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Impact of Green Jobs on Worker Classification and Categorization

Lyazat Aktayeva[1], Alimzhan Bekmagambetov[1], Laura Yedilbayeva[1], Anar Rakhmetova[1], Gulzhan Daumova[2*], Elmira Kulmagambetova[1], Nurgul Sagindykova[1]

[1] Scientific Research Center, Republican Research Institute for Occupational Safety and Health, Astana 010000, Kazakhstan
[2] School of Earth Sciences, D. Serikbayev East Kazakhstan Technical University, Ust-Kamenogorsk 070018, Kazakhstan

Corresponding Author Email: gdaumova@edu.ektu.kz

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ABSTRACT

The aim of the study is to develop and test an improved system for categorizing employees by working conditions, taking into account the concept of "green" workplaces. The empirical basis of the study is based on the example of a large industrial enterprise, the phosphorus plant of the Republic of Kazakhstan, where 41 professions were included in the analysis. The data of workplace certification, indicators of the severity and intensity of the labor process, as well as the results of medical examinations, temporary disability certificates, and information on occupational diseases of employees for the period 2019-2023 were used. The methodological framework includes a comparative analysis of the general hygienic assessment of working conditions and employee health monitoring data using a risk-based approach. The categorization was carried out by classes of working conditions (CWC 1-4), which made it possible to compare the formal results of the certification with the actual state of health of the staff. The main results of the study showed that according to the initial hygienic classification, 4 professions were classified as class 3.1 (moderate degree), 27 as class 3.2 (high degree), and 10 as class 3.3 (very high degree). After the revision, taking into account medical data, 12 professions retained the same class, and for 25 professions it was changed, including confirmation of class 2.4 (very high degree) for three professions. The most unfavorable occupational risk profile is established for the professions of gas purification apparatchiks, charge workers, granulation and drying apparatchiks, electricians, electric and gas welders, and repair fitters. The practical significance of the work lies in the fact that the proposed categorization model not only captures the level of occupational risk, but also forms the basis for targeted preventive measures, equipment modernization, automation of the most dangerous processes, and the development of a medical monitoring system. The introduction of the category of "green" workplaces (CWC 1-2) into the national classification makes it possible to form a balanced occupational safety system that integrates the tasks of reducing harmful factors and maintaining a safe working environment.

1. INTRODUCTION

In the context of global challenges such as climate change, demographic shifts, and the transition toward sustainable development, occupational health and the reduction of professional risks have acquired strategic importance. Modern industrial processes increasingly require the integration of environmental and social dimensions into occupational safety management systems. However, traditional methodological approaches, which rely mainly on hygienic regulatory thresholds, no longer fully capture the complex and multi-level nature of occupational risks. Previous studies have highlighted these limitations and called for the adoption of more comprehensive and flexible risk management models [1, 2].

Traditional methodological approaches to assessing working conditions, such as the hygienic classification of the Ministry of Health of the Republic of Kazakhstan [3] and similar international methods (NIOSH [4], EU-OSHA [5]), are based primarily on quantifying the effects of harmful and dangerous factors and recording the degree of exceedance of permissible levels. Their main focus is on identifying and compensating for existing adverse conditions, while the preventive component is often overlooked. Such models effectively describe the levels of industrial risks but do not reflect modern requirements for integrating environmental and social criteria into the occupational safety system.

In contrast, the concept of "green" workplaces, proposed by UNEP/ILO/IOE/ITUC [6] and actively developed within the framework of the European Green Deal and OECD programs [7], expands the scope of the classical classification. It focuses not only on minimizing harmful effects but also on creating working conditions that initially comply with the principles of sustainability and decent work. While traditional classifications fix the "level of harmfulness," the new model is

complemented by a category of workplaces that meet optimal and acceptable conditions (grades 1–2 according to hygienic criteria), which are proposed to be considered "green." This allows the focus to shift from reacting to consequences toward proactive occupational risk management.

Thus, the key difference of the proposed approach lies in the integration of environmental sustainability and social responsibility criteria into the existing system of classification of working conditions. This ensures the formation of a new category of employment aimed at preventing occupational diseases and preserving labor potential, which underscores the scientific novelty of the study.

The complexity and multifactorial nature of harmful and hazardous factors [8, 9] necessitate revising existing models for assessing working conditions. Such models must account for cumulative and combined effects, the interaction of multiple workplace exposures, and individual susceptibility of workers. This is especially critical in high-technology industries, where noise, vibration, aerosols, chemical vapors, and physical workload interact to increase the risk of chronic diseases and reduced work capacity.

In this context, the concept of “green” jobs is gaining importance, emphasizing the creation of working conditions that minimize adverse impacts on both worker health and the environment. The development of such occupations is linked not only to ecological benefits but also to the prevention of occupational diseases, the integration of ergonomic solutions, and the overall improvement of quality of working life. Therefore, the transition to “green” jobs can be regarded as a strategic direction for modernizing occupational health and safety systems, shifting the focus from reactive measures to proactive risk prevention and the design of safe production environments.

At the same time, rethinking approaches to assessing working conditions should address not only the reduction of harmful exposures but also the strategic transformation of the labor market driven by the transition to a “green” economy. This shift involves the emergence of new occupational categories oriented toward sustainable development and worker health. Integrating the concept of “green” jobs into classification systems allows occupational safety and health objectives to align with environmental and social goals, ensuring comprehensive protection of both workers and the environment.

In the context of global climate [10] and social commitments [11], “green” jobs—occupations designed to minimize negative impacts on the environment and human health—are gaining increasing importance. Recent studies [12, 13] highlight that the rapid growth of the green sector is accompanied by new and heightened risks associated with innovative materials, technologies, and organizational forms of labor. Scholars emphasize the need to revise risk assessment methodologies, strengthen prevention and protection protocols, train specialists with “green” competencies, and incorporate ergonomic principles (“green ergonomics”) to reduce occupational diseases and injuries.

Other authors [14] note that, although there is no unified definition of “green” jobs, they are consistently linked to sustainable development and to green and circular economy models. A central element is the creation of decent work that ensures work–life balance and involves local authorities, underscoring the need for a systematic approach to job development and classification with regard to environmental and social impacts.

In this context, “green” jobs are understood as workplaces that promote environmental sustainability while also meeting standards of decent work and occupational safety [14]. According to the joint UNEP/ILO/IOE/ITUC report [6], a “green” job is any decent work that improves the environment [10], provided it complies with occupational safety requirements and fair employment conditions [15]. European policy, particularly the European Green Deal, emphasizes the creation of such jobs that combine environmental benefits with worker health and well-being. The UNEP/ILO/IOE/ITUC partnership supports these initiatives to ensure a just transition to a sustainable “green” economy [6].

