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RESEARCH ON OCCUPATIONAL SAFETY METHODS IN FIRE-RESCUE COMBAT TRAINING

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ANNOTATION
The article is dedicated to the fire-rescue operations conducted by firefighters in various conditions, primarily inside buildings and structures, where situations mainly involve the use of individual respiratory protection devices. It examines how the level of professional skills and practical abilities manifests during the execution of fire-rescue unit norms, performed while using individual respiratory protection equipment. The study focuses on determining correction values for fire-rescue unit norms executed with individual respiratory protection devices and analyzes the results of the conducted research.
KEYWORDS: *protection, usage, unit, norm, research, analysis, value, approval, correction, respiration, result, rescue.*

INTRODUCTION

Modern fire and rescue work is one of the most complex and demanding forms of physical and mental labor. Firefighters, in performing their duties, not only perform activities that require a high level of physical strength and endurance, but also experience rapid decision-making, concentration and high mental load in complex environments. Therefore, the issues of ensuring the safety and productivity of fire and rescue workers are of great importance not only in protecting their health and lives, but also in preparing for and effectively responding to all emergency situations.

Research in the field of occupational safety is related to the meteorological conditions of the environment in which firefighters work, including factors such as air temperature, humidity, and speed of movement, and their impact on their body temperature, blood pressure, and general condition is being studied in depth. It is necessary to ensure a balance and interdependence between microclimatic conditions that are important for the performance and health of each firefighter. In this case, the correct combination of elements such as temperature, humidity, and air speed allows them to maintain their body's thermal balance and protect them from excessive heat or cold.

Also, the specific characteristics of physical and mental labor and their combined effects that occur in the work of firefighters are also a topic of great interest.

Mental workload can cause increased blood pressure and changes in the cardiac and respiratory systems, which in turn negatively affects labor productivity and safety.

Therefore, in the process of training firefighters, there is a need not only for physical training, but also for coordination of working conditions with microclimatic factors, for safe and efficient organization of labor. Taking into account the territorial characteristics of microclimatic conditions plays an important role in increasing the efficiency and safety of firefighters. Each region has its own microclimatic factors, which can increase or decrease the stress and complexity of working conditions during work.

Therefore, identifying microclimate conditions through scientific research, creating optimal working conditions, and searching for ways to coordinate them are considered an urgent scientific and practical issue.

This article examines the influence of microclimate factors, their interrelationships, and the methodology for creating optimal conditions to ensure occupational safety in the activities of firefighters.

The study examined the microclimatic characteristics of the area in detail and, based on scientifically based results, developed proposals to increase the efficiency of firefighters and improve working conditions.

At the same time, modern methods of controlling microclimate conditions based on the combination of physical and mental labor, as well as the theory of heat balance, were considered.

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As a result, this study provides scientifically sound, practically significant results that serve to protect the health and safety of firefighters and improve their work efficiency.

This creates an important foundation for effective human factor management in the field of emergency situations and ensuring high-quality fire and rescue services.

LITERATURE REVIEW

The issues of ensuring the occupational safety of firefighters and increasing their work efficiency have been actively studied in the field of emergency situations and security in recent years. Within the framework of these studies, special attention is paid to the influence of microclimate factors on the human body, especially on the physical and mental state of firefighters. Scientific works in this area are analyzed by many specialists, and modern methods and recommendations are developed to solve these problems. First, there is a large-scale study of the importance of microclimate factors in the labor process. For example, XX Islamov (2017) in his scientific work deeply analyzed the relationship between the physical activity of firefighters and microclimate conditions. He identified the influence of factors such as temperature, humidity and air movement in working conditions on the human body, especially on heat balance, and emphasized the need to create optimal microclimate conditions. This study shows the importance of controlling microclimate factors in increasing labor productivity.

Secondly, the issue of the impact of physical and mental work on the health of firefighters has also been studied in many scientific works. MS Karimov (2019) in his work detailed how the mental and physical loads of employees working in emergency situations affect blood pressure, heart rate and other physiological indicators. He provides scientific evidence of the negative impact of stress caused by mental workload on the body's heat balance, as well as the impact of this situation on the labor efficiency of firefighters. These studies serve as the basis for developing the necessary measures to optimize working conditions.

