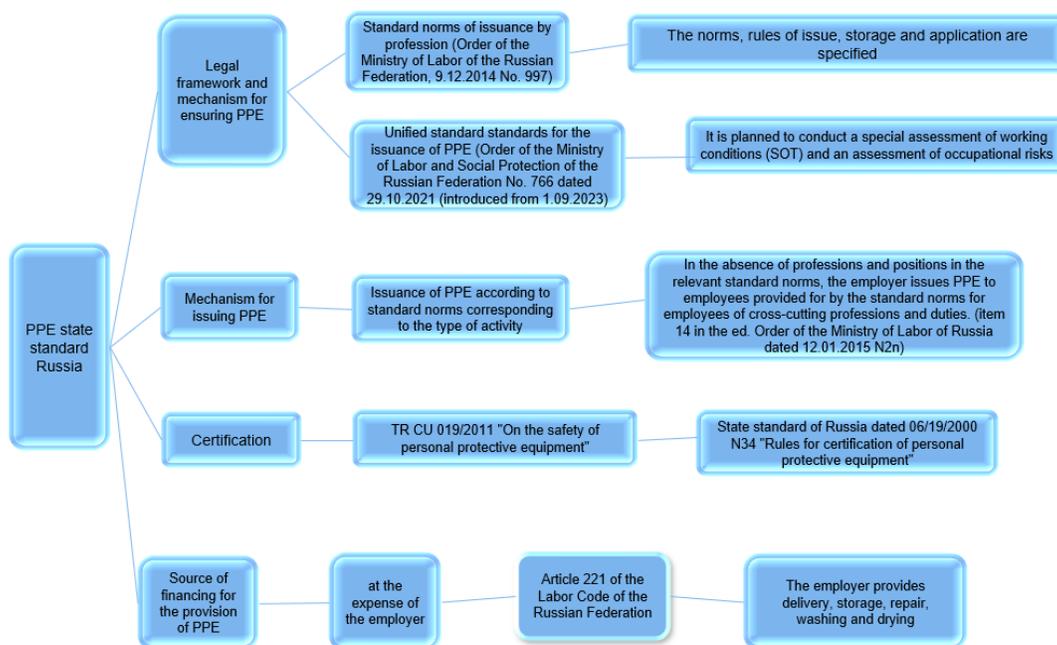


Fig. 1 - Mechanism for Providing and Issuing PPE in Russia

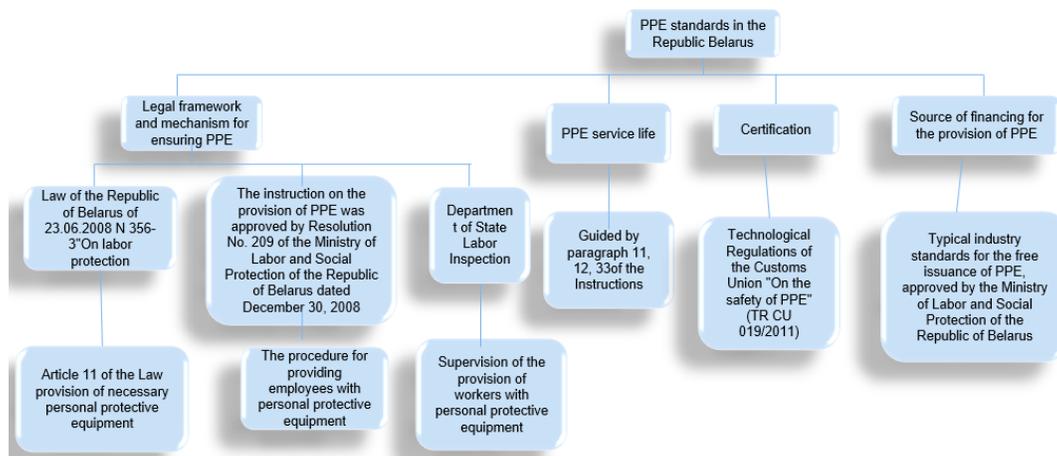


Fig. 2 - Mechanism for Providing and Issuing PPE in the Republic of Belarus

Materials and methods. The theoretical and methodological basis of the study was based on regulatory documents, scientific works and developments of domestic and foreign scientists

on the use of PPE against the impact of harmful and hazardous production factors and their selection based on RBA [8].