This reflects the global trend toward formalizing the concept of “green” occupations and embedding occupational safety indicators into sustainable employment frameworks. Within the international research and regulatory agenda, the identification of “green” jobs as a form of sustainable and safe employment is becoming increasingly relevant. Reports from the NIOSH [4], EU-OSHA [5], and ILO [16] highlight that “green” jobs are characterized by minimal or absent occupational hazards, adherence to occupational health and sustainable development principles, and the promotion of climate-neutral technologies alongside a just transition to a green economy.

International practice highlights the importance of classifying jobs by considering both environmental and occupational factors. Several countries have already introduced systems that include categories such as low-risk or “green” occupations. For example, the International Labour Organization (ILO), through its “Green Jobs” programme, proposes criteria that assess occupations based on their contribution to environmental protection and the provision of decent working conditions [17]. Similarly, the European Agency for Safety and Health at Work (EU-OSHA) defines “green” jobs as occupations across various sectors that support environmental sustainability while requiring effective control of occupational risks [18]. The Organisation for Economic Co-operation and Development (OECD) has suggested an international classification dividing occupations into “green” and “brown” categories, thereby integrating environmental considerations into employment policy [7].

Incorporating similar approaches into national legislation and worker classification systems under the new framework of working conditions can help align occupational safety objectives with the goals of the green economic transition.

In line with global trends, the categorization proposed in this study—which introduces a dedicated “green” category—provides an effective tool for integrating sustainability and health indicators into occupational risk management. The proportion of jobs with optimal conditions can serve as a measurable indicator of progress in occupational health and safety, enhancing both the practical relevance and applied value of the model for advancing sustainable and safe employment at the national level.

A key aspect in developing a new classification of working conditions — which incorporates the category of “green” jobs — is the legislative consolidation of clear approaches and criteria for their definition. According to Mathieu [19], in developing economies, the effective implementation of the green jobs concept requires a strong economic and regulatory framework that balances short-term economic objectives with long-term sustainability goals. A review of 516 scientific publications indicates that, for such countries, the main prerequisites include adapting the concept to national contexts,

accounting for industry-specific features, engaging the informal sector, and investing substantially in human capital and small-scale technologies.

An important contribution to advancing the scientific and practical understanding of "green" jobs is provided by Bradley et al. [20], who conducted a systematic review of empirical studies combined with analytical discussions involving practitioners. The authors highlight that effective development of green jobs requires integrating scientific approaches with the practical experience of employers and policymakers, as well as establishing common criteria for their definition and evaluation. Particular emphasis is placed on monitoring tools that not only track the number of green jobs but also assess their quality, including working conditions, occupational risk levels, and compliance with sustainability principles. These findings are directly relevant to the task of categorizing workers in harmful and hazardous occupations, as incorporating environmental sustainability criteria into classification systems helps align occupational safety objectives with the goals of the green economic transition.

The need for a systematic approach to developing "green" jobs is highlighted by contemporary researchers, who view them not only as a driver of environmental transformation but also as a foundation of socio-economic stability. The authors [21], for example, point out that their expansion is constrained by cultural, economic, organizational, political, technological, and behavioral barriers, while key drivers include social norms, government policy, cultural values, demographic trends, inclusion, and technological innovation. The EU experience, supported by EUROSTAT data, shows that sustainable growth in "green" jobs is possible only with comprehensive institutional and legislative support. For developing economies such as Kazakhstan, this evidence is particularly relevant: consolidating clear legislative criteria enables the integration of environmental priorities with occupational safety objectives and the creation of a safer working environment.

The scientific novelty of this study lies in the development of an improved methodology for classifying workers employed in harmful and hazardous working conditions. Unlike traditional approaches that rely mainly on hygienic criteria, the proposed framework systematically integrates hygienic, biomedical, and production-factor indicators.

For the first time, an algorithm for categorizing working conditions has been implemented in alignment with the updated hygienic classification and modern risk-oriented management principles. This ensures higher accuracy, reproducibility, and objectivity in occupational safety decision-making and allows a transition from reactive measures to proactive occupational risk management and workplace health promotion.

The proposed approach is particularly relevant in the context of the strategic shift toward the development and promotion of "green" jobs. These positions are designed to minimize the impact of workplace factors on workers' health, enhance the environmental sustainability of production processes, and support the principles of sustainable development. By linking occupational safety with environmental and social objectives, the methodology contributes to the creation of safer, healthier, and more sustainable workplaces.

The proposed framework establishes scientifically grounded criteria for accurately classifying workers employed in harmful or hazardous conditions. Given the growing complexity of production processes and the variability of workplace environmental and operational factors, there is a clear demand for objective and standardized assessments of working conditions. Without such specification, the classification of workers may remain inconsistent, reducing the effectiveness of preventive measures, underestimating compensation, and undermining labor rights.

The relevance of this research is driven by the need to modernize occupational safety management systems in accordance with current regulatory requirements and advanced risk assessment methodologies. Establishing universal and transparent criteria for classifying workers in harmful and hazardous conditions will improve the identification of occupational risks, strengthen disease prevention, secure social guarantees, and support safe work practices.

The scientific novelty of this study lies in the development of a comprehensive methodology for categorizing workers employed in harmful or hazardous conditions through the systematic integration of hygienic, biomedical, and production-factor criteria. For the first time, an algorithm for classifying working conditions has been implemented in alignment with the updated hygienic classification and modern approaches to occupational risk management. This methodology improves accuracy, reproducibility, and objectivity in occupational safety decision-making, while enabling a shift from reactive measures to proactive risk management and workplace health promotion.

This development is particularly relevant within the strategic course toward expanding "green" jobs, which aim to minimize harmful workplace exposures, enhance the environmental sustainability of production processes, and advance the principles of sustainable development.

The aim of this study is to develop and test an improved system for categorizing workers according to working conditions, integrating the concept of "green" jobs into a risk-oriented classification framework. The study seeks to bridge the gap between traditional hygienic models and modern approaches that incorporate both harmful and hazardous factors, as well as safe and sustainable conditions aligned with the principles of sustainable development and decent work. Using empirical data from a phosphorus plant in Kazakhstan, the research evaluates 41 occupations through workplace assessments, medical health monitoring, and analysis of occupational morbidity in 2019–2023. This approach allows for the identification of discrepancies between formal hygienic classifications and actual health outcomes, providing a more accurate categorization of professional risks and highlighting the role of "green" jobs in promoting a safe, sustainable, and resilient working environment.

2. METHODS AND MATERIALS OF RESEARCH

The study was conducted in accordance with the requirements of the new classification of working conditions adopted in the Republic of Kazakhstan, with a breakdown into Classes 2.2, 2.3, and 2.4 (permissible and "green" working conditions), Classes 3.1–3.4 (hazardous working conditions of varying degrees), and Class 4 (dangerous working conditions). The assessment included indicators of hygienic conditions (levels of dust, noise, vibration, lighting, and the presence of chemical agents), as well as parameters of the severity and intensity of the labor process.