Also, practical research on managing microclimate conditions and ensuring occupational safety is widespread. For example, scientific research conducted by ABSobirov and colleagues (2020) proposed methods for increasing the work efficiency of firefighters by optimizing microclimate factors at their workplace. A number of our local scientists have also conducted many studies and research in these areas , for example, B.Ibragimov, E.Sobirov, A.Letyaga, R.Normamatova, O.Yuldoshiva, Ch.Khujanov, etc. The results of the study show that constant monitoring and management of microclimate parameters is important in fulfilling occupational safety requirements. This allows stabilizing the physical condition of firefighters and protecting them from stress.

On the other hand, the theory of heat balance and the scientific assessment of microclimate conditions have also been widely studied in the field of research. In his dissertation, XX Nurmatov (2021) analyzed microclimate conditions based on the principles of heat balance of the human body and proved that this method is effective in optimizing the working conditions of firefighters.

These studies provide an opportunity to deeply understand the direct impact of microclimate on physical and mental performance.
The international scientific literature has also extensively studied the working conditions and microclimate factors of firefighters. For example, a study by Smith et al. (2018) examined the effects of temperature and humidity on the resistance of firefighters to heat stress. They proposed strategies to reduce heat stress by using special clothing and equipment, as well as microclimate management.
These studies will contribute to a deeper understanding of global experience in ensuring the safety of firefighters.

RESEARCH METHODOLOGY

Psychophysiological studies also play an important role in studying the relationship between physical activity and microclimatic conditions. Using psychophysiological monitoring methods developed by Uzbek and foreign scientists, methods are being developed to determine the physical and mental state of firefighters and to adjust microclimatic conditions to ensure their labor productivity and safety. These methods serve to reduce stress, improve concentration, and improve the quality of decision-making.

At the same time, scientific advances in the fields of biomechanics, physiology, and environmental studies are being widely used to comprehensively analyze the physical activity and microclimatic conditions of firefighters. Such an integrated approach creates new opportunities for ensuring occupational safety and increasing the efficiency of service in emergency situations.

The results of the research show that microclimate factors have a significant impact on the physical and mental state of firefighters. High temperatures and humidity, as well as insufficient air movement, lead to heat stress in the body. This condition is manifested by difficulties in the respiratory system, impaired cardiovascular function, and impaired concentration. Therefore, proper management and optimization of microclimate conditions can help maintain the health of firefighters and increase their productivity.

It is also necessary to coordinate exercise and rest periods with microclimatic factors. This will allow firefighters to reduce fatigue, relieve stress, and improve their overall well-being.

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Studies show that adapted microclimate conditions during rest help the body recover and increase work efficiency.
In conclusion, it is important to take into account microclimatic factors in ensuring the occupational safety of firefighters. Studies show that creating optimal microclimatic conditions not only protects their physical and mental health, but also maintains the working capacity necessary for effective operation in emergency situations. Therefore, it is very important to continue research and development in this area, to introduce new technologies and methods.

Light rescuers perform mental work along with physical labor, and the work of a firefighter in terms of labor safety is determined by the meteorological conditions of the environment in which he is moving, air temperature, humidity, speed of movement, his own body temperature and blood pressure. It was taken into account that in order for an employee engaged in physical labor of a certain severity to feel good, that is, not to overheat or cool down, microclimatic conditions should be interconnected to a certain extent. The above factors are specific only for a specific place, and the microclimate of the area was also studied.