The results of the review revealed that in the

post-Soviet countries (RF, RB, RK) PPE and its components must comply with the requirements of the Technical Regulations of the Customs Union "On the safety of personal protective equipment" (hereinafter - TR CU019/2011) [9].

In the Russian Federation, there are currently standard standards for the issuance of PPE for 195 professions in accordance with the Order of the Ministry of Labor of Russia dated December 9, 2014 "On approval of standard standards for the free issuance of special clothing, special footwear and other personal protective equipment to workers of cross-cutting professions and positions of all types of economic activity engaged in work with harmful and (or) hazardous working conditions, as well as in work performed in special temperature conditions or associated with pollution" [10], which specifies the standards, rules for the issuance, storage and use

of PPE. In the Republic of Belarus, the procedure for providing workers with PPE is regulated by the Instructions for Providing Workers with PPE. Figures 1 and 2 show the mechanisms for providing and issuing PPE in Russia and the Republic of Belarus, respectively.

Based on the results of the review of best practices in PPE provision mechanisms using the example of Canada, the USA, Great Britain, Poland, and Japan [11-17], two countries from the North American continent were identified as leaders.

The priority in ensuring occupational safety in Canada is the organization of preventive measures, i.e., the reduction and elimination of hazards. PPE is designed to protect against safety and/or health threats. For example, helmets, safety glasses, and safety boots are designed to prevent or reduce the severity of injury in case of emergency (Figure 3).

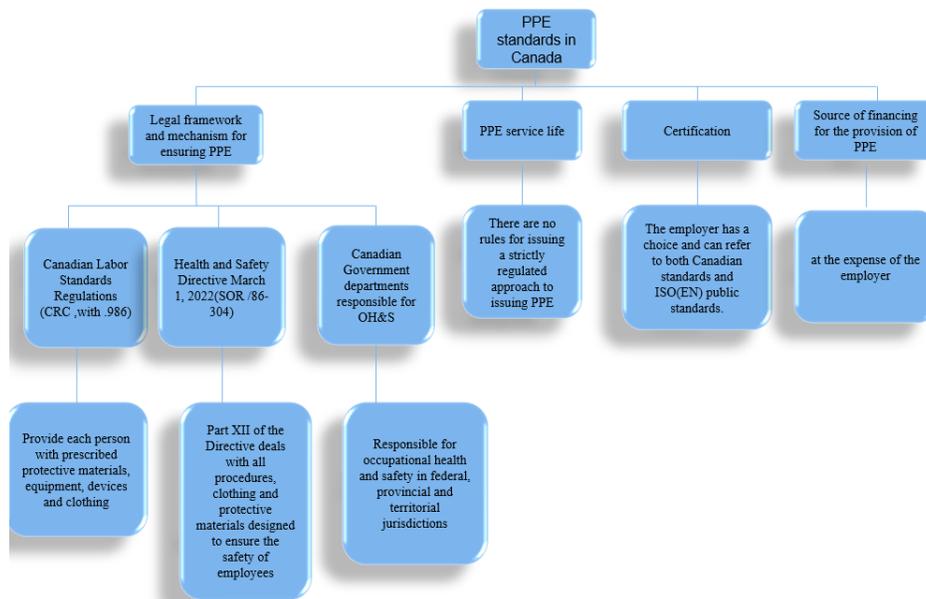


Fig. 3 - Mechanism for providing and issuing PPE in Canada

The type and nature of hazards in the workplace in the USA are the main indicators of the correct choice of PPE purchased at the employer's expense [12]. At the same time, employees are given instructions on the risks that can be avoided or limited by using PPE, the reasons for using PPE, how to use it safely and effectively, and the actions to maintain it in good condition, such as cleaning,

replacing, storing (Figure 4).