The biomedical component of the analysis was based on data on occupationally related diseases, disability rates, and the frequency of diagnosed chronic disorders confirmed during periodic medical examinations. In addition, a reclassification of working conditions was performed in accordance with the new scale, and cases were identified in which occupations fell into the "green" category - where hazardous and dangerous factors are absent or remain within permissible levels.

The classification of working conditions within the risk-oriented approach is based on the assessment of hazardous working conditions using two groups of criteria:

1. Industrial-hygienic criteria - for the general hygienic assessment of working conditions, taking into account the combined effects of occupational factors as a predictor of occupational health damage.
2. Medical-functional criteria - for adjusting the general hygienic assessment of working conditions based on the analysis of monitoring data on manifestations of occupational health damage, serving as a resultant indicator of the impact of hazardous occupational factors.

The medical-functional criteria include:

- Occupationally related diseases (structure, relative risk, etiological fraction);
- Registered occupational diseases;
- Degree of loss of professional work capacity;
- Disability (total diseases, occupational diseases, occupational injuries).

The study was conducted at a large industrial facility - a phosphorus plant in the Republic of Kazakhstan - which comprises workshops with diverse technological processes [22].

For the analysis, data from the workplace certification of the enterprise were used, including sanitary and hygienic measurements, results of medical examinations, and information on production processes and working conditions across 41 occupational groups.

Data collection was carried out on the basis of workplace certification (sanitary and hygienic measurements of noise, vibration, airborne dust, concentrations of chemical agents, illumination parameters), as well as analysis of employees' medical records, sick leave certificates, and the results of periodic medical examinations for 2019–2023. In total, more than 1,200 cases were analyzed and compared with specific working conditions and occupations. The measurements were conducted in accordance with the approved methodological guidelines "Hygienic criteria for assessment and classification of working conditions based on the harmfulness and hazard factors of the production environment, severity and intensity of the labor process" [3], using a risk-based approach. For each occupation, indicators of the production environment (noise, vibration, dustiness, gas composition of the air, illumination, etc.) and of the labor process (severity and intensity of work) were determined.

The analysis was performed in three stages:

- Hygienic classification of working conditions on a scale of 1–3.4 (optimal, acceptable, harmful to varying degrees, dangerous);
- Adjustment based on medical data — including registered occupational diseases, frequency of sick leave, the level of disability (SUPT), and cases of incapacity;
- Integration of data within the framework of the new risk-based classification with the introduction of categories 2.2, 2.3, 2.4 (acceptable /«green» conditions) and confirmation of the most severe cases (class 3.4 and higher).

This approach made it possible to compare the results of the formal hygienic assessment with the actual health status of employees and to identify a new category of "green" jobs, thereby increasing the accuracy and practical applicability of the developed model.

Based on the obtained data, the class of working conditions (CWC) was assigned according to a scale ranging from Class 1 (optimal conditions) to Class 3.4 (hazardous working conditions of a very high degree).

Occupational health monitoring was carried out using employee medical records, data from periodic medical examinations, and sick leave certificates for the period 2019–2023. In total, over 1,200 cases of temporary disability were analyzed, with identification of diseases potentially related to working conditions.

For each employee, the following were determined:

- Nosological forms of diseases (with an emphasis on occupationally related conditions);
- Frequency of seeking medical care;
- Association of identified pathologies with specific hazardous and dangerous workplace factors.

The comparative analysis included:

- Distribution of occupations by class of working conditions;
- Reclassification of CWC categories according to the new classification;
- Identification of priority worker groups with an elevated level of occupational risk.

The obtained data formed the basis for the development and testing of a worker categorization model incorporating the "green" workplace concept, which made it possible to move from a formal assessment of working conditions to practical measures for managing occupational risks at the enterprise.

3. RESULTS AND DISCUSSION

This study has led to the development of an improved worker categorization system that takes into account both the degree of harmfulness of occupational factors and the concept of "green" jobs. This model reflects modern occupational safety requirements and is focused on proactive reduction of occupational risks.

We recommend three main groups of employees, classified according to the level of occupational risk in accordance with the class of working conditions (CWC), based on a risk-oriented approach (Table 1):

The categorization of employees by the degree of harmfulness of working conditions is presented below:

1. Employees engaged in work with "green" working conditions:
   - Acceptable working conditions (1st degree of occupational risk).
2. Employees engaged in work with harmful working conditions:
   - Harmful working conditions of moderate degree (2nd degree of occupational risk);
   - Harmful working conditions of significant degree (3rd degree of occupational risk);
   - Harmful working conditions of a high degree (4th degree of occupational risk).

3. Employees engaged in work with hazardous working conditions:
   - Harmful working conditions of very high degree (5th degree of occupational risk).

In this study, the concept of "green" jobs is reflected through the introduction of a new first category of employees working under optimal and permissible working conditions (Table 1), i.e., those employed in environments that do not have a harmful impact on health. The novelty of this approach lies in the fact that, for the first time at the national level, it is proposed to explicitly identify such a group—employees working within the so-called "green" safety zone. This category covers occupations where working conditions meet the optimal (Class 1) or permissible (Class 2) levels according to the current hygienic classification. The proactive inclusion of this group in the working conditions assessment system logically advances the idea of "green" jobs within the framework of the national classification, shifting the focus from merely identifying harmful factors toward promoting a safe production environment. Formal recognition of the category of employees with favorable (safe) working conditions aligns the risk management system not only with the mitigation of existing hazards but also with the preservation and expansion of inherently safe working conditions.

The introduction of this first category (employees in optimal/permissible conditions) reflects the core principles of sustainable employment, health protection, and prevention of occupational risks. In practice, these are workplaces that ensure long-term productivity without undermining the health of personnel—fully consistent with the international goals of decent work and sustainable development.

Thus, the emphasis shifts from responding to existing harm toward its prevention: the categorization model stimulates the proactive creation of working conditions in which risks are initially minimized. This strengthens the preventive orientation of the occupational health and safety system and supports workers' health, ultimately enhancing human capital resilience and the economic efficiency of enterprises. A logical next step was to confirm the applicability of this approach using actual industrial data, enabling the transition from a theoretical model to its practical implementation.