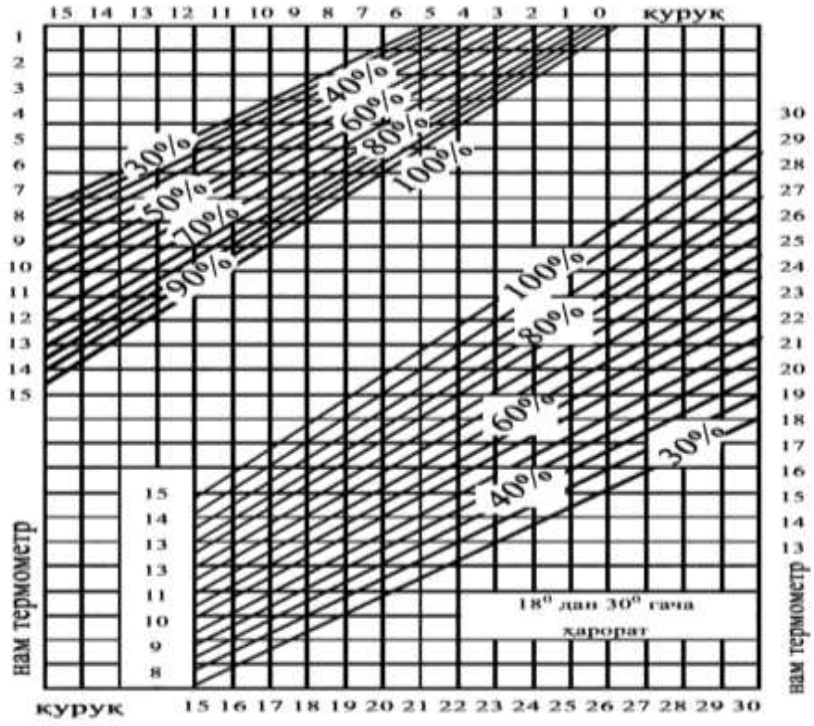
The focus of attention was on the set of meteorological factors affecting the mood of the firefighter in the microclimate of the research site, the unity of these factors, which ensure the best mood and the highest working capacity of the firefighter, comfortable (most favorable) conditions in all respects in a particular field setting. Comfort (most favorable) conditions for a given type of work can only be achieved when heat balance is ensured. In this case, the heat balance was calculated based on the following formula.

$$Q = Q_{\dot{y}} + Q_K + Q_H + Q_{\acute{o}} + Q_x$$

Here Qo' is the thermal conductivity of clothing; Qk is convection around the body; Qn is radiation to surrounding surfaces; Qb is evaporation of moisture from the body; Qh is heating of the inhaled air.

Attention was paid to ensuring labor protection at the research site. It was first studied that when the air temperature is high, the blood vessels of firefighters dilate, blood begins to flow to the skin more than normal, and heat transfer to the environment increases slightly. This stops when the air temperature is above 30-35 oC. A person sweats, as a result of which salts necessary for the body are also released with sweat. When the air temperature at the research site decreases, blood vessels narrow, blood flow to the skin slows down, and the body's heat transfer to the external environment decreases. Thus, it was studied that a certain combination of temperature, relative humidity and air velocity is necessary for a firefighter standing at the research site to feel good in working conditions. The humidity of the research site has a great influence on adjusting body temperature. High relative humidity (φ>80%) leads to drying of the respiratory mucosa. The optimal value of humidity is considered to be 40-60%, but when firefighters fulfill the requirements of the “Fire and Rescue Standards”, changes in relative humidity were observed. Figure 1 shows a nomogram for determining the relative humidity of the air (according to the Assman psychrometer).

At the same time, in any situation, the first priority should be given to the problem of human health and labor protection. Air circulation in workplaces is an important factor in improving working conditions.



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Figure 1. Nomogram for determining relative humidity of air (according to Assman psychrometer).

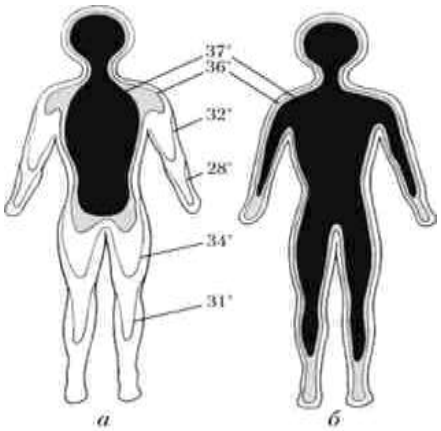


Figure 2. Distribution of temperature zones inside and on the surface of the human body during the experiment: a - front view; b - back view

Thermoregulation is the ability of a firefighter's body to exchange heat with the environment and maintain its temperature at a certain, constant level (36.5oC). Heat production by a firefighter's body occurs due to heat loss from the skin surface and evaporation of moisture. If the temperature of the environment is lower than the temperature of the skin, then thermoregulation occurs due to heat loss.