In the UK, eliminating the hazard is the most effective way to manage risks. According to the PPE provision policy (Figure 5), after conducting a risk assessment using various control levels, the employer is obliged to provide PPE to its employees at its own expense [13].

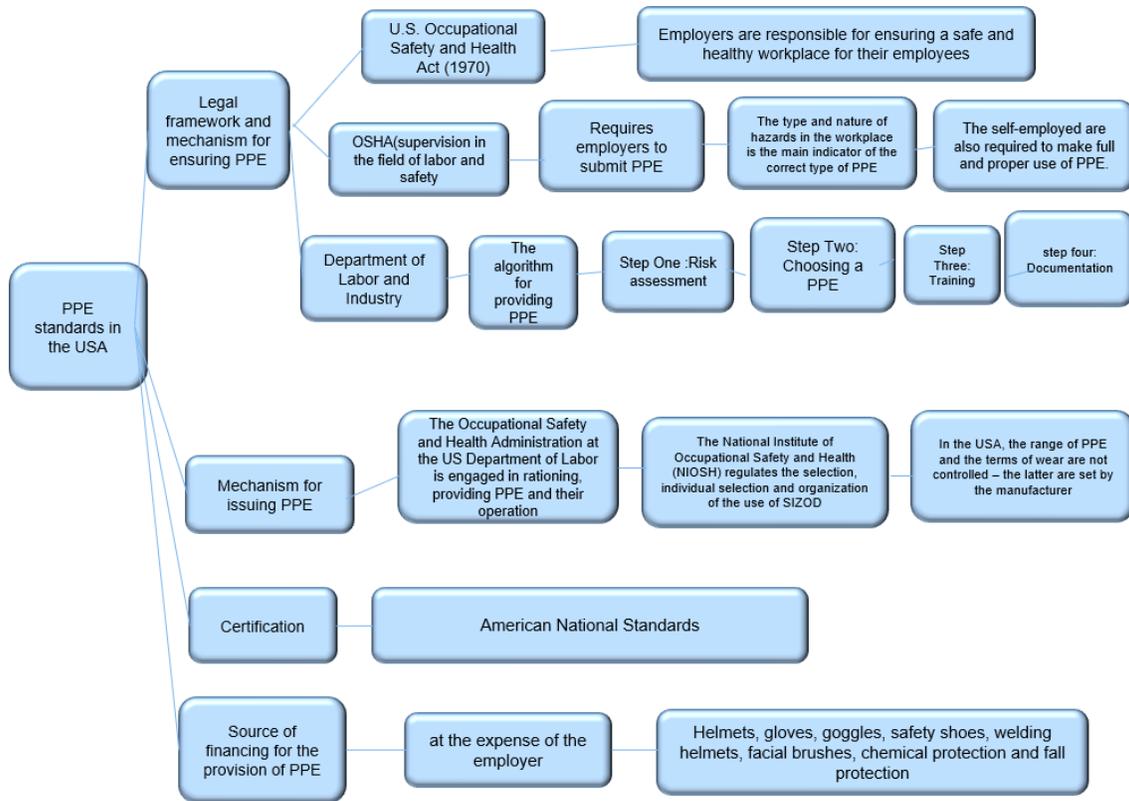


Fig. 4 - PPE provision and issue mechanism in the USA

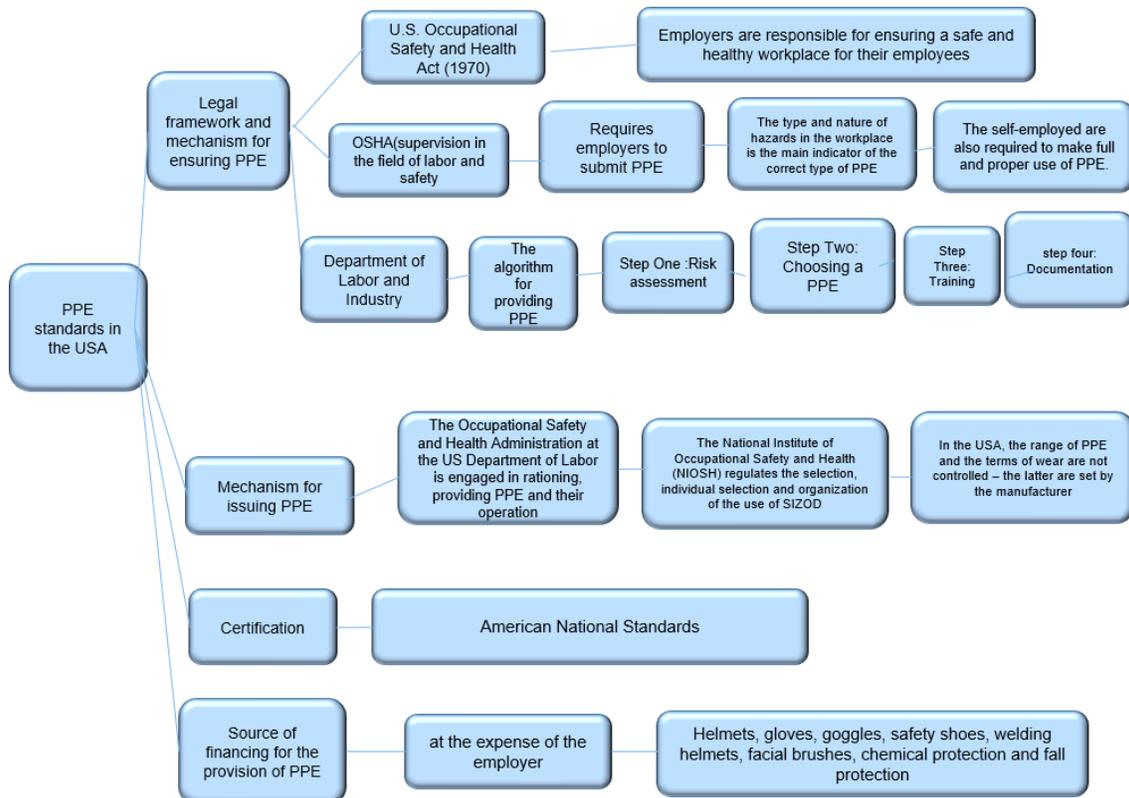


Fig. 5 - PPE provision and issue mechanism in the UK

In the EU countries, the conformity assessment processes for personal protective equipment are carried out only in accordance with the EU Regulation 2016/425. Thus, in Poland they must also comply with the requirements specified in the Act dated August 30, 2002 "On the Conformity Assessment System" [14]. In Japan,

the regulations on the provision of PPE are based on risk assessment (Figure 6). According to the requirements of the Occupational Safety and Health Act, Japanese employers are required to independently develop accident prevention programs at work and determine what protective equipment they will use to prevent accidents [16].