Table 1. Determination of the category of workers engaged in harmful and hazardous working conditions and the criteria for their classification, taking into account the indicators of the working environment and the labor process

Category of Persons Employed in Harmful and/or Dangerous Working Conditions	**Class of Working Conditions for Harmful and Other Factors**	**General Hygiene Assessment (Estimated Occupational Risk)**	**Assessment of Occupational Health Damage (Resultant Factor)**			
			Work-related Diseases	**Occupational Diseases**	**Loss of Professional Working Capacity (DLWC)**	**Disability**
1 Workers employed in jobs with "green" working conditions	Acceptable working conditions (1)	Optimal working conditions (Class 1) Acceptable working conditions (Class 2)	Practically healthy worker, occupationally fit, or a worker temporarily unfit for work, requiring outpatient or inpatient follow-up examination and treatment.			
	Harmful working conditions of moderate degree (2)	Class 3, Degree 1 (Subclass 2.1)	A worker is temporarily unfit for work, requires inpatient examination and treatment, and needs follow-up medical supervision and sanatorium-resort treatment.		Transfer to light-duty work for a period of 2 to 6 months.	
2 Workers engaged in jobs with harmful working conditions	Harmful working conditions of a significant degree (3)	Class 3, Degree 2 (Subclass 3.2)	Suspected occupationally-related and/or occupational diseases; requires examination at an occupational pathology center.	Occupational diseases	DLWC from 5% to 29%	Group II: moderately pronounced impairments leading to limitations in vital activity.
	Harmful working conditions of high degree (4)	Class 3, Degree 3 (Subclass 3.2)	Suspected occupationally-related and/or occupational diseases; requires examination at an occupational pathology center.	Occupational diseases	DLWC from 30% to 59%	Group I: pronounced impairments leading to significant limitations in vital activity.
3 Workers engaged in work with dangerous working conditions	Very high degree of harmful working conditions (5)	Class 3, Degree 4 (Subclass 3.4)	Suspected occupationally conditioned and/or occupational diseases; requires examination at an occupational pathology center.	Occupational diseases	DLWC from 60% to 89%	Group I: the most severe impairments requiring constant care.
		Dangerous (extreme) working conditions			DLWC from 90% to 100%	Death resulting from an occupational disease.

The present study is a logical continuation of the work by Bekmagambetov et al. [22]. The results obtained in that earlier research made it possible to identify production units with the highest degree of occupational disease prevalence and to determine the key harmful factors. Based on these findings, the current study developed an approach to categorizing

employees according to working conditions in line with the new classification of harmful and hazardous factors, thus enabling a transition from risk assessment to practical measures for occupational health and safety management at the enterprise.

The proposed model for working conditions categorization requires validation of its applicability under real industrial conditions. For this purpose, the present study compared data from the general hygienic assessment of working conditions with occupational health monitoring records for employees in 41 occupations at the investigated enterprise. This approach makes it possible to identify discrepancies between the formal hygienic assessment and the actual health status of workers, thereby improving the accuracy of assigning the class of working conditions (CWC) and the degree of occupational risk.

Table 2 presents the results of the comparative analysis of the general hygienic assessment of working conditions and occupational health monitoring across 41 occupations of the studied enterprise, with the determination of the working conditions category and identification of harmful and hazardous factors.

Table 2. Comparative analysis of the general hygienic assessment and occupational health monitoring data

General Hygienic Assessment, CWC	Occupations	Occupational Health Monitoring	Occupations
1 and 2		1st degree of occupational risk (OR) – green working conditions (WC)	
3.1	1. Storekeeper; 2. Apparatchik of preparation of chemical solutions; 3. Worker of industrial baths; 4. Elevator operator;	2nd degree of occupational risk (OR) – moderately hazardous working conditions (WC)	
3.2	1. The dosing apparatchik; 2. Cooling apparatchik; 3. Gas purification apparatchik; 4. Hot Agglomerate crusher; 5. Agglomerator; 6. Yellow phosphorus production apparatchik (for cleaning electrostatic precipitators); 7. Cleaner of industrial and office premises; 8. Yellow phosphorus production apparatchik (charge worker); 9. Yellow phosphorus production apparatchik (for maintenance of dust and gas collecting plants); 10. Yellow phosphorus production apparatchik (granulation); 11. Yellow phosphorus production apparatchik (senior); 12. Yellow phosphorus production (recycling) apparatchik; 13. The seeding apparatchik; 14. Crane operator; 15. Drying apparatchik; 16. Plumber; 17. Yellow phosphorus production apparatchik (for the discharge of ferrophosphorus); 18. Yellow phosphorus production apparatchik (remote control); 19. Yellow phosphorus production apparatchik (condensation); 20. The electrode sensor; 21. Yellow phosphorus production apparatchik; 22. Gas drying apparatchik; 23. Machinist of compressor units; 24. Shop mechanic; 25. Operator of pumping units; 26. Air separation apparatchik; 27. Cylinder filler	3rd degree of occupational risk (OR) – significantly hazardous working conditions (WC)	1. The dosing apparatchik; 2. Cooling apparatchik; 3. Gas purification apparatchik; 4. Hot Agglomerate crusher; 5. Agglomerator; 6. Yellow phosphorus production apparatchik (for cleaning electrostatic precipitators); 7. Cleaner of industrial and office premises; 8. The storekeeper; 9. Apparatchik of preparation of chemical solutions; 10. Yellow phosphorus production apparatchik (condensation); 11. The electrode sensor; 12. Yellow phosphorus production apparatchik;
3.3	1. The mechanic-repairman; 2. Electric and gas welder; 3. Electrician for repair and maintenance of electrical equipment; 4. Conveyor operator; 5. The driver of the car dumper;	4th degree of occupational risk (OR) – highly hazardous working conditions (WC)	1. Conveyor operator; 2. The driver of the car dumper; 3. The crusher; 4.Mixer; 5. Bunkerman; 6. Remote control operator;

	6. The crusher; 7. Mixer; 8. Bunkerman; 9. Remote control operator; 10. The charge master		7. The charge collector;
3.4		5th degree of occupational risk (OR) – dangerous working conditions (WC)	1. Yellow phosphorus production apparatchik (charge worker); 2. Yellow phosphorus production apparatchik (for maintenance of dust and gas collecting plants); 3. Yellow phosphorus production apparatchik (granulation); 4. Yellow phosphorus production apparatchik (senior); 5. Yellow phosphorus production (recycling) apparatchik; 6. The seeding apparatchik; 7. Crane operator; 8. Drying apparatchik; 9. Plumber; 10. Yellow phosphorus production apparatchik (for the discharge of ferrophosphorus); 11. Yellow phosphorus production apparatchik (remote control); 12. Worker of industrial baths; 13. Elevator operator; 14. Yellow phosphorus production apparatchik (condensation); 15. The electric sensor; 16. Yellow phosphorus production apparatchik; 1. The mechanic-repairman; 2. Electric and gas welder; 3. Electrician for repair and maintenance of electrical equipment; 4. Gas drying apparatchik; 5. Machinist of compressor units; 6. Shop mechanic; 7. Operator of pumping units; 8. Air separation apparatchik; 9. Cylinder filler
CWC 3.1	4 occupations	A total of 41 occupations 2 occupations were reclassified to class 3.2; 2 occupations were reclassified to class 3.3.	1. Storekeeper 2. Apparatchik of preparation of chemical solutions 1. Worker of industrial baths; 2. Lifter
CWC 3.2	27 occupations	10 occupations with no changes; 11 occupations moved to Class 3, Degree 3 (Subclass 3.3); 6 occupations moved to Class 3, Degree 4 (Subclass 3.4)	1. The dosing apparatchik; 2. Cooling apparatchik; 3. Gas purification apparatchik; 4. Hot Agglomerate crusher; 5. Agglomerator; 6. Yellow phosphorus production apparatchik (for cleaning electrostatic precipitators); 7. Cleaner of industrial and office premises; 8. Yellow phosphorus production apparatchik (condensation); 9. The electrode sensor 10. The yellow phosphorus apparatchik
			1. Yellow phosphorus production apparatchik (charge worker); 2. Yellow phosphorus production apparatchik (for maintenance of dust and gas collecting plants); 3. Yellow phosphorus production apparatchik (granulation); 4. Yellow phosphorus production Apparatchik (senior);