Figure 2 shows the distribution of temperature zones inside and on the surface of the human body during the experiment. It was scientifically proven that in hot weather conditions, when the requirements of the "Firefighters' Standards" are met, the heat transfer from the firefighter's body to the environment improves, and vice versa, in cold weather conditions, the heat transfer from the firefighter's body to the environment (heat exchange) deteriorates.

As a result of eating and working, heat is generated in the firefighter's body, which is then released into the environment mainly through the skin and to a lesser extent through the lungs. The meteorological conditions of the environment should be such that the amount of heat given off to the environment is within the limits of the firefighter's condition, taking into account the specific properties of the firefighter's body - thermoregulation, and thermoregulation - evaporation - when the temperature of the skin and the environment is equal or when the skin temperature is lower than the temperature of the environment.
The rate of evaporation from a firefighter's skin surface was also studied, as was the humidity and speed of movement of the air, and how reducing air humidity at high temperatures has a positive effect on a person's ability to sense thermal changes, and how dry air evaporates less than humid air.

High air temperature and high humidity together make the evaporation process difficult, reducing heat loss as a result of evaporation, which causes heat to remain in the body, while at low temperatures, increased air humidity accelerates the cooling of the body, since moist skin and moist air conduct heat better, and it has been studied for the first time that high and low air humidity are uncomfortable for humans.

Labor activity was carried out at the expense of the energy of the firefighter's brain, nerves, and muscles. The firefighter's mental work usually slows down the pulse, but in some cases, mental stress accelerated the contraction of the heart and blood vessels, increased blood pressure during mental work, rapid breathing, increased blood supply to the cerebral vessels, and decreased blood supply to the abdominal and leg vessels.

It has been studied that prolonged mental work leads to a decrease in conditioned vascular reflexes and the formation of paradoxical reactions, and that states such as tension and changes in the functions of the respiratory system during mental work are observed.

It was established that mental work is closely related to the work of the sensory organs, primarily hearing and vision, which in calm conditions cause cerumen leakage, intense work leads to both mental and severe fatigue, as well as physical, and the release of heat from the firefighter's body to the environment through convection, radiation, heat transfer, evaporation and respiration has a negative impact on labor efficiency. The most favorable meteorological conditions at the place of research work

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Given in Table 1.

Table 1. Optimal

Jobs category	Of the year hot on time		Cold and transitional time of year	
	air temperature, t, ºC	of the air speed, V, m/s	air temperature, t, ºC	of the air speed, V, m/s
Light Moderate II a II b Heavy III	22-25 21-23 20-22 18-21	0.2 0, 30, 40,5	20-23 18-20 17-20 16-18	0.2 0, 20, 30,3

I Category – light physical works . Such in the works fire - rescuer spending power from 175 W (175 J / h) does not exceed . This affairs sitting , standing standing or walking will be done and lift and transportation demand does not do ;

II Category – only walking and upright standing doable , how much heavy not (10 kg) up to) things lift with related was and 233-290 W(230-295 J / s) power expendable average heavy physical works ;

III Category – permanent physical tension with , as well as much heavy (10 kg) from heavy things to move and transportation with related , in which 290 W (295 J / s) more than power expendable heavy physical works .

Of the year hot period for research transferable on the spot meteorological of the circumstances permission done The indicators are in Table 2. cited .