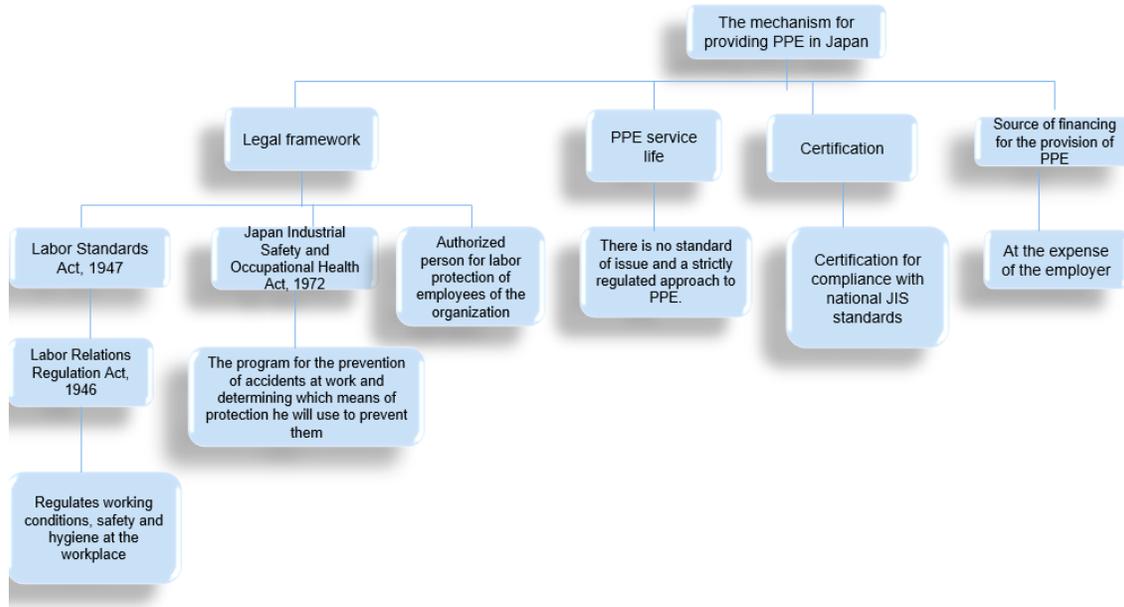


Fig. 6 - Mechanism for providing and issuing PPE in Japan

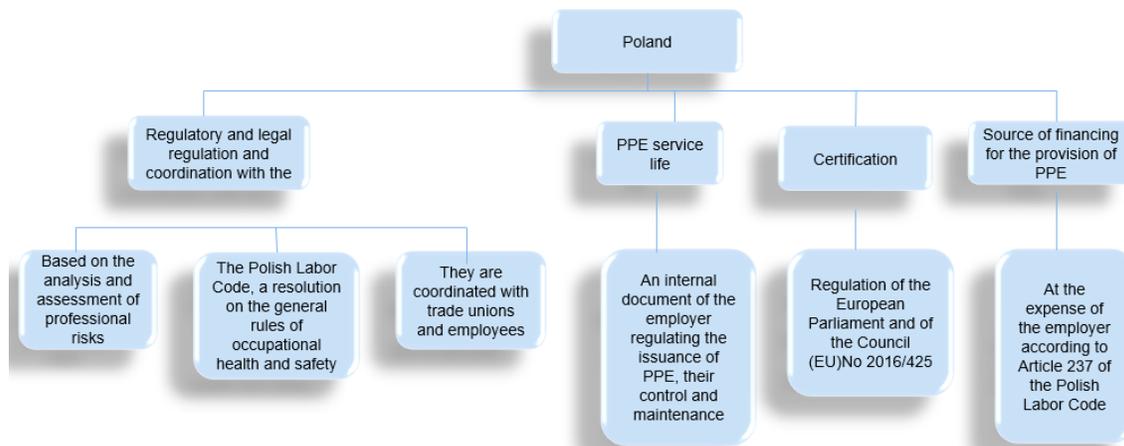


Fig. 7 - Mechanism for providing and issuing PPE in Poland

Mixed/hybrid approach – is currently typical for providing PPE in Poland (Figure 7) and Russia. In Poland [14], according to the Labor Code,

the employer determines the types of personal protective equipment, as well as work clothes and footwear, the use of which is required in

certain positions. At the same time, this is done on the basis of the Resolution of the Minister of Labor and Social Policy of September 26, 1997 "On General Rules for Occupational Health and Safety", which contains detailed rules for the use of PPE, including a list of risks that require personal protective equipment ("Types of work requiring the use of personal protective equipment with an indication and decoding of the types of personal protective equipment"). At the same time, the period of wear and operation is determined based on the manufacturer's requirements provided in the documentation for the PPE. Accordingly, the regulatory framework for the list of risks imposes on the employer an obligation to assess the professional risk of each employee, which is provided for by the Labor Code.

Thus, the employer of any enterprise must develop and approve by a local act the standards for the free issuance of PPE to employees, based on the Unified Standard Standards, taking into account the results of the special assessment of working conditions, the results of the assessment of professional risks, the opinion of the representative body of employees. These standards can be developed by the enterprise itself, as well as by involving third-party organizations or specialists [14].