			5. Yellow phosphorus production (recycling) apparatchik; 6. The seeding apparatchik; 7. Crane operator; 8. Drying apparatchik; 9. Plumber; 10. Yellow phosphorus production apparatchik (for the discharge of ferrophosphorus); 11. Yellow phosphorus production apparatchik (remote control); 1. Gas drying apparatchik; 2. Machinist of compressor units; 3. Shop mechanic; 4. Operator of pumping units; 5. Air separation apparatchik; 6. Cylinder filler 1. Conveyor operator; 2. The driver of the car dumper; 3. The crusher; 4. Mixer; 5. Bunkerman; 6. Remote control operator; 7. The charge collector; 1. The mechanic-repairman; 2. Electric and gas welder; 3. Electrician for repair and maintenance of electrical equipment
CWC 3.3	10 occupations	7 occupations with no changes; 3 occupations moved to Class 3, Degree 4 (Subclass 3.4)	

As a result of comparing the data from the general hygienic assessment of working conditions and the monitoring of workers' occupational health, a number of discrepancies were identified.

In the general hygienic assessment of working conditions, two occupations (storekeeper; chemical solution preparation operator) were classified as Class of Working Conditions (CWC) 3.1. However, occupational health monitoring revealed signs of more significant exposure to workplace hazards among employees, resulting in the assignment of CWC 3.2, corresponding to the 3rd degree of occupational risk (OR) — hazardous working conditions of substantial degree:

1. Storekeeper - exposure: inorganic dust (calcined soda), work severity; health outcomes: upper respiratory tract diseases, cervical plexus plexitis.
2. Chemical solution preparation operator - exposure: inorganic dust (calcined soda); health outcome: arterial hypertension.

For two other occupations (industrial bath operator; lift operator), the general hygienic assessment assigned CWC 3.1, while occupational health monitoring assigned CWC 3.3 (4th degree of OR - hazardous working conditions of high degree):

1. Industrial bath operator — exposure: work severity; health outcomes: disorders related to functional overstrain and overload of specific body systems (osteochondrosis).
2. Lift operator - exposure: inorganic dust (quartzite, coke, phosphorite, gypsum); health outcome: upper respiratory tract diseases.

For five occupations - gas dosing operator, cooling operator, gas cleaning operator, hot agglomerate crusher, and agglomerator — the general hygienic assessment determined CWC 3.2. However, occupational health monitoring for these occupations indicated a lower degree of exposure, leading to the reassignment to CWC 3.1, corresponding to the 2nd degree of OR - hazardous working conditions of moderate degree.

Considering the principle of prioritizing the worst-case values in cases of discrepancies between assessments, the final classification retained Class of Working Conditions (CWC) 3.2 - as the stricter category, ensuring a higher level of worker protection and preventive measures:

1. Gas dosing operator - exposure: inorganic dust (coke, phosphorite, gypsum), noise, vibration, work severity; health outcomes: upper respiratory tract diseases, osteochondrosis, arthritis, gastritis, varicose veins.
2. Cooling operator - exposure: inorganic dust (agglomerate, charge mix), phosphine; noise, vibration, work severity; health outcomes: respiratory diseases, osteochondrosis, arthritis, hernia.
3. Gas cleaning operator - exposure: inorganic dust (agglomerate, charge mix), phosphine, noise, vibration, work severity; health outcomes: respiratory diseases, arthritis, pyelonephritis, back contusion, arm paresis, femoral fracture (domestic injury, considered a potentially concealed occupational injury — subject to verification with the medical institution).
4. Hot agglomerate crusher - exposure: inorganic dust (agglomerate, charge mix), phosphine; health outcomes: upper respiratory tract diseases, hernia, osteochondrosis.
5. Agglomerator - exposure: noise, work severity; health outcomes: upper respiratory tract diseases, arthritis, leg contusions (domestic injury, considered a potentially concealed occupational injury — subject to verification with the medical institution).

According to the general hygienic assessment of working conditions, five occupations were assigned CWC 3.3, which remained unchanged under occupational health monitoring (4th degree of occupational risk (OR) - hazardous working conditions of high degree):

1. Yellow phosphorus production operator (electrofilter cleaning) - exposure: noise, work severity, inorganic dust

(white phosphorus), phosphorus oxide; health outcomes: upper respiratory tract diseases, diabetes mellitus, allergies.
2. Industrial and office premises cleaner - exposure: inorganic dust (quartzite, coke, phosphorite, gypsum), work severity; health outcomes: respiratory diseases (bronchitis).
3. Yellow phosphorus production operator (condensation) — exposure: noise, phosphorus oxide, work severity; health outcomes: upper respiratory tract diseases, ischemic heart disease, osteochondrosis, allergies.
4. Electrode operator - exposure: noise, inorganic dust (coke, phosphorite, gypsum); health outcomes: upper respiratory tract diseases, arthritis.
5. Yellow phosphorus operator - exposure: white phosphorus, phosphine, work severity, and work strain; health outcomes: upper respiratory tract diseases, arthritis, osteochondrosis, gastritis, arterial hypertension, pyelonephritis.