Table 2
Of the year hot period for research transferable on the spot meteorological of the circumstances permission done indicators

Job category	Air velocity in case of excess heat, V, m/s		Air temperature in open air, t, ºC		Temperature , t, ºC	Relative humidity , %
	less	much more	less	much more		
I	0.2-0.5	0.2-0.5	External from the air many with 30 ºC more than , but 300 ºC from high it's not	External from the air many with 30 ºC more than , but 300 ºC from high it's not	28 27	55 60
IIa	0.2-0.5	0.3-0.7			26 25	65 70
IIb	0.3-0.7	0.5-1.0			24 and from this low	75
III	0.3-0.7	0.5-1.0	External from the air many with 30 ºC more than , but 280 ºC from high it's not	External from the air many with 30 ºC more than , but 280 ºC from high it's not	26 25 24 and from this low	65 70 75

Of the year cold period for research transferable on the spot meteorological of the circumstances permission done The indicators are described in Table 3 .

Table 3
Of the year cold period for research transferable on the spot meteorological of the circumstances permission done indicators

Jobs category	The air temperature, t, ºC	The air movement speed, V, m/s	The air temperature , t, ºC
III aII bIII	19-25 17-23 15-21 13-19	0.2 0.3 0.4 0.5	15-26 13-24 13-24 12-19

So, high temperature and high humidity of mood and to your health very bad impact shows the above. in consideration received without, firefighters age into account fire and rescue row criteria after completion then body temperature and blood under pressure face giving changes determination 6 for young in the category (up to 20 years old , 21 to 25 years old , 26 to 30 years old , 31 to 35 years old , 36 to 40 years old) and from 41 to 45 years old was firefighters between) test experiences Test was conducted. Transfer for "100 m distance" obstacles over running exercise selectively taken. Test experience as follows conducted : test exercise from the beginning before fire rescuers body temperature 3 from the place from the nose , from the neck and from the stomach and blood pressure was measured . From that then fire - rescuer handle with at the start stood up . The test to start permission was given . In this fire - rescuer everyone installed from obstacles running pass , finish line handle with cut passed .

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Table 4
Firefighters young categories in consideration received without , body temperature and blood under pressure face gave changes

Age Category	Body Temperature						Blood Pressure	
	From The Nose		From The Neck		From The Belly			
	Before	Later	Before	Later	Before	Later	Before	Later
Under 20	34.3	35.9	32.8	36.2	35.9	36.1	110/70	130/90
Up to 21-25 years old	34.3	36.2	32.8	34.6	32.6	33.1	120/80	130/90
Up to 26-30 years old	33.1	36.2	36.1	36.2	36.1	33.2	110/70	120/80
Up to 31-35 years old	36.1	36.2	36.1	35.9	32.3	34.3	130/90	140/100
Up to 36-40 years old	35.8	36.1	35.8	36.2	32.3	34.3	110/70	120/80
Up to 41-45 years old	32.3	32.8	32.3	32.6	35.6	35.8	120/80	130/85

Immediately after the test experiment, the body temperature of the firefighters was measured from the nose, neck and abdomen, as well as their blood pressure. The results were entered and analyzed in Table 4. Three firefighters from each age group participated in the test experiment, and their average score was entered in Table 4.

Analyzing the results, it was found that after the end of the test experiment, the body temperature of rescuers under 20 years old increased by 4.7% compared to the previous condition when measured through the nose, by 10.4% compared to the previous condition when measured through the neck, by 1.5% compared to the previous condition when measured through the abdomen, and their blood pressure increased by 20/20. After the end of the test experiment, it was found that the body temperature of rescuers aged 21 to 25 years old increased by 5.5% compared to the previous condition when measured through the nose, by 5.49% compared to the previous condition when measured through the neck, by 0.5% compared to the previous condition when measured through the abdomen, and their blood pressure increased by 10/10. After the test experiment, it was found that the body temperature of rescuers aged 26 to 30 years old increased by 9.4% when measured through the nose, increased by 0.28% when measured through the neck, decreased by 8.7% when measured through the abdomen, and their blood pressure increased by 10/10 compared to the previous condition. After the test experiment, it was found that the body temperature of rescuers aged 31 to 35 years old increased by 0.28% when measured through the nose, decreased by 5.57% when measured through the neck, decreased by 6.19% when measured through the abdomen, and their blood pressure increased by 10/10 compared to the previous condition. After the test experiment, it was found that the body temperature of rescuers aged 36 to 40 years old increased by 8.38% when measured through the nose, increased by 1.12% when measured through the neck, decreased by 6.19% when measured through the abdomen, and their blood pressure increased by 10/10 compared to the previous condition. After the test experiment, it was found that the body temperature of rescuers aged 41 to 45 years old increased by 1.55% when measured through the nose, increased by 0.9% when measured through the neck, decreased by 0.56% when measured through the abdomen, and their blood pressure increased by 10/5.