Based on the results of the analysis, the mechanisms and features of the legal regulation of the provision of PPE were grouped as follows:

The list approach, which is based on strict regulatory consolidation of the list of professions and types of work, for which PPE is provided, sets and wearing periods are regulated, in some cases, provision in excess of standards is prohibited. Regulation is carried out on an industry basis, equalizing the working conditions of employees without taking into account the actual state and measures taken by the employer to improve working conditions (change in technology, technical re-equipment, use of collective protective equipment, exclusion of employee employment directly in the zone of exposure to harmful factors, etc.). Approval of standards by an act of the employer is formal in nature, the assessment of the provision of PPE

consists in comparing it with uniform/industry standards. This approach is observed in post-Soviet countries such as Russia, Belarus, Kazakhstan.

Risk-oriented approach, which is based on mandatory assessment of the professional risk of a specific employee. The provision of PPE is not standardized at the legislative level, but the employer's responsibilities to ensure the protection of employees are legislatively established. However, there are certain PPE that are presented in the standards for specific works (helmet and high-visibility vest for loading and unloading works without the obligation to provide special clothing against contamination, etc.) [18-21]. The standards for issuing and the terms of wearing/operation of PPE are tied to the information contained in the technical documentation for a specific product. The role of employee representatives in this aspect is very important, since the formation of the PPE register by the employer is carried out with their participation/agreement, often with the agreement of the employee himself. This approach is used in Canada, the USA, Great Britain, and Japan.

A mixed/hybrid approach, which is currently typical for providing PPE in Poland and Russia. In Poland, according to the Labor Code, the employer determines the types of personal protective equipment, as well as work clothes and footwear, the use of which is required in certain positions. At the same time, this is done on the basis of the Resolution of the Minister of Labor and Social Policy of September 26, 1997 "On General Rules for Occupational Health and Safety" [15], which contains detailed rules for the use of PPE, including a list of risks that require personal protective equipment ("Types of work requiring the use of personal protective equipment with an indication and decoding of the types of personal protective equipment"). At the same time, the period of wear and operation is determined based on the manufacturer's requirements, given in the documentation for the PPE. Accordingly, the regulatory framework for the list of risks imposes on the employer an obligation to assess the professional risk of each employee, which is provided for by the Labor Code.

Russia is in a transitional stage from the list approach and the hybrid approach used alongside it, characterized by legislative regulation of the procedure for providing PPE (Rules, Standard Standards) without taking into account the industry focus. The key reform provides for the transition from Standard Industry Standards for the Issuance of PPE (more than 60 documents) in favor of Uniform Standard Standards acceptable for all industries and sectors of the economy, which indicate the names of professions, names and types of PPE, their quantities per year. Risk-focused approach consists in introducing standards for the issuance of PPE depending on the hazards that pose a threat to the life and health of workers. A separate appendix provides the names of hazards identified based on the results of the assessment of professional risks, PPE that must be issued with a possible design, additional elements and quantity per year. The approved standards serve as the basis for local regulations at enterprises.

Results and discussion. At the same time, the employer's obligation to use certified PPE remains a single regulated requirement for all approaches. There is a significant regulatory

and technical framework, standards, bodies for confirming product compliance with safety and quality requirements, and state control is carried out.

The study found that to ensure occupational safety, it is necessary to identify hazards, subsequently assess the risk of their impact, and provide protective equipment taking into account the risk. The basis for identifying hazards is the classification of hazardous and harmful production factors. It is necessary to highlight those features that will allow the best identification of hazardous and harmful production factors, assess the risks of their impact on the worker's body, develop protective measures and implement them in practice, thereby preventing injuries and diseases associated with the employee's work and the employer's production activities. Based on the classification, it is possible to fully and reliably identify hazards in the workplace [21-24].

In this regard, in the course of scientific work, a classifier of risks associated with the impact of production factors on the worker's body was developed (Table 1-2) [25,26].