For 11 occupations - Yellow phosphorus production operator (charge preparation), Yellow phosphorus production operator (dust and gas collection system maintenance), Yellow phosphorus production operator (granulation), Senior yellow phosphorus production operator, Yellow phosphorus production operator (utilization), Screening operator, Crane operator, Drying operator, Plumber, Yellow phosphorus production operator (ferrophosphorus discharge), Yellow phosphorus production operator (remote control panel) — the Class of Working Conditions (CWC) determined by the general hygienic assessment was 3.2, whereas occupational health monitoring results indicated 3.3 (4th degree of occupational risk — hazardous working conditions of high degree):

1. Yellow phosphorus production operator (charge preparation) - exposure: noise, inorganic dust, phosphine, white phosphorus, work severity; health outcomes: upper respiratory tract diseases, osteochondrosis, leg fracture, arm burn (domestic injury, considered a potentially concealed occupational injury — verification with the medical institution required).
2. Yellow phosphorus production operator (dust and gas collection system maintenance) - exposure: noise, inorganic dust, phosphine, white phosphorus, work severity; health outcomes: upper respiratory tract diseases, leg fracture (domestic injury, potentially concealed occupational injury - verification required).
3. Yellow phosphorus production operator (granulation) - exposure: noise, inorganic dust, phosphine, phosphorus oxide, white phosphorus, work severity; health outcomes: upper respiratory tract diseases, hand injury, leg dislocation (domestic injury, potentially concealed occupational injury - verification required), poisoning.
4. Senior yellow phosphorus production operator - exposure: noise, inorganic dust, phosphine, white phosphorus, work severity; health outcomes: upper respiratory tract diseases, osteochondrosis, gastritis, arthritis, orbital burn.
5. Yellow phosphorus production operator (utilization) - exposure: noise, inorganic dust (phosphine, white phosphorus), work severity; health outcomes: upper respiratory tract diseases.
6. Screening operator - exposure: noise, vibration, inorganic dust (coke, phosphorite, gypsum), work severity; health outcomes: upper respiratory tract diseases, osteochondrosis, poisoning, conjunctivitis.
7. Crane operator - exposure: noise, insufficient lighting, work severity, phosphine; health outcomes: upper respiratory tract diseases, conjunctivitis, osteochondrosis.
8. Drying operator - exposure: noise, vibration, work severity; health outcomes: upper respiratory tract diseases, gastritis.
9. Plumber - exposure: noise, inorganic dust (quartzite, coke, phosphorite, gypsum), work severity; health outcomes: upper respiratory tract diseases, pyelonephritis.
10. Yellow phosphorus production operator (ferrophosphorus discharge) - exposure: noise, phosphorus oxide, inorganic dust (phosphine, white phosphorus), work severity; health outcomes: upper respiratory tract diseases, hernia, arthrosis, arthritis, gastritis, conjunctivitis.
11. Yellow phosphorus production operator (remote control panel) - exposure: noise, inorganic dust (phosphine, white phosphorus), work severity; health outcomes: upper respiratory tract diseases, arthritis, osteochondrosis, hernia.

For six occupations - Gas drying operator, Compressor unit operator, Workshop mechanic, Pump unit operator, Air separation unit operator, Cylinder filler — the Class of Working Conditions (CWC) determined by the general hygienic assessment was 3.2, whereas occupational health monitoring results indicated 3.4 (5th degree of occupational risk — hazardous working conditions of very high degree):

1. Gas drying operator - exposure: noise; health outcomes: upper respiratory tract diseases.
2. Compressor unit operator — exposure: noise; health outcomes: sensorineural hearing loss, upper respiratory tract diseases.
3. Workshop mechanic - exposure: noise, work severity and strain; health outcomes: sensorineural hearing loss, upper respiratory tract diseases (bronchitis).
4. Pump unit operator - exposure: noise; health outcomes: sensorineural hearing loss, upper respiratory tract diseases, radiculitis.
5. Air separation unit operator - exposure: noise; health outcomes: sensorineural hearing loss, arterial hypertension, upper respiratory tract diseases, osteochondrosis.
6. Cylinder filler - exposure: noise; health outcomes: sensorineural hearing loss, upper respiratory tract diseases, otitis, cataract, gastritis.

For three occupations - Repair fitter, Electric gas welder, Electrical fitter for repair and maintenance of electrical equipment — the CWC determined by the general hygienic assessment was 3.3, whereas occupational health monitoring results indicated 3.4 (5th degree of occupational risk — hazardous working conditions of very high degree):

1. Repair fitter - exposure: noise, vibration, inorganic dust (coke, phosphorite, gypsum); health outcomes: upper respiratory tract diseases, arterial hypertension.
2. Electric gas welder - exposure: noise, inorganic dust (coke, phosphorite, gypsum); health outcomes: upper respiratory tract diseases, pyelonephritis, osteochondrosis, leg fracture (domestic injury, considered a potentially concealed occupational injury — verification with the medical institution required).
3. Electrical fitter for repair and maintenance of electrical equipment - exposure: noise, vibration, inorganic dust (coke, phosphorite, gypsum); health outcomes: upper respiratory tract diseases, otitis, osteochondrosis.

For seven occupations — Conveyor operator, Wagon tipper operator, Crusher operator, Mixer operator, Bunker operator, Remote control panel operator, and Charge preparer — the Class of Working Conditions (CWC) determined by the general hygienic assessment was 3.3, and occupational health

monitoring results confirmed the same value (no change) (4th degree of occupational risk — hazardous working conditions of high degree):

1. Conveyor operator — exposures: noise, vibration, insufficient lighting, inorganic dust (charge mixture), work severity; health outcomes: upper respiratory tract diseases, osteochondrosis, hernia, arthrosis, pyelonephritis.
2. Wagon tipper operator — exposures: noise, inorganic dust (quartzite, coke, phosphorite, gypsum); health outcomes: upper respiratory tract diseases, cataract, leg fracture (domestic injury, considered a potentially concealed occupational injury — verification with the medical institution required).
3. Crusher operator — exposures: noise, vibration, dust, work severity; health outcomes: upper respiratory tract diseases.
4. Mixer operator — exposures: noise, inorganic dust (quartzite, coke, phosphorite, gypsum); health outcomes: osteochondrosis, hand laceration (domestic injury, considered a potentially concealed occupational injury — verification with the medical institution required), sciatica.
5. Bunker operator — exposures: noise, insufficient lighting, inorganic dust (charge mixture), work severity; health outcomes: back contusion.
6. Remote control panel operator — exposures: noise, insufficient lighting, inorganic dust (charge mixture), phosphine, work severity; health outcomes: upper respiratory tract diseases, hernia, clavicle fracture, arm fracture (domestic injury, considered a potentially concealed occupational injury — verification with the medical institution required).
7. Charge preparer — exposures: noise, insufficient lighting, inorganic dust (charge mixture), work severity; health outcomes: upper respiratory tract diseases, osteochondrosis, arterial hypertension.

In total, 17 occupations showed full agreement between the CWC determined by the general hygienic assessment and the results of occupational health monitoring. This indicates that the assessment of working conditions was validated by the actual health status data of the employees.

To confirm the scientific validity and practical significance of the research results, the proposed methodology was tested using statistical analysis of the temporary disability leave records from the enterprise under study.

According to the analysis results, 4 occupations were classified under Class of Working Conditions (CWC) 3.1 (hazardous working conditions of moderate degree), 27 occupations under CWC 3.2 (high degree), and 10 occupations under CWC 3.3 (very high degree).