In general, it was found that the younger the age category of a firefighter, the higher his work efficiency. The higher the age category, the lower his work efficiency, which can lead to injuries, changes in body temperature, and increased or decreased blood pressure.

Analysis and results. The results of this study allowed for an in-depth analysis of the impact of microclimatic conditions on the labor efficiency and health of firefighters. Based on the data collected through experimental and empirical methods, it was determined to what extent microclimatic factors affect the physical, psychological state and safety indicators of firefighters.

The influence of microclimate parameters . According to the monitoring results, high temperature and high humidity in the working environment are a great burden on the body of firefighters and significantly reduce the effectiveness of physical activity. It was observed that physiological indicators such as heart rate, respiratory rate and body temperature increase by an average of 20-30% in high temperature conditions, which leads to a state of overstrain of the body. In such conditions, labor productivity decreases, the number of errors increases, and physical fatigue accelerates.

The psychological state also changes negatively in connection with temperature and humidity indicators. The test results showed that microclimate conditions affect the ability of workers to concentrate and make decisions. In particular, in conditions of high temperature and humidity, stress levels increase, and instability in the mental state negatively affects occupational safety.

Results of empirical surveys and interviews. Data obtained through questionnaires showed that firefighters directly feel the impact of microclimatic conditions in their workplaces on labor productivity and health. More than 85% of employees reported that working in conditions of high temperature and humidity is uncomfortable, and more than 70% noted that this condition reduces their concentration. These results clearly indicate the need to improve microclimatic conditions.

Statistics and analysis. As a result of statistical analysis of the data, a strong positive correlation was found between the influence of microclimate factors on the labor productivity of firefighters (r=0.76). Regression analysis showed that temperature and humidity

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were the causes of a decrease in labor productivity by up to 60%. This means that by improving the microclimate, work efficiency can be significantly increased.
A small pilot project was also implemented based on the recommendations developed to improve working conditions and ensure safety.

Initial results of the project showed that the efficiency of employees working in high temperature conditions increased by 15-20%, as well as significant improvements in safety conditions and employee well-being.

Learning function . The main goal of the study is to develop and implement effective approaches to ensure the efficiency and safety of firefighters in microclimatic conditions. To this end, the learning function was organized in the following main areas:

Identifying and assessing microclimate conditions: Determining the extent to which the microclimate affects physical and mental well-being by measuring and monitoring factors such as temperature, humidity, and air movement in the work environment. This step is the main entry point for the study and ensures an accurate assessment of real-world working conditions.

Physiological and psychological state monitoring: Continuously monitor the physiological indicators of firefighters (heart rate, respiratory rate, body temperature), as well as study the mental state through psychological tests and interviews. With this function, the impact of microclimate conditions on the human body and mind is expressed in clear indicators.

Statistical analysis of data: In-depth analysis of the obtained data using statistical tools, identifying correlations, and drawing scientific conclusions based on the results. This function ensures the scientific level of the research and makes the results reliable.

Development of practical recommendations: Based on the results of the study, develop specific and effective recommendations to improve microclimate conditions, optimize working conditions, strengthen safety measures, and define measures to protect the health of workers. This step will serve to make the study practical and effective.

Monitoring and Re-evaluation: Establish a systematic monitoring system to continuously monitor the effectiveness of recommendations as they are implemented and make changes as necessary. This function ensures that research results are continuously improved and remain relevant to current requirements.