Table 1 - Classifier of harmful and hazardous production factors

No.	Factor code	Name of risks associated with factors of the production environment	Need to provide PPE (+/-)
1	1	Impact of industrial factors of mechanical nature	
2	1.1	Fall in the work area	
3	1.1.1	Fall from a height or to a depth	+
4	1.1.2	Fall when slipping on slippery surfaces	+
5	1.1.3	Fall, collapse, avalanche of objects (solid, liquid or gaseous objects)	+
6	1.1.4	Fall, destruction of buildings, structures and their elements	+
7	1.2	Road accident	
8	1.2.1	Vehicle collision	+
9	1.2.2	Transport accidents	-
10	1.3	Impact of production equipment	

11	1.3.1	Moving and rotating parts of equipment, mechanisms, machines, tools (impacts, grips, crushing)	+
12	1.3.2	Stationary cutting parts of production equipment, mechanisms, machines, tools (cuts, scratches)	+
13	1.3.3	Impact of high surface temperatures of equipment, mechanisms, machines, tools, liquids, gases, vapors	+
14	1.3.4	Impact of low surface temperatures of equipment, mechanisms, machines, tools	+
15	2	Impact of production factors of a physical nature	
16	2.1	Impact of electric current	
17	2.1.1	Electric shock from equipment, mechanisms, machines, tools	+
18	2.1.2	Impact of an electric arc	+
19	2.2	Risk of fire or explosion	
20	2.2.1	Ignition of flammable substances	+
21	2.2.2	Static electricity	+
22	2.2.3	Exposure to smoke, steam, harmful gases and dust	+
23	2.2.4	Working with pressure vessels	+
24	2.3	<i>Climate/microclimate</i>	
25	2.3.1	Increased air temperature in open areas	+
26	2.3.2	Decreased air temperature in open areas	+
27	2.3.3	Increased air velocity in open areas	+
28	2.3.4	Increased air humidity in open areas	+
29	2.3.4	Increased air temperature indoors	+
30	2.3.4	Decreased air temperature indoors	+
31	2.3.4	Increased air velocity indoors	+
32	2.3.4	Increased air humidity indoors	+
33	2.3.4	Increased thermal radiation	+
34	2.3.4	Increased atmospheric pressure	-
35	2.4	<i>Ionizing radiation</i>	
36	2.4.1	Alpha radiation	+
37	2.4.2	Beta radiation	+
38	2.4.3	Gamma radiation (expository)	+
39	2.4.4	X-ray radiation	+
40	2.4.5	Electrically charged air particles - aeroions	+

The proposed classifier consists of 6 main groups, 19 names, and 55 subgroups of production factors, and its application is substantiated using examples.

Table 2 - Classifier of harmful and hazardous production factors

No.	Factor code	Name of risks associated with factors of the production environment	Need to provide PPE (+/-)
1	2.5	<i>Non-ionizing radiation</i>	
2	2.5.1	Electrostatic field	+
3	2.5.2	Permanent magnetic field (including hypogeomagnetic)	+
4	2.5.3	Industrial frequency electric and magnetic fields	+
5	2.5.4	Broadband electromagnetic fields generated by personal computers	-
6	2.5.5	Infrared radiation	+
7	2.5.6	Ultraviolet radiation	+
8	2.5.7	Laser radiation	+
9	2.6	<i>Vibroacoustic factors</i>	
10	2.6.1	Continuous noise	+
11	2.6.2	Pulsed noise	+
12	2.6.3	General vibration	+
13	2.6.4	Local vibration	+
14	2.6.5	Infrasound	+
15	2.6.6	Ultrasound	+
16	2.7	<i>Light environment</i>	
17	2.7.1	Insufficient illumination of the work area	+
18	2.7.2	Increased illumination of the work area (brightness of light, direct and reflected, increased pulsation of the light flux)	+
19	2.8	<i>Aerosol composition of air</i>	
20	2.8.1	Highly and moderately fibrogenic aerosols	+
21	2.8.2	Low-fibrogenic aerosols	+
22	3	Impact of industrial factors of chemical nature	
23	3.1	<i>Chemical substances contained in the air of the working area (aerosols, vapors, gases, fumes)</i>	
24	3.1.1	Acute toxicity substances	+
25	3.1.2	Irritant substances	+
26	3.1.3	Carcinogenic substances	+
27	3.1.4	Allergenic substances	+
28	3.1.5	Substances hazardous to reproductive health	+
29	3.1.6	Substances prohibited for inhalation and skin contact (antitumor drugs, estrogen hormones, narcotic analgesics)	+