Following the reassessment under the new classification of working conditions:

12 occupations retained their previously assigned class;

For 3 occupations (Maintenance fitter, Electric gas welder, and Electrician for repair and maintenance), CWC 3.3 was confirmed as subclass 2.4 (very high degree);

For 6 occupations (including Gas drying operators, machinists, and mechanics), CWC 3.2 was also upgraded to subclass 2.4;

16 occupations previously classified as CWC 3.2 were reassigned to subclass 2.3 (high degree);

4 occupations (including Storekeeper and Chemical solution operator) previously assigned CWC 3.1 were reassigned to subclasses 2.2 and 2.3.

The distribution of occupations by category of working conditions is shown in Figure 1.

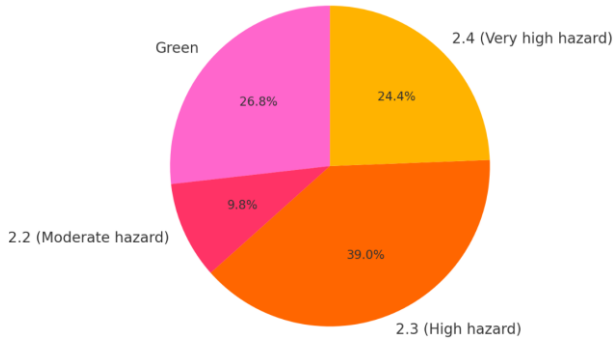

Figure 1. Distribution of occupations by categories of working conditions

The most common harmful factors of the working environment include: inorganic dust (sinter, charge, phosphorite, coke, quartzite, soda), noise, vibration, exposure to phosphorus compounds (phosphine, white phosphorus, phosphorus oxide), as well as insufficient lighting. Factors related to the work process include the physical severity and intensity of labor.

Among the most frequently observed work-related diseases are: osteochondrosis, chronic obstructive bronchitis, gastritis, gastroesophageal reflux disease, hypertension, arthritis, hernias, angina, pharyngitis, COPD, as well as traumatic injuries (fractures, contusions, cuts).

The most unfavorable occupational risk profile was identified for the following occupations: gas purification operator, charge feeder, granulation and drying operator, electrician, electric welder, and repair fitter. These groups are characterized by a combination of high exposure levels to hazardous substances, significant physical workload, and confirmed occupational pathology (including Group 3 disability).

To provide a visual representation of the findings, a heat map is presented below (Figure 2), illustrating the frequency of occupational diseases by occupation and class of working conditions. The higher the value, the greater the number of recorded disease cases among workers in the respective group.

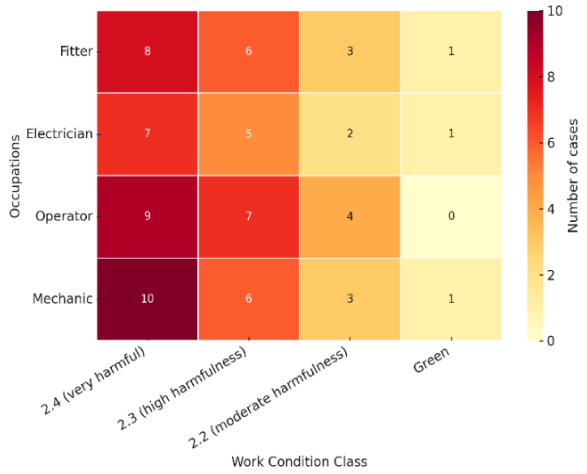

Figure 2. Frequency of occupational diseases by occupation and class of working conditions

Thus, the categorization of employees according to the new classification of working conditions not only refines the assessment of occupational risk levels but also provides a

foundation for targeted preventive and organizational-technical measures. The introduction of the "green" workplace category expands the assessment framework by adding a focus on preserving safe conditions and promoting their dissemination. This approach makes the occupational safety system more balanced, integrating the objectives of reducing harmful factors with the creation of a sustainable and safe working environment that aligns with international trends and the goals of sustainable development.

The analysis demonstrates that revising working conditions with the inclusion of occupational health monitoring provides a more accurate assessment of actual risks. In 25 professions, the category of working conditions changed compared with the initial hygienic evaluation, confirming that reliance solely on formal hygiene criteria without medical correction may underestimate real hazards. The highest-risk profiles were observed among gas purification apparatchiks, charge workers, granulation and drying apparatchiks, electricians, welders, and repair locksmiths, who face both high exposure to harmful factors and confirmed occupational pathologies.

Comparison with other studies shows consistency with international findings. Vitale et al. [12] and Vitale et al. [13] report that even in "green" occupations, significant risks from chemicals and ergonomic factors persist, reflected in the prevalence of musculoskeletal and respiratory diseases, which aligns with our results. Turner et al. [10] note that climate change and the transition to a "green" economy intensify thermal, aerosol, and psychophysiological exposures, corroborated by our data showing higher rates of chronic illness among heavy industry workers. In the national context, our results agree with Bekmagambetov et al. [22], who also found notable discrepancies between formal workplace indicators and actual employee health outcomes. These findings confirm the effectiveness of our methodology in refining classifications and identifying target groups for preventive measures.

The key contribution of this study is the formal introduction of "green" jobs in Kazakhstan, reflecting optimal and acceptable working conditions (CWC 1–2). This shifts the focus of occupational safety and health from reactive measures to prevention, in line with EU-OSHA [18] and OECD [7] recommendations. The integration of biomedical indicators strengthens the linkage between workplace exposures and health outcomes, thereby improving the evidence base for management decisions.

Overall, our findings not only clarify the occupational risk profile at the enterprise level but also enrich the theoretical and methodological framework for assessing working conditions in line with global trends. Incorporating "green" jobs into the classification system provides a practical tool for adapting national occupational safety policies to international standards, enhancing their preventive and social orientation.

4. CONCLUSIONS

The study confirmed the effectiveness of a risk-based approach to the classification of working conditions, supplemented by the category of "green" jobs. Using the case of a phosphorus plant with 41 analyzed professions, it was established that:

- 4 professions were assigned to CWC 3.1, 27 to CWC 3.2, and 10 to CWC 3.3;
- after revision with health monitoring data, 12 professions retained their class, while 25 were reclassified;
- a very high level of occupational risk (CWC 2.4) was confirmed in three professions: repairman, welder, and electrician;
- the most unfavorable risk profiles were observed among workers in gas purification, granulation, drying, and welding.

The main scientific contribution lies in demonstrating that traditional hygienic assessments do not fully reflect workers' health status and must be supplemented with medical data. The introduction of a distinct "green jobs" category provides a basis for proactive occupational risk management and aligns with international trends in the transition to a green economy.