This study function forms a comprehensive approach to improving the work efficiency of firefighters and protecting their health by improving microclimatic conditions. The mechanisms and methods identified during the study will be implemented in practice and serve as the basis for developing new standards and protocols in the military and emergency situations.

Development function. The development function of research is to determine long-term strategic directions aimed at improving the working conditions and increasing labor efficiency of firefighters based on existing results and studies. This function creates a basis for systematic development and the introduction of innovations, based on the problems and opportunities identified during the research process.

Technological development and innovation. The application of modern technologies and methods to improve microclimate conditions is a key part of the development function. This process involves the development of new monitoring tools, automated control systems, as well as ergonomic and microclimate-adapted models of personal protective equipment and workwear.

With the help of technological innovations, the working conditions of firefighters are significantly improved and the level of safety is increased.

Personnel training and advanced training . Continuously improving the skills of firefighters and developing educational programs aimed at learning new technologies and work methods is also an important part of the development function. The educational process aims to increase work efficiency by organizing special training on adaptation to microclimatic conditions, introducing stress management techniques and increasing physical endurance.

Continuous optimization of the working environment. The development function envisages the introduction of continuous optimization mechanisms through regular monitoring and analysis of the microclimate conditions of workplaces and the working environment. This will ensure adaptation to changing climatic conditions, efficient use of resources and preservation of employee health. Also, ways will be developed to improve and implement standard operating procedures prepared for emergency situations.

Conclusions and suggestions. The study was aimed at in-depth study of the issues of improving the working conditions of firefighters and their adaptation to microclimatic conditions, and a number of important scientific and practical results were achieved. During the study, the impact of microclimatic factors on the activities of firefighters, their negative and positive effects on their health were analyzed in detail. Also, modern technologies, methods of optimizing the working environment, and directions for improving the skills of personnel were identified.

The results showed that the effectiveness of fire and rescue operations is directly dependent on microclimatic conditions, and a systematic and integrated approach is needed to improve these conditions. This can be achieved through technological innovations, advanced training, and improvements in labor protection and safety policies.

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The main points highlighted during the study are that the use of modern technologies allows firefighters to be protected not only during the work process, but also during the preparation phase. Also, regular training and educational programs help to increase stress resistance of employees, strengthen their physical health and improve work efficiency. Constant monitoring and optimization of the working environment reduces risks and ensures effective action in emergency situations.

Proposals. Introduction of technological innovations. It is recommended to widely use advanced sensor systems and automated control methods for microclimate monitoring in fire and rescue services. This, in turn, will allow for real-time monitoring of the working conditions of employees and immediate response measures.

Regular training and advanced training of personnel: Special training should be organized annually for firefighters on adaptation to microclimatic conditions, stress management, and increasing physical endurance. Training programs should include more extensive coverage of experiences in the use of modern technologies and safety standards.

Improving working conditions: New methods of air purification, ventilation, and heat balance should be introduced in firefighter workplaces. It is also advisable to establish special services for constant monitoring of conditions.

Strengthening the regulatory framework: Laws and regulations related to improving the working conditions of firefighters should be constantly reviewed and updated based on international standards. For this, it is recommended to establish special working groups and study the experience of advanced countries.

Expanding research: Additional research is needed to develop new scientific directions on the impact of microclimate on the human body and its improvement. This will contribute to the development of innovations in the field of health and safety.

Optimization of work in emergency situations: It is necessary to improve standard operating procedures, taking into account microclimatic conditions, when organizing the work of firefighters. It is recommended to develop regulatory documents that take into account the physical and psychological state of these processes.

Development of international cooperation: Studying international experiences in improving microclimatic conditions in the field of fire and rescue and implementing innovative projects in collaboration with them will lead to effective results. Scientific exchange and training programs are of particular importance in this regard.

Based on these proposals, it is possible to significantly increase the efficiency and safety of fire and rescue workers. As a result, the effectiveness of protecting human life and property in emergency situations will be further enhanced, which will serve to increase the level of preparedness of our country for emergency situations.

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