30	3.1.7	Solutions of acids, alkalis, etc., solid and bulk substances that affect the skin and mucous membranes	+
31	4	Impact of production factors of biological nature	
32	4.1	Microorganisms-producers, preparations containing living cells and spores of microorganisms	+
33	4.2	Pathogenic microorganisms and viruses (causative agents of especially dangerous and other infectious diseases)	+
34	4.3	Getting of poisons, waste products and plants themselves, insects, arachnids, animals on the skin and inside the body	+
35	5	Impact of production factors of psychophysiological nature	
36	5.1	Difficulty of labor	-
37	5.2	Intensity of labor	-
38	6	Exposure to general industrial contaminants	
39	6.1	Water (including contaminated) and solutions of non-toxic substances (dyes, adhesives, oily and other substances) and labor products	+
40	6.2	Non-toxic dust (fine chips, small fragments, coarse dust)	+

The classifier contains the following main names of risks associated with the impact of factors of the production environment and the work process on the worker's body:

- impact of production factors of a mechanical nature (fall in the work area, road traffic accident, impact of production equipment);

- impact of production factors of a physical nature (electric current, threat of fire or explosion, climate/microclimate, ionizing radiation, non-ionizing radiation, vibroacoustic factors, light environment, aerosol composition of air);

- impact of production factors of a chemical nature (chemical substances contained in the air of the working area (aerosols, vapors, gases, fumes);

- impact of production factors of a biological nature (microorganisms - producers, pathogenic microorganisms and viruses, waste products of plants, insects, arachnids, animals);

- impact of production factors of a psychophysiological nature (severity of work, labor intensity);

- impact of general industrial pollutants (water and solutions of non-toxic substances, non-toxic

dust)

Conclusions. Analysis of the current mechanisms for providing PPE in the Republic of Kazakhstan has established that regulation is determined by 22 industries and 3,544 professions based on approved standards for issuing special clothing and other personal protective equipment to employees of organizations of various types of economic activity.

Compliance with the established standards in practice puts the employer in a strict framework, on the one hand, with the need to purchase PPE that is inadequate for working conditions, on the other hand, with the impossibility of increasing/decreasing the wearing period and quantity, changing the completeness, etc. The domestic mechanism for providing PPE is characterized by a "list" approach and strict regulation of the types of PPE depending on the profession or position of the employee, which in some cases leads to the creation of barriers in ensuring safe work at enterprises. At the same time, the experience of developed countries shows the effectiveness of using RBA in providing PPE.

Thus, developed foreign countries use models

for providing PPE based on an assessment of professional risks, analyzing specific hazards and providing relevant means of protection against them. The introduction of risk assessment into the labor legislation of the Republic of Kazakhstan and the existing regulatory mechanism for the provision of PPE, which does not take into account the specifics of the labor process and the presence/absence of harmful production factors and professional risks, requires revision. It is assumed that based on the results of the assessment of professional risks, as well as taking into account the physical, chemical, biological factors of the production environment and factors of the labor process, employers should be able to independently develop and approve standards for providing PPE to employees of the enterprise [2].

In this regard, it is necessary to improve the current regulatory mechanism for providing special clothing, footwear and other PPE with increased flexibility in determining the contingent of employees, choosing protective equipment, assigning additional sets, replacement and complex PPE, service life.

Thus, the employer of any enterprise must develop and approve by a local act the standards for the free issuance of PPE to employees, based

on the unified standard guidelines, taking into account the results of the special assessment of working conditions, the results of the assessment of professional risks, the opinion of the representative body of employees. These standards can be developed by the enterprise itself, or by involving third-party organizations or specialists.

Considering that the range of modern PPE fully covers protection against all possible factors of the production environment and professional risks, a methodology for providing PPE based on RBA will be developed and implemented, as well as a nomenclature of PPE corresponding to the degree and type of exposure to harmful and (or) hazardous production factors [2].

Also, based on the results of the study, a classifier of risks associated with the impact of production factors on the worker's body, as well as a classifier of harmful and hazardous production factors were developed.

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