Practical and policy recommendations (global level):

1. Incorporate the "green jobs" category into national and international labor standards to encourage safe and environmentally sustainable employment.
2. Accelerate automation and digitalization of hazardous industrial processes to reduce physical and chemical exposures.
3. Strengthen global employee health monitoring with emphasis on early diagnosis and prevention of occupational diseases.
4. Use the categorization system as an indicator of progress toward the Sustainable Development Goals, particularly SDG 3 (health and well-being) and SDG 8 (decent work and economic growth).
5. Promote international exchange of best practices through ILO, EU-OSHA, and other platforms to harmonize working condition assessment.
6. Develop state support measures—such as tax incentives, certification, and subsidies - for enterprises that create and sustain "green" jobs.

Thus, the findings are relevant not only for Kazakhstan but also for global practice. They demonstrate that shifting the focus from response to risk prevention strengthens workforce sustainability, improves workers' health, and fosters a safe, productive, and environmentally oriented working environment worldwide.

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REFERENCES

[1] Mouras, F., Badri, A. (2020). Survey of the risk management methods, techniques and software used most frequently in occupational health and safety. International Journal of Safety and Security Engineering, 10(2): 149-160. https://doi.org/10.18280/ijsse.100201

[2] Abikenova, S., Daumova, G., Kurmanbayeva, A., Yesbenbetova, Z., Kazbekova, D. (2022). Relationship between occupational risk and personal protective equipment on the example of ferroalloy production. International Journal of Safety and Security Engineering, 12(5): 609-614. https://doi.org/10.18280/ijsse.120509

[3] Moldayazova, L., Shagatayeva, B., Zhapalakov, B., Utegenova, E., Amrin, M. (2024). Sanitary-Hygienic research to ensure state sanitary-epidemiological surveillance in the Republic of Kazakhstan. Disaster Medicine and Public Health Preparedness, 18: e249. https://doi.org/10.1017/dmp.2024.147

[4] Daniels, R.D., Gilbert, S.J., Kuppusamy, S.P., Kuempel, E.D., et al. (2020). Current intelligence bulletin 69: NIOSH practices in occupational risk assessment. The National Institute for Occupational Safety and Health (NIOSH), 69: 20058767. https://doi.org/10.26616/NIOSHPUB2020106

[5] Park, R.M. (2025). A review of OSHA-permissible exposure limits for occupational carcinogens in relation to quantitative risk assessments based on epidemiological findings. Journal of Occupational and Environmental Hygiene, 22(1): 17-30. https://doi.org/10.1080/15459624.2024.2406234

[6] Kozar, Ł.J., Sulich, A. (2023). Green Jobs in the energy sector. Energies, 16(7): 3171. https://doi.org/10.3390/en16073171

[7] Scholl, N., Turban, S., Gal, P.N. (2023). The green side of productivity: An international classification of green and brown occupations (No. 33). OECD Publishing. https://doi.org/10.1787/a363530f-en

[8] Abikenova, S., Issamadiyeva, G., Kulmagambetova, E., Daumova, G., Abdrakhmanova, N. (2023). Assessing occupational risk: A classification of harmful factors in the production environment and labor process. International Journal of Safety and Security Engineering, 13(5): 871-881. https://doi.org/10.18280/ijsse.130511

[9] Mousavi, Z., Ehsani, H., Elahi, H., Etemadinezhad, S., Hossein Hossein Nataj, A., Samaei, S.E. (2025). The cognitive and physiologic effects of occupational heat exposure on operational field workers: An exploratory study. Journal of Research and Health, 15(3): 311-318. https://doi.org/10.32598/JRH.15.3.2433.1

[10] Turner, M.C., Basagaña, X., Albin, M., Broberg, K., Burdorf, A., van Daalen, K.R., Guseva Canu, I., Kolstad, H.A., Kogevinas, M., Lowe, R., Pearce, N., Pega, F., Saget, C., Schubauer-Berigan, M.K., Svensson, S., Vineis, P., Straif, K. (2025). Occupational health in the era of climate change and the green transition: A call for research. The Lancet Regional Health – Europe, 54: 101353. https://doi.org/10.1016/j.lanepe.2025.101353

[11] Kozar, Ł.J., Sulich, A. (2023). Green Jobs: Bibliometric Review. International Journal of Environmental Research and Public Health, 20: 2886. https://doi.org/10.3390/ijerph20042886

[12] Vitale, E., Salvago, P., Campanella, A.F., Cirrincione, L. (2024). Emerging occupational risks in green jobs: A review. International Journal of Occupational Medicine and Environmental Health, 37(3): 244-256. https://doi.org/10.13075/ijomeh.1896.02396

[13] Vitale, E., Salvago, P., Campanella, A.F., Cirrincione, L. (2024). A protocol of prevention and protection measures on new occupational risk Factors in Green Jobs in Italian Workplaces. Sustainability, 16: 6691. https://doi.org/10.3390/su16156691

[14] Stanef-Puică, M.R., Badea, L., Șerban-Oprescu, G.L., Șerban-Oprescu, A.T., Frâncu, L.G., Crețu, A. (2022). Green jobs - A literature review. International Journal of Environmental Research and Public Health, 19: 7998. https://doi.org/10.3390/ijerph19137998

[15] Bowen, A., Kuralbayeva, K., Tipoe, E.L. (2018). Characterising green employment: The impacts of 'Greening' on workforce composition. Energy Economics, 72: 263–275. https://doi.org/10.1016/j.eneco.2018.03.015

[16] https://www.ilo.org/topics-and-sectors/just-transition-towards-environmentally-sustainable-economies-and-societies/what-green-job

[17] Sulich, A., Sołoducho-Pelc, L. (2022). The circular economy and the Green Jobs creation. Environmental Science and Pollution Research, 29(10): 14231-14247. https://doi.org/10.1007/s11356-021-16562-y

[18] European Agency for Safety and Health at Work. (2023). Health and safety of workers in green jobs. EU-OSHA. https://oshwiki.osha.europa.eu/en/themes/health-and-safety-workers-green-jobs.

[19] Mathieu, A. (2024). Foundations and conditions of green jobs in developing economies: Systematic literature review and bibliometric analysis. Development and Sustainability in Economics and Finance, 2–4: 100016. https://doi.org/10.1016/j.dsef.2024.100016

[20] Bradley, P., Whittard, D., Green, E., Brooks, I., Hanna, R. (2025). Empirical research on green jobs: A review and reflection with practitioners. Sustainable Futures, 9: 100527. https://doi.org/10.1016/j.sftr.2025.100527

[21] Streimikis, J., Mura, L., Kyriakopoulos, G.L., Simanavicius, A., Delibacic, M. (2024). Green jobs: Barriers and Drivers in the EU. Contemporary Economics, 18(2): 138-152.

[22] Bekmagambetov, A., Rakhmetova, A., Yedilbayeva, L., Daumova, G., Kulmagambetova, E., Abdrakhmanova, N., Sagindykova, N. (2025). A study on causal relationships between working conditions and occupational diseases: A case study of a phosphorus plant in Kazakhstan. International Journal of Safety and Security Engineering, 15(5): 973-985. https://doi.org/10.18280/ijsse.